Oxford Global Summit for Young Leaders (China)

01

Fall 2022

阿思丹 ASDAN China

Oxford Global

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This is a semi-annually journal publishing the essay that was awarded Essay Excellence Award at Oxford Global Summit for Young Leaders(China). The topic in our journal will cover six fields from Mathematics, Computer Science, Chemistry, Biomedicine, Economics to Psychology. The grading system is based on the following points:

1. How well you answered the question
2. How critical and evaluative you were in giving both sides of the argument
3. How you used your evidence (from the slides or for from further reading)
4. The structure of your essay or presentation (point, evidence, analysis, linkage)

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01 Mathematics

Oxford Global Summit for Young Leaders (China)

1 Mathematics

Expectation of world's population by year 2050

YING YAN, YANXI WANG, XINGRUI XIANG and XIAOYU TIAN

1 Abstract

Population is related to a country's prosperity and people's well-being, and together with capital and technology, it determines the potential growth rate of the economy. The population factor changes slowly in most periods, but in the transition period, the change speeds up and the trend sinks strongly. The global population is facing a major change in the upcoming years and the population boom is coming to an end.

2 Introduction

In general, the world population prospects is regarding as a concern that attaches great importance from the globe. There are different influence factors that might have an impact on the trend of population growth, including natural factors and artificial factors.

The United Nations released projections of global population growth over the coming century. In the year 2050 the world's demographics will look very different from today's The latest predictions for population growth from the United Nations indicate the Earth will be more crowded than previously thought. The global population is currently about 7.3 billion. The UN estimates that by 2050, that number will grow to 9.7 billion, which people will have to cram together on the Earth's surface.

3 Assumptions

As variations of situations in the unpredictable future might affect the current fixed model, some assumptions have been made to enhance the effectiveness of the model.

1. The model would only be functioned in a closed system which things are happening in spontaneity and in a natural manner under regular circumstances and natural evolution

2. Population structure isn't correlated with any governments' policies

3. Governments' policies to fertility remain unchanged

4. Other countries except China and India don't have policies that affect the birth and death rates, but follow the natural evolution instead.

5. The death factors are only separated into two, disease factor and non-disease factor. All non-disease factor are regarded as a whole, which its quantity can be derived from the formula of "Death — death from disease = death from non-disease"

4 Approaches & Methodology

4.1 Factors

4.1(1) Factors affecting fertility rate

1. Government legislation and policies for regulation of fertility rate
2. Age structure for China and India, and other countries' age structure will be estimated based on this

4.1(2) Factors affecting death rate

1. Diseases
2. Other factors（non-disease factors）

4.2 Mathematics model

The mathematical model, **Population= Constant(initial conditions)+fertility-death,** where fertility and deaths are to be found by further calculations

4.3 Derivation of formulas

Birth rate

We suppose that the rate of change of population due to birth in a region is directly proportional to the birth rate in that region, where B is the birth rate.

$$\frac{dP_{birth}}{dt} = kB$$

In China, the population structure is flat with massive mid-age people Where we suppose the aging of old people will form later years, meaning the rate of change of population increase will decrease.

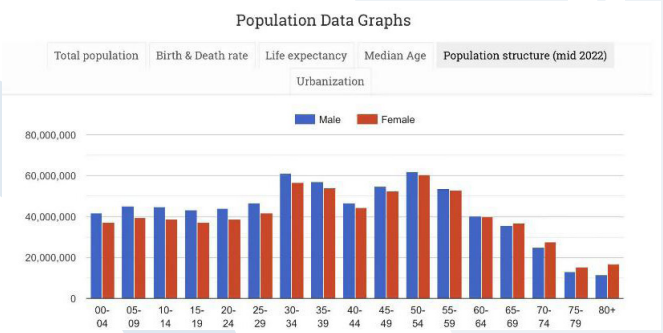

Figure 1

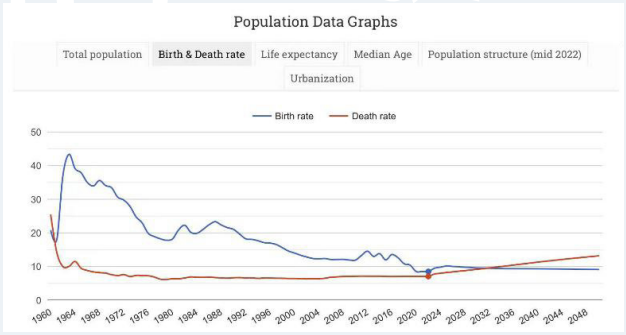

Figure 2

By the graph，from 1980 to 2020 the decreasing birth rate is directly proportional to the time.
For which we can write as:

$$B = k_2 t_{form1980} + C$$

By calculation the constant will be -0.2505 and will be 10.3722

Hence, for China, and by integration:

$$\frac{dP_{birth}}{dt} = k_1(-0.2505t + 10.3722) \text{ and } P_{birth} = -0.12525k_1t^2 + 10.3722k_1t + C_2$$

By initial condition the population in China in 2022, when t is 42, P_{birth} is 1531,

When t is 20, P_{birth} is 1374

And thus for China:

$$k_1 = 2.7377 \text{ and } C = 1543.239$$

The function is

$$P_{birth} = -0.3423t^2 + 28.396t + 1543.239$$

The population estimation is 1854 million.

China Population History

Show by | 10 years | 5 years | 1 year | main data | all data

YEAR	TOTAL	MALE	FEMALE	SEX RATIO	GROWTH RATE	BIRTH RATE	DEATH RATE	FERTILITY RATE	LIFE EXP., TOTAL	LIFE EXP., MALE	LIFE EXP., FEMALE	MEDIAN AGE	URBANIZATION
2022	1416 M	726 M	690 M	1.05	0.21%	8.52	7.07	1.70	77.10	74.95	79.41	38.12	63.56%
2020	1411 M	724 M	687 M	1.05	0.21%	8.52	7.07	1.70	77.10	74.95	79.41	37.42	61.43%
2015	1380 M	709 M	671 M	1.06	0.70%	11.99	7.07	1.67	75.93	73.79	78.29	35.70	55.50%
2010	1338 M	687 M	650 M	1.06	0.67%	11.90	7.11	1.63	74.41	72.48	76.57	34.03	49.23%
2005	1304 M	670 M	634 M	1.06	0.90%	12.40	6.51	1.61	72.99	71.30	74.85	31.57	42.52%
2000	1263 M	648 M	615 M	1.05	1.18%	14.03	6.45	1.60	71.40	69.60	73.41	28.98	35.88%
1995	1205 M	618 M	587 M	1.05	1.61%	17.12	6.57	1.66	69.89	67.92	72.10	26.35	30.96%
1990	1135 M	582 M	553 M	1.05	2.16%	21.06	6.67	2.31	69.15	67.45	71.00	23.86	26.44%
1985	1051 M	539 M	512 M	1.05	2.10%	21.04	6.78	2.65	68.47	67.00	70.02	22.55	22.87%
1980	981 M	504 M	478 M	1.05	1.87%	18.21	6.34	2.61	66.84	65.43	68.30	20.86	19.36%
1975	916 M	470 M	446 M	1.05	2.14%	23.01	7.32	3.86	63.92	62.53	65.32	19.28	17.40%
1970	818 M	420 M	398 M	1.05	3.40%	33.43	7.60	5.73	59.09	57.33	60.90	18.26	17.40%
1965	715 M	368 M	347 M	1.06	2.99%	37.88	9.50	6.39	49.55	47.96	51.26	18.76	18.09%
1960	667 M	344 M	323 M	1.06	-0.18%	20.86	25.43	5.76	43.73	42.43	45.19	20.26	16.20%

Figure 3

In India, the population is an upside-down triangle, meaning more proportion of young people.

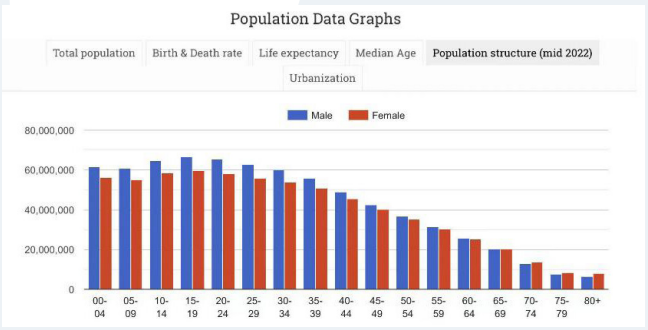

Figure 4

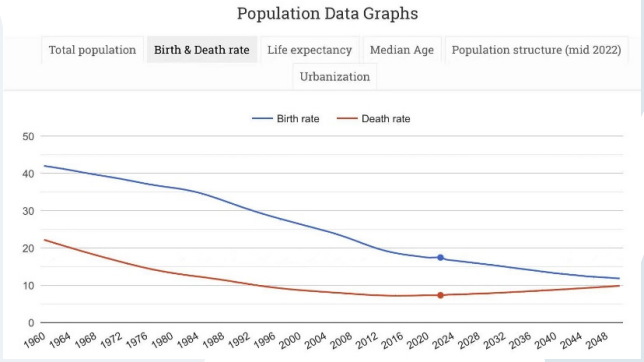

Figure 5

However, the graph illustrates that the birth rate is still decreasing.

Taking the same method, omitting the process the function for India population is (t is from 1980):

$$B = -0.30583t + 30.285$$

And the function will be :

$$P_{birth} = k_3(-0.1529t^2 + 30.285t) + C$$

The initial conditions will be when t =20 , $P_{birth} = 1180$, when t=42, $P_{birth} = 1684$

And thus for India: $k_3 = 1.02247 \text{ and } C = 623.223$

The function is $P_{birth} = -0.1563t^2 + 30.9655t + 623.223$

We estimate Population in India in 2050 will be 2025 million.

India Population History

Show by 10 years | 5 years | 1 year | main data | all data

YEAR	TOTAL	MALE	FEMALE	SEX RATIO	GROWTH RATE	BIRTH RATE	DEATH RATE	FERTILITY RATE	LIFE EXP, TOTAL	LIFE EXP, MALE	LIFE EXP, FEMALE	MEDIAN AGE	URBANIZATION
1960	451 M	233 M	218 M	1.07	0.89%	42.00	22.18	5.91	41.42	42.27	40.53	19.18	17.92%
1970	555 M	287 M	268 M	1.07	1.28%	39.11	17.19	5.59	47.74	48.35	47.10	18.32	19.76%
1980	699 M	362 M	337 M	1.08	1.72%	36.17	13.29	4.83	53.81	53.76	53.91	19.20	23.10%
1990	873 M	453 M	420 M	1.08	1.90%	31.52	10.86	4.05	57.87	57.54	58.23	20.09	25.55%
2000	1057 M	549 M	507 M	1.08	2.04%	26.40	8.69	3.31	62.51	61.73	63.33	21.71	27.67%
2010	1234 M	642 M	592 M	1.08	1.82%	21.11	7.49	2.58	66.69	65.72	67.73	24.10	30.93%
2020	1380 M	717 M	663 M	1.08	1.39%	17.44	7.30	2.18	69.89	68.68	71.20	27.43	34.93%
2022	1407 M	731 M	676 M	1.08	1.39%	17.44	7.30	2.18	69.89	68.68	71.20	28.05	35.87%

Figure 6

For the rest of the countries, we just use the global data to estimate it.

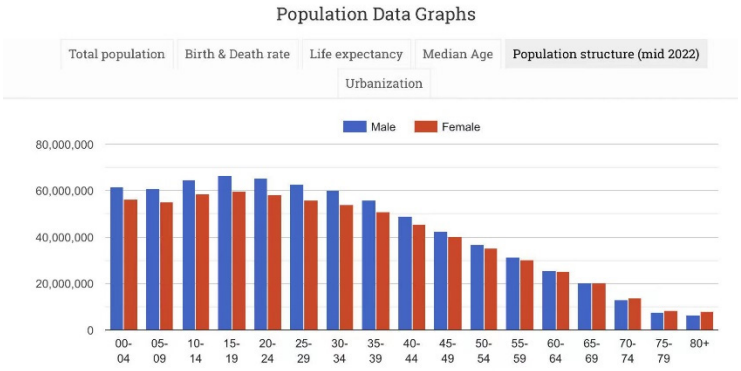

Figure 7

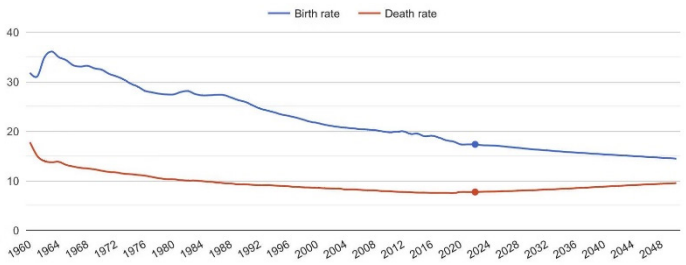

Figure 8

Taking the same method, omitting the process the function for India population is (t is from 1980):

$$B = -0.2416t + 27.33$$

And the function will be :

$$P_{birth} = k_4(-0.1208t^2 + 27.33t) + C$$

The initial conditions will be when t =20 , $P_{birth} = 3794$, when t=42, $P_{birth} = 5091$

And thus for the rest countries

$$k_c = 2.97 \text{ and } C = 2313$$

The function is

$$P_{birth} = -0.3588t^2 + 81.17t + 2313$$

The population will be 6236 million.

World Population History

Show by 10 years | 5 years | 1 year | main data | all data

YEAR	TOTAL	MALE	FEMALE	SEX RATIO	GROWTH RATE	BIRTH RATE	DEATH RATE	FERTILITY RATE	LIFE EXP, TOTAL	LIFE EXP, MALE	LIFE EXP, FEMALE	MEDIAN AGE	URBANIZATION
1960	3032 M	1516 M	1514 M	1	0.79%	31.75	17.71	4.98	52.58	50.74	54.61	21.65	33.62%
1970	3682 M	1845 M	1835 M	1.01	1.70%	32.38	11.99	4.78	58.58	56.58	60.75	20.52	36.55%
1980	4433 M	2226 M	2205 M	1.01	1.67%	27.42	10.27	3.71	62.84	60.77	65.09	21.60	39.35%
1990	5280 M	2655 M	2622 M	1.01	1.80%	25.88	9.23	3.25	65.43	63.29	67.75	23.04	43.03%
2000	6114 M	3077 M	3035 M	1.01	1.53%	21.65	8.55	2.70	67.55	65.41	69.87	25.33	46.69%
2010	6922 M	3488 M	3431 M	1.02	1.52%	19.78	7.85	2.52	70.56	68.43	72.84	27.46	51.65%
2020	7764 M	3913 M	3848 M	1.02	1.25%	17.33	7.71	2.39	72.75	70.57	75.06	29.88	56.16%
2022	7914 M	3988 M	3923 M	1.02	1.25%	17.33	7.71	2.39	72.75	70.57	75.06	30.33	57.01%

Figure 9

As for the diseases, about 55% (check) people died for it, but the death rate of diseases have been ameliorating for decades, so we suppose that the number of people died due to illness each year is directly proportional to the death rate since 1980.

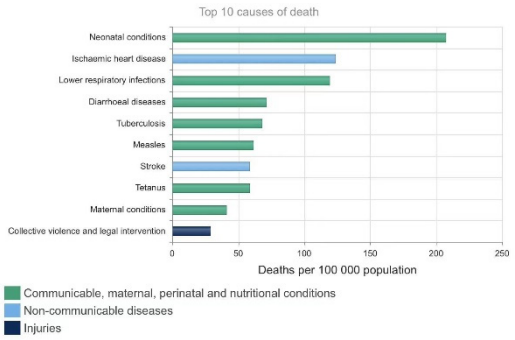

Figure 10

So, the percentage of death is actually about a constant, and for each 10years, the mean death population per year will be 60,000,000 per year and for 28 years, 280,000,000.

$$P_{total} = (P_{China} + P_{India} + P_{Other\ countries})_{due\ to\ birth} - death\ population$$

$$P_{total} = 6{,}236{,}000{,}000 + 2{,}025{,}000{,}000 + 1{,}854{,}000{,}000 - 1{,}680{,}000{,}000 = 8{,}435{,}000{,}000$$

5 Data collection & Analysis

5.1 Initial conditions

1. Global population at 2017, 2018, 2021

5.2 Boundary conditions

1. Time boundary

The boundary condition will be a set of range of time, which the experiment only seeks to predict the global population up to year 2050，with the given initial conditions

6 Evaluation

6.1 Improvements

6.1(1) Improvements on Model

- From aspect of mathematics:

1. Use different equation systems to ensure a wide range of mathematical applications

- From aspect of methodologies:

1. We shouldn’t regard the rest of the countries as a whole party when modeling. Instead, each countries are better to be regarded as an individual for enhancing accuracy of the model.

- From aspect of complexity:

1. Inferring coefficients for each functions before combining them into one.

7 Conclusion

After the investigation and the experiment, we conclude that our model isn’t that precise due to some unpredictable and unprocurable variables. However, we model all the data by the proximally accurate methodology and attempted to simulate a closest situations and approach to the most accurate and effective model.

8 References

[1]. Population of China: https://populationstat.com/china/

[2]. Population of India: https://populationstat.com/india/

[3]. Global population: https://populationstat.com

[4]. Top 10 causes of death

https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death

Expectation of Covid-19 cases in the year 2023-25

YIHANG XIAO, YAN XU and YUHAN ZHOU

Introduction

In this essay, we present a mathematical model aimed at predicting the number of Covid-19 cases in the year 2023-25. The main goal is to create a line graph showing the number of cumulative cases, projected from the data we have from 2020 up to now. All citations are placed beside the paragraph where relevant information is used. *This is the "rough paper" for the calculation: https://www.desmos.com/calculator/viehp9vwiw*

Approach

1.Find reliable data for the number of Covid-cases from 2020 up to now

2.It is impossible to analyze or visualize data from all counties, so we chose 6 representative counties (UK, Brazil, USA, Australia, South Africa and China), one for each continent, and we will build a prediction for each, using the same model

3.Plot their number of cases against time

4.Select our mathematical function for modeling, an improvement of the epidemic curve. We will use this twice, each time for different purposes

5.First usage of model: Using the equation for curve fitting. By using regression algorithms, we found the approximate value of the w, 'effective transmission rate', which is used in the model

6.Second usage of model: Prediction. Using the cases in 20/7/2020 (now) as the initial condition, we substitute it for i0 in the model. Also using the value of w we arrived at earlier, we produce the final predicted functions for each of the representative counties.

7.We multiply the cases predicted for each of the 6 counties by the ratio between the population of the continent they represent and their population. This way we get an approximate value for the number of cases in each continent.

8.Summing these numbers, we arrive at the global predicted cases.

Our model:

$$i(t,p) = \frac{1}{1 + \frac{1 - i_0}{i_0} e^{-w\,(1 - E * \frac{v(t,p)}{p})\,t}}$$

Where:

i(t, p) = Percentage of infected people at time t in a population of p people

i0 = Starting percentage of infected people

b = Effective rate of transmission

E = Efficacy of Vaccine, which we assume to equal 0.8

= ratio of vaccinated people to entire population p, of the selected country

Where:

$$v(t,p) = 0.67p * e^{-l(t-931)} + \frac{5.21 * 10^6 * \frac{p}{7.96 * 10^9}}{l}(1 - e^{-l*(t-931)})$$

Derivation of model:

Derivation of $i(t,p)$: Let where i=I/p I is the number of people infected in the total population of p people. Then using the same idea as the logistic equation, we have

$$\frac{di}{dt} = b * i * (1 - i)$$

Integrating, yields

$$i(t) = \frac{1}{1 + \frac{1 - i_0}{i_0} e^{-bt}}$$

Where we model b as a separate function of time

Specifically, b = $(1 - E * \frac{v(t,p)}{p})$.

From websites:

https://ourworldindata.org/covid-vaccinations

Duration of effectiveness of vaccines against SARS-CoV-2 infection and COVID-19 disease: results of a systematic review and meta-regression - The Lancet

We get the information that 66.8% of the world population has received at least one dose of a COVID-19 vaccine and 5.21 million are now administered each day. The second article says the average drop in efficacy of covid vaccine over 6 months is 21%. This means, assuming vaccine efficacy starts at 100%, we have:

$$(1 - \frac{21}{100}) = 0.79 = e^{-l*0.5} \quad (where\ l\ is\ decay\ constant\ and\ 0.5 is\ half\ a\ year)$$

$$l = -\frac{\ln(0.79)}{0.5} = 0.471$$

$$Finally, half\ life\ of\ vaccine = T = \frac{\ln(2)}{l} = 1.471\ years$$

Also, assuming a situation where a constant number of vaccines are administered each day, but the efficacy of the vaccine exponentially decays once administered. If N = total number of people vaccinated and that their vaccine is still efficient, V = number of new vaccines administered daily, l = decay constant, n=number vaccinated already: $\frac{dN}{dt} = V - lN$

Solving the differential equation gives: $N = ne^{-lt} + \frac{V}{l}(1 - e^{-lt})$

Substituting the value for n=0.67p, V=: $5.21 * 10^6 * \frac{p}{7.96 * 10^9}$

$$v(t,p) = 0.67p * e^{-l(t-931)} + \frac{5.21 * 10^6 * \frac{p}{7.96 * 10^9}}{l}(1 - e^{-l*(t-931)})$$

Assumptions

A: The representative countries can precisely represent all counties in their associated continent

(UK, Brazil, USA, Australia, South Africa, China)

1. Different counties have different policies

The way different counties operate affects how many people are infected directly. For example, in China, lockdown policies prevent possibly infected people to go to other populous places to infect others. This is not exercised in other Asian countries.

2. Different testing ability

Every country allocates a different amount of effort and resources into covid testing. If a lot of testing is done, it is more likely that the statistic is going to reflect the true level of cases, the opposite can be said of doing not enough tests.

3. Population/Environment

The infectiousness of a virus depends a lot on the environment. For instance, greater population density means it's easier for the virus to spread.

These 3 assumptions all affect the prediction's accuracy when we perform step 8 in our approach.

B: Correctness of our model

1. Incomplete description

The way our model is derived relies on people moving ceaselessly, the number of infected people and uninfected people in a perfect mix, infected people also don't get cured and will continue to infect others

2. It does not consider all countermeasures against the virus, such as lockdown and closing up borders of a country. It is just impossible to consider all of them. But it does consider the increase in the percentage of people getting vaccinated and the waning efficacy of the vaccines over time

3. In step five of our approach. We substituted (p-1) for $\frac{1-i_0}{i_0}$. As $\frac{1-i_0}{i_0} = \frac{1}{i0} - 1 = \frac{p}{i} - 1.$ And here we assumed i = 1. In other words, in every country, 1 person is infected on 1/1/2020. This is not true, for example, China has 0 cases on 1/1/2020 and 1 case on the day after. Brazil only began to have 1 case at the start of February that year. We assumed this, first, because it simplifies calculations, secondly, because there were likely cases not discovered before the first positive test.

4. Infected people don't die

See more related assumptions in the derivation section.

Initial conditions

1.The number of cumulative cases in the UK, Brazil, USA, Australia, South Africa, and China on 20/7/2022 - the latest data available. We substitute these numbers, i_0, in the model for the corresponded country.

2. 66.8%. percent of people were vaccinated with at least one dose on 20/7/2022. So, 0.668p for a country with population p

3.Now, about 5.21 million new doses of vaccine are administered each day.

Citations

(1): https://covid19.who.int/WHO-COVID-19-global-data.csv

(2) and (3): Coronavirus (COVID-19) Vaccinations - Our World in Data

Boundary conditions

1.Time when model finishes, last day of 2025

2.Cumulative cases cannot exceed 7.96 billion, the total population of human, assuming each person can only catch covid once

(2): World Population Clock: 7.96 Billion People (2022) - Worldometer (worldometers.info)

Calculations

Step1: Plot past data

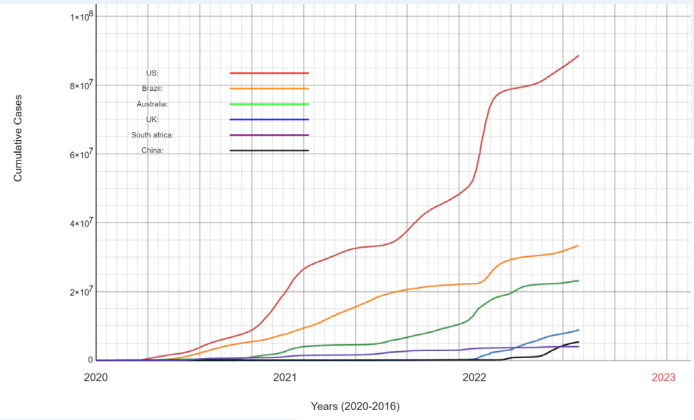

Figure 1

Step2: Use the model for curve-fitting, using least square regression to get the w value, effective rate of transmission, for each country.

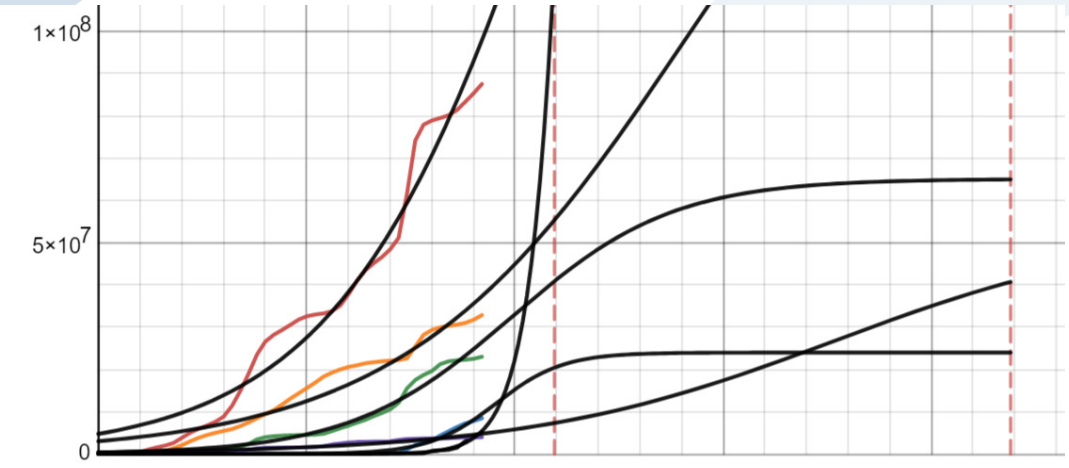

Figure 2

This is the curve fitting with our model visualized.

Doing regression on the curve for each country, we yield a sequence of w's. They are named $w_i \; for \; i = (1,2,3,4,5,6)$. For instance, this is the regression done on the USA.

$$Y_{us} \sim \frac{3212 \cdot 10^5}{1 + \left(3212 \cdot 10^5 - 1\right) e^{-w_1 (T-1)}}$$

STATISTICS

$R^2 = 0.963$

RESIDUALS

e_3

PARAMETERS

$w_1 = 0.00366034$

Step3: Calculate the term $\frac{\mathbf{1 - i_0}}{\mathbf{i_0}}$ for each country with i0 being the number of cases on 20/7/2022.

Having stored the cumulative cases data for each country in a list. The term should be $\frac{p}{\max \; (list)} - 1$ for each country's list. Where p is the population of the country. As an example, for USA and Brazil, they will be named as w_{us}, w_{br} respectively.

Step4: Use the model to find the equation for each country.

$$f_{US}(x) = \frac{3212 \cdot 10^5}{1 + w_{us} e^{-w_1 V\left(x, 3212 \cdot 10^5\right)(x - 921)}}$$

Here we substituted w_{us} obtained in step 3, obtained in step 2, USA's population $3212 * 10^5$.

Do the same for the other 6 countries.

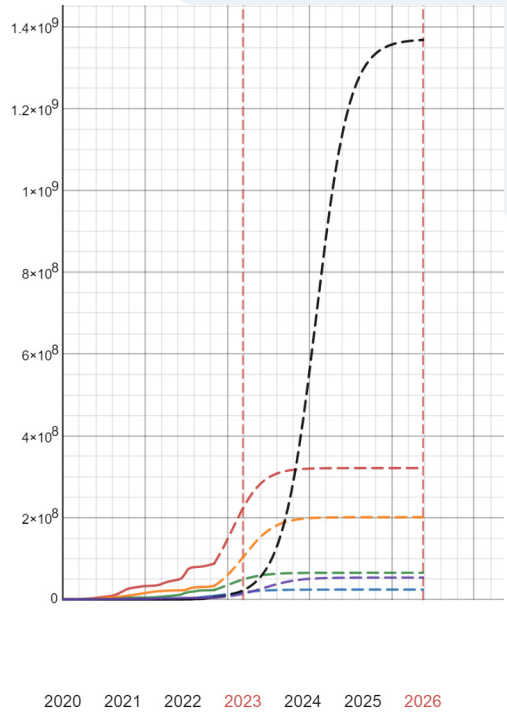

Figure 3

The dotted curve is the curve predicted by the model for each of the 6 countries

Step5: We obtain a table of results for the ratio of the population of the continents and their representative country.

(The abbreviations are for North America, South America, Europe, Australia/Oceania, Asia, Africa)

$$N_A = \frac{600292136}{3212 \cdot 10^5}$$

$$N_A = 1.868904533$$

$$S_A = \frac{436816608}{201 \cdot 10^6}$$

$$S_A = 2.17321695522$$

$$E_U = \frac{743147538}{65.08 \cdot 10^6}$$

$$E_U = 11.4189849109$$

$$A_U = \frac{45038554}{24 \cdot 10^6}$$

$$A_U = 1.87660641667$$

$$A_S = \frac{4721383274}{1.37 \cdot 10^9}$$

$$A_S = 3.4462651635$$

$$A_f = \frac{1426730933}{53491333}$$

$$A_f = 26.6721888011$$

Data from:

Population by Continent 2022 (worldpopulationreview.com)

Step6: Finally, we take the weighted sum:

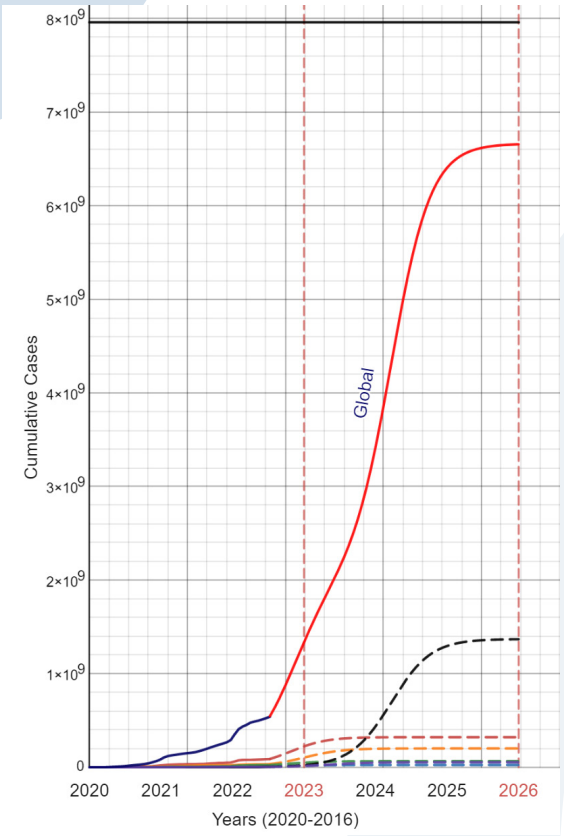

Figure 4

$$N_A f_{US}(x)+S_A f_{BR}(x)+A_U f_{AU}(x)+E_U f_{UK}(x)+S_A f_{SA}(x)+A_S f_{CH}(x)$$

Where the $f_{BR}, f_{AU}\cdots$ are functions of the form described in step 4. And this is the curve for the number of cumulative cases globally, from 20/7/2022 to 31/12/2025

Interpretation of the final result:

You can see the bright red curve is the predicted curve for the global cases.

At the start of 2023, the model predicts 1.337 billion people will be infected.

The model predicts a continuous increase in the rate of infection starting from now up to 2024. From then on, the rate decreases, and it reaches a plateau in the middle of 2025. By the end of 2015, there will be 6.65 billion cases in total, which makes up 83.5% of the world's population.

Also, note that while from 2020 up to now, China (black line) has the second lowest cumulative cases, but the model predicts cumulative cases in China will rise to become the highest of the six countries.

The main reason being China has the highest population, so there are "more potential" for increase. As you can see in the graph, its value keeps increasing all the way to 2016, while that of other countries stops at around 2024. On a larger scale, this means cases from Asia will contribute the highest percentage of global cases from 2023 to 2026.

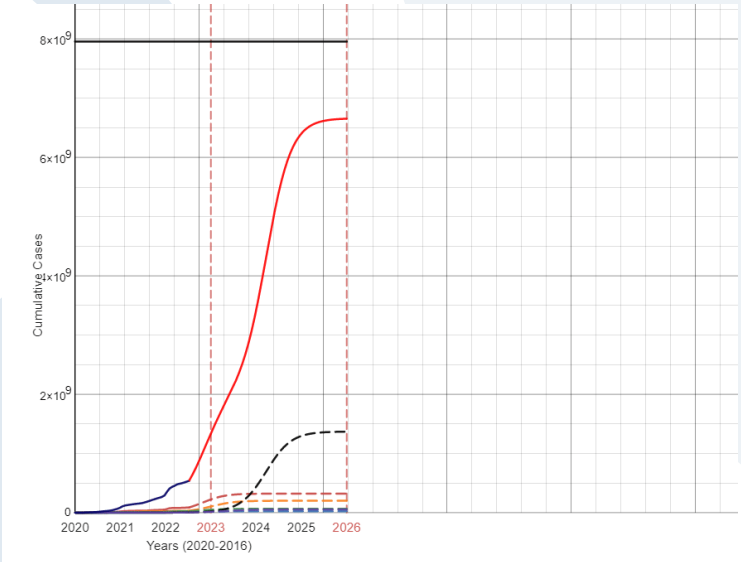

Figure 5

Related observation

By adding 0 up to 900 to the half-life of the efficacy of the vaccine, the number of cases is seen to decrease dramatically, with the range of 3.3 billion. The curve also flattens out earlier as well. It just shows quantitively and very visually how much can be prevented if the vaccine's effect can last longer.

Project-Expectation of world's population by year 2050

JIANYUAN REN, NINGKE SUN, BOYI HUA, PEIYI CHENG and YINAN TIAN

Chapter One Introduction

1.1. Problem statement

With the development of science and technology and the improvement of medical and living standards, the increase of population has also led to the intensification of population aging, which means that in the future, perhaps in 2050, the labor force will decline significantly, the social burden will increase, and the potential economic growth rate will gradually decline. At the same time, too many people will also have a large or small impact on the environment.

Population changes will have an impact on the country's basic policymaking, social welfare arrangements and labor distribution. The continuous reduction of fertility and mortality will lead to a substantial increase in the elderly population. Our population prediction model can roughly estimate the population in 2050. The government can prepare in advance through the population prediction model, and appropriately modify policies or formulate laws to ensure the stability of the country.

1.2. Introduction

The world population has been growing very fast over the past few decades. The current world population is 7.95 billion.

There are several key factors that influence world population. They include death, birth, immigration and emigration. In the context of this project, we shall only consider birth and death because immigration and emigration take place in the same world limit.

Moreover, we can see that there are so many factors that may affect the population, and in the essay, we collected the birth rate and mortality rate from 1990 to 2022 and drew a line chart to predict the birth rate and mortality rate from 2022 to 2050.

Factors influencing birth rate:

-Policy -Education

-Religion -Countries

Factors influencing death rate:

-Economic factors

-Climate & Environment

-Medical level

Chapter Two Research

2.1. Approach (Where we test our assumption)

For our project, we communicate with each other and list those conditions and assumptions that can affect our expectations. After our description, we find that the change of fertility rates and the death rates are easier to describe the total change of the population, they are convenient to search, and the databases are safe enough. Those datum mostly comes from the United Nation database, which accuracy can be promised. They give us the chance to predict the population at that time based on our database, so we choose fertility rates and death rates as the core of our prediction and model.

As for the period, we start from 1960 and end with the present day to predict the future datum. We find the total fertility rates and death rates all over the world and build the model on top of them and draw graphs of them. The function is also available after the graph is clear. Those functions can help us yield the change and trend of the fertility rates and death rates, from them we can see how they change, in which period it is growing rapidly and in what parts its gentler. Then using the area between our two lines can help us to describe the increased parts between that time. In this process, we get a quadratic equation for fertility rates and a logistic equation for death rates. At last, we plug in the number we want and integrate the two functions to get the total change at that time, between 1960 and 2050. Using the population at that time and summing it with this number, we can get our expectations.

2.2. Assumption

(https://population.un.org/wpp/Graphs/DemographicProfiles/Line/900)

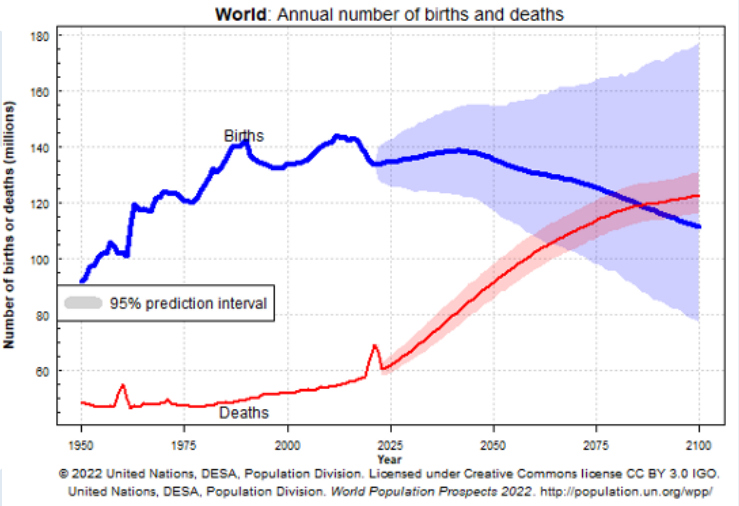

Figure 1

According to the data published by the united nation, we draw the line graph. If we place it with a smooth curve, then we could figure out that the curve is similar to that of the hyperbola. So, we use the equation to describe it. $y = -\frac{3}{160}(x - 2015)^2 + 150$

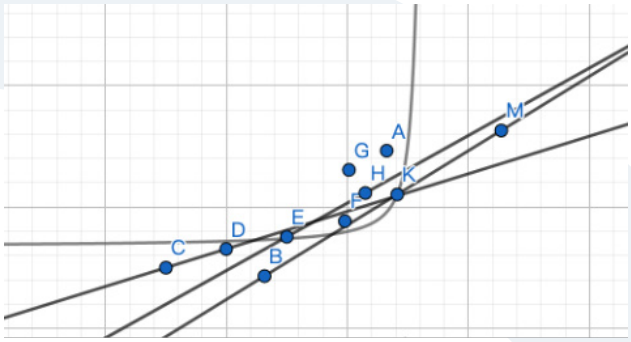

Figure 2

As for estimation of the death number, we plot some dots which is correspondent to the data collected between 1980 and 2000. And we observed that the trajectory can be described with logistic equation approximately. $\frac{dy}{dx} = \frac{2}{75} y \left(1 - \frac{y}{135}\right)$

2.3. How to interpret it

1. The 20th country is the country of technology boom coupled with rapid increase in population. And now it's the end for most of that generation. So, we can find that the increase rate of death is comparatively high recently.

2. Because the population is much higher than that in the past. So, it is understandable that death rate is higher.

3. We should omit year 2020 in calculation.

2.4. Initial condition

1. Birth rates (1990-2020) (people per thousand): about 17 people per thousand in 2020

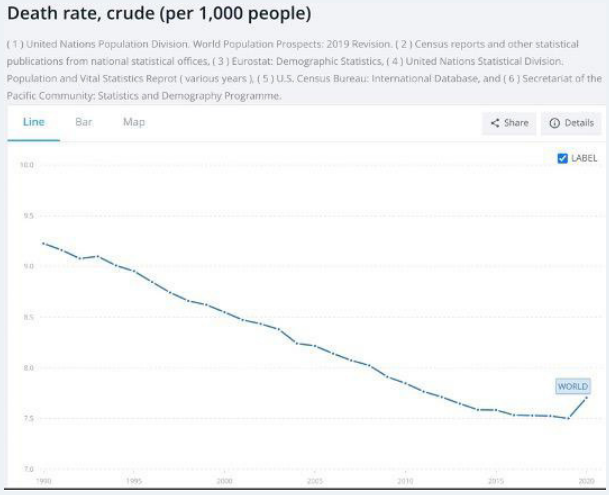

Figure 3

2. Death rates (1990-2020) (people per thousand): about 8-9 people per thousand in 2020

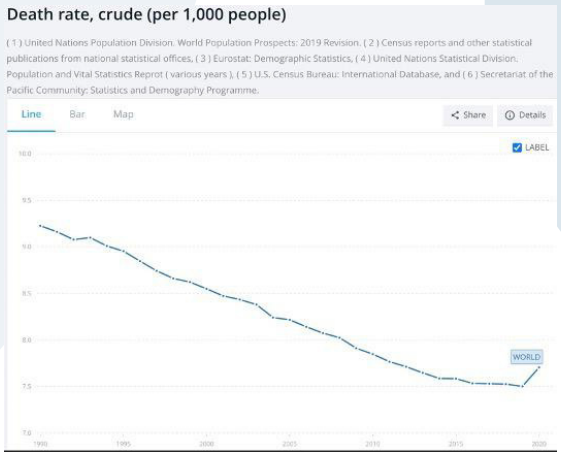

Figure 4

3. Annual growth rate of world population (1700-2019): 1.08% in 2019

4. World population (1700-2019): 7.7 billion in 2019

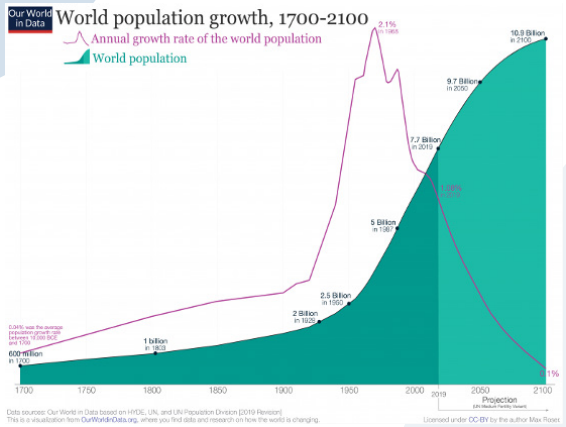

Figure 5

5. Population growth (1990-2020): over 80 million in 2020

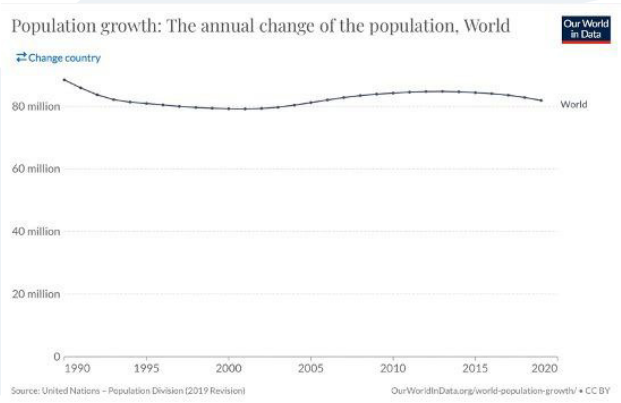

Figure 6

6. World population (1990-2020): 7794798739 in 2020

year(July 1)	population
2020	7794798739
2019	7713468100
2018	7631091040
2017	7547858925
2016	7464022049
2015	7379797139
2010	6956823603
2005	6541907027
2000	6143493823
1995	5744212979
1990	5327231061

Figure 7

7. World population yearly change rate (1990-2020): 1.05% in 2020

year(July 1)	Yearly(%) Change)
2020	1.05%
2019	1.08%
2018	1.10%
2017	1.12%
2016	1.14%
2015	1.19%
2010	1.24%
2005	1.26%
2000	1.35%
1995	1.52%
1990	1.81%

Figure 8

8. Yearly Change (1990-2020): 81330639 in 2020

year(July 1)	Yearly Change
2020	81330639
2019	82377060
2018	83232115
2017	83836876
2016	84224910
2015	84594707
2010	82983315
2005	79682641
2000	79856169
1995	83396384
1990	91261864

Figure 9

9. Median Age (1990-2020): 30.9 in 2020

year(July 1)	Median Age
2020	30.9
2019	29.8
2018	29.8
2017	29.8
2016	29.8
2015	30
2010	28
2005	27
2000	26
1995	25
1990	24

Figure 10

10.Fertility Rate (1990-2020): 2.47% in 2020

year(July 1)	Fertility Rate
2020	2.47%
2019	2.51%
2018	2.51%
2017	2.51%
2016	2.51%
2015	2.52%
2010	2.58%
2005	2.65%
2000	2.78%
1995	3.01%
1990	3.44%

Figure 11

2.5. Boundary condition

1. From 2020, January to 2050 January.

2. We used Africa and India as our regions, because as the world population prospects 2022 said, more than half of the projected increase in global population up to 2050 will be concentrated in Africa and India, and India is projected to surpass China as the world's most population country during 2023.

2.6. Calculations & Results

2.6.1 The first approach to calculation : Prediction with calculus

We use this formula $y = -\frac{3}{160}(x-2015)^2 + 150$, and make a definite integral. The upper and lower limits are 2050 and 2022 respectively ($\int_{2022}^{2050} -\frac{3}{160}(x-2015)^2 + 150$) . From this, we can roughly estimate that the number of new populations in these 28 years is about 3.934 billion.

In addition, In the same way, we can get that the number of deaths in these 28 years is about 2.144 billion, so we can get that the population has increased by about 1.79 billion in these 28 years. Therefore, through our model analysis, we predict that the population will reach 974 billion in 2050.

2.6.2 The second approach to calculation : Statistical linear regression

Using linear regression to predict the world population

First, we load getCsvData. In the file, we send the file name as the only function argument, which returns an array of cells with Year as the first column and Population for that year as the second column.

```
function data_reshape = getCsvData(filename)
%GETCSVDATA load the csv data into cell array

    fileID = fopen(filename,'r');
    % Start row is 1 since the first line is the heading (name of the columns)
    startRow = 1;
    data = textscan(fileID, '%d %d\n', 'Delimiter', ';',...
        'HeaderLines', startRow,'ReturnOnError', false);
    fclose(fileID);

    [M N] = size(data{1,1});
    data_reshape = cell(M,2);

    for i=1:M
        data_reshape{i, 1} = data{1,1}(i);
        data_reshape{i, 2} = data{1,2}(i);
    end
end
```

Figure 12

After plotting the data, we get the chart below as a visualization of the actual population.

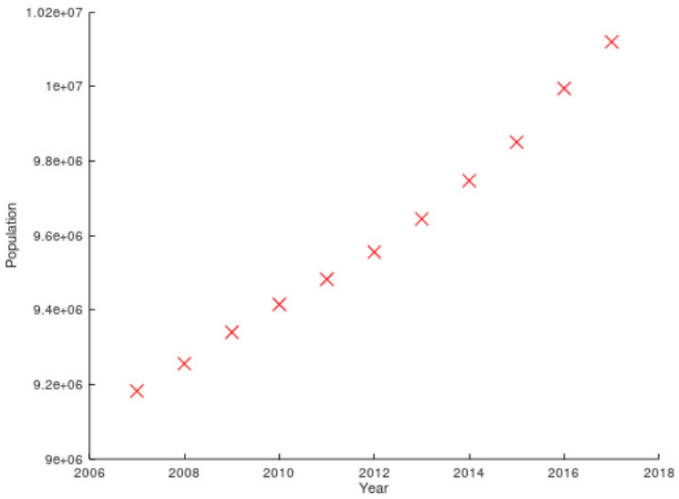

Figure 13

We used a gradient descent algorithm to optimize the cost function shown in the figure below, or in other words, to find θ_0 and θ_1 values that return the lowest value of the J function.

$$J(\theta_0, \theta_1) = \frac{1}{2m} \sum_{i=1}^{m} \left(h_\theta(x^{(i)}) - y^{(i)}\right)^2$$

The general Gradient Descent formula is

$$\frac{d}{d\theta_0} J(\theta_0, \theta_1) = \frac{d}{d\theta_0} \left(\frac{1}{m} \sum_{i=1}^{m} \left(h_\theta(x^{(i)}) - y^{(i)}\right)^2 \right)$$

It takes the partial derivative with respect to θ. Using calculus, we know that the slope of a function is the derivative of that function with respect to some value.

We moved on to the code implementation of the gradient descent algorithm. Here we use matrices to compute the values.

```
function theta = gradientDescent(X, y, theta, alpha, num_iters)
%GRADIENTDESCENT Performs gradient descent to learn theta
% by making num_iters number of iterations with step alpha

% Initialize variables
m = length(y);

for iter = 1:num_iters
    % Calculate step by formula
    step = (alpha/m);
    % Calculate difference between expected and predicted values
    matrix = (X * theta) - y;
    % Adjust the theta values
    theta = theta - (step * (X' * matrix)) ;
end
end
```

Figure 14

Next we use the function below to get the theta values.

```
% Choose some alpha value
alpha = 0.1;
% Set number of iterations
num_iters = 400;
% Initialize theta
theta = zeros(2, 1);
...% Init Theta and Run Gradient Descent
theta = gradientDescent(X_norm, y, theta, alpha, num_iters)
```

And this represents the linear equation:

```
h = 300261.58789 * x + 9599389
```

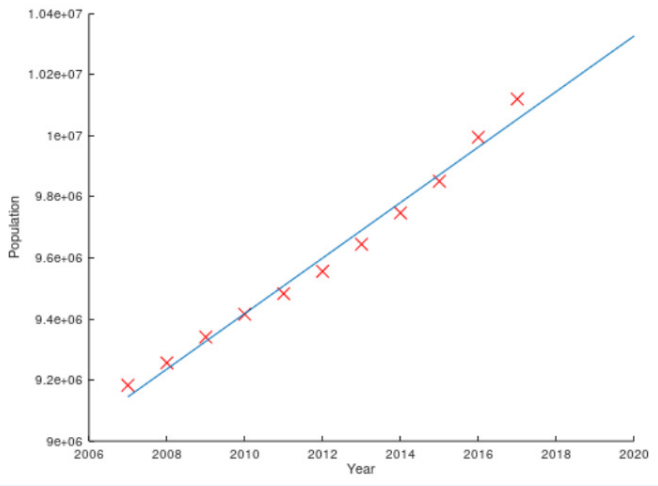

Figure 15

Now that we have the value of the equation, we should make a population forecast for the next few decades. Let's calculate the projected population in 2050.

In Gradient Descent, since we have completed feature normalization, it is important not to forget feature normalization before we use variables themselves and for prediction.

```
% Predict population for 2050
pred_year = 2050;% Dont forget to normalize the feature
before prediction
pred_year_val = (pred_year .- mu)./sigma;% Add first column
pred_year_norm = [1 pred_year_val];% Calculate predicted
value
pred_value = pred_year_norm * theta;
```

So here the predicted population in 2050 is also 18 447 698k people.

2.7. Conclusion

In conclusion, I will summarize all point that we made and our basic intention. It is very pertinent to estimate global population because of the significant impact it has on global well-being. We estimated that the world's population by the year 2050 will be 18 447 698k people. We considered loads of different factors including birth rate, death rate and migration, so it is quite accurate. It is actually very important for us to predict the world population since the problem that is carried by population explosion has been intensified quite seriously.

Reference

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02 Computer science

Oxford Global Summit for Young Leaders (China)

2 Computer science

How AI and ML can be applied in national internet security and its sub-unities, with viable precautions

HAOYU WANG, HAO LI, LIUHAICHEN YANG

Introduction

In many parts of the world, governments emphasize national cybersecurity (internet security). Related internet security systems have been widely studied in many branches of artificial intelligence (AI), from computer vision to robotics. Among all those categories, machine learning (ML) could be regarded as the most multiuse and non-specific method. Summarized to Anthony (2022), over $28 billion was funded in machine learning applications, and over $14 billion was invested in the machine learning platform, which occupies the most in the field of AI. As asserted by Columbus (2020), this value will continue to increase soon. This essay will first focus on the importance of national internet security and elementary factors in AL and ML during application in its subunits, followed by a specific example of an algorithm. Available precautions and some ethical dilemmas will be included as well.

Application of AI and ML

With the capacity to simulate human intelligence (Oxford University Press, n.d.), AI is applied in various industries to free up labor forces and provide compliant services. The applications of AI nowadays mainly focus on the AI's abilities to process information and robotics (Babuta, Oswald & Janjeva 2020; Hunter et al. 2018). Compared with humans, AI bears constancy, efficiency, and accuracy when facing mass data and doing repetitive work. One simple usage of AI, as proposed by Babuta, Oswald, and Janjeva (2020), is to collate resources. By scanning solid books, processing videos and audios with the help of NLP (Natural Language Processing), and analyzing online documents, artificial intelligence can swiftly classify mass information into distinct categories. We can utilize this ability of AI in online information documenting works in libraries or databases. Furthermore, this ability to process data also allows AI to act as an online filter: AI can separately predict the preference and orientation of its users based on their behavior history of them. In standard cases, online recreation industries utilize the ability of AI to customize the recommended goods for every customer (Covington, Adams & Sargin, 2016). In the information security field, we can make use of this online behavior analysis and predict the capacity of AI to screen malevolent users according to their past behaviors, which AI recorded as potentially damaging (Babuta, Oswald & Janjeva, 2020). Thus, AI would prevent harmful attacks from happening.

Robotics requires AI to run machines automatically and respond to the changing environment in real situations. Murphy (2019) asserts that it often involves the positioning system and sensors to make up an AI-monitored robot. The primary function of AI in that robot is to process real-time data transferred from various sensors and then manipulate the machine to respond to the situations confronted in the given time. The applications of AI in robotics include auto security systems, self-driving cars, and on and on. However, AI is not a thing that can serve various functions by just putting it to work. AI, like a human, starts from infancy and grows up as it absorbs information. Machine learning is the strategy that trains AI to be capable of its job. Machine learning involves inputting mass data to the AI through suitable algorithms - different algorithms would be designed for various uses (Bishop, 2013). One machine learning application instance is NLP (Akella et al., 2017). In this case, machine learning help AI understands and classify words in audio and visual ways. Thus, AI can categorize and evaluate expressions or be a Chabot like Siri on iPhone.

AI in national security

Despite potential severe hazards brought by the collapse of cyber security, there are still several possible precautions for it. Many methods can be adopted at different stages. On a national level, we can build an AI infrastructure in case of future risks. This system should combine the data collecting procedure, machine learning models, and control systems. Before being stored in the database, data from various data sources must be cleaned by the filter algorithms. Data from previous real hacking or simulation hacking and the data from ordinary users should be considered. These data can be labeled with corresponding sources for training the ML models. Any existing record of network attacks needs to be considered, such as the characteristics of the code used by the hackers and the time when the hackers broke into the system. We can also apply this research idea to ordinary people and study when ordinary users use characteristics, such as login duration and response time when encountering problems. Those mentioned data can be input into our training models and algorithms with the correct source labeled. To train our machine learning algorithms to anticipate, identify and infer possible attacks, and potential dangers in future operations. As Xenonstack (2022) mentioned, pattern-matching algorithms may fit best during this classification procedure. Therefore, it will make a response in time. Besides informing the programmers and relative authorities about potential dangers, AI-self-defense systems can also be developed with the help of the neuron network to carry out spontaneous humanlike protection. Some people might stress that AI can only work to discriminate in some cases but cannot be completely invulnerable. However, it is an actual network attack event. If the AI once identifies a potential threat, closes the database, and cuts off the server, the system may crash temporarily,but the data is not lost. In turn, the outcome is undoubtedly better than the previous one of doing nothing. This system can become one of the national infrastructures of the network, and can be widely used in the government, research, and medical systems. This designed procedure must be done as soon as possible because it must be faster than hacking. So, it will be facilitated by a computer with more computing power, which might cost billions of dollars.

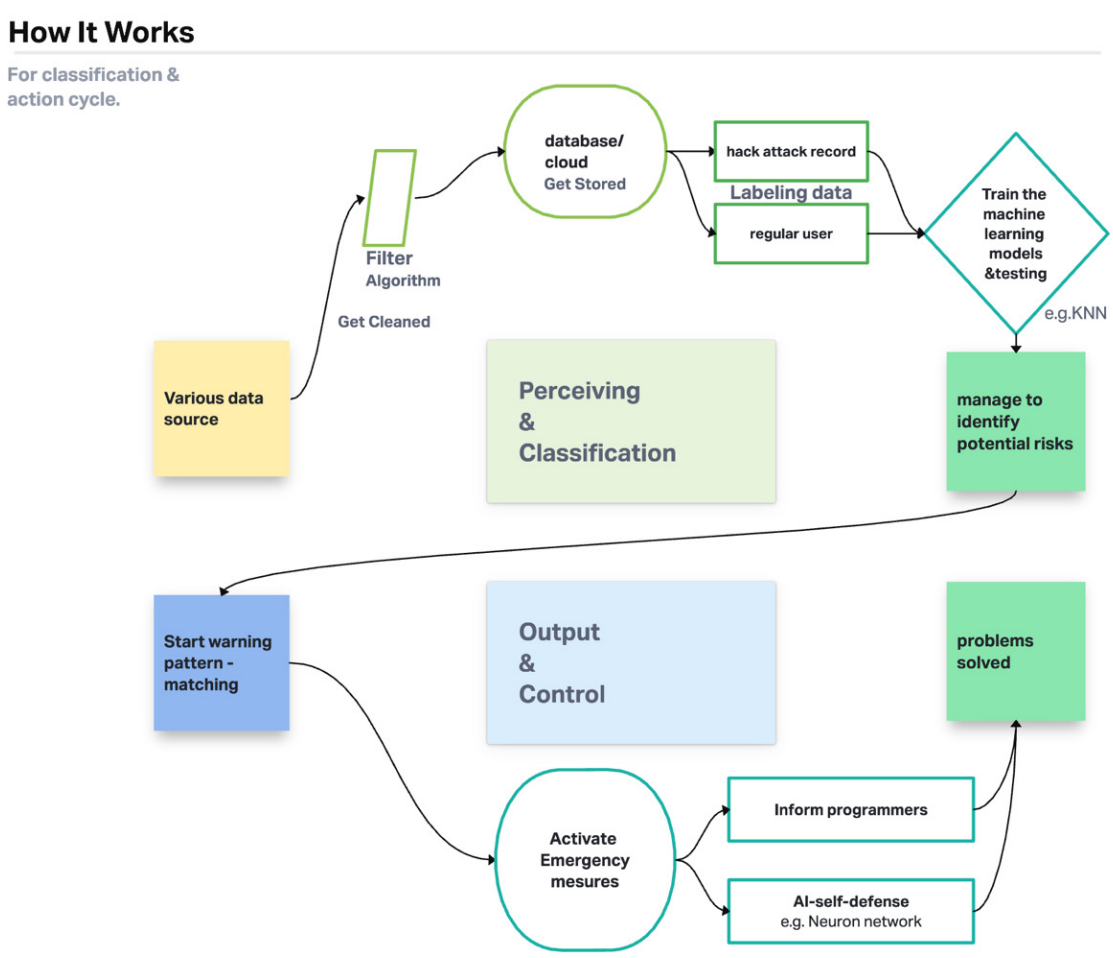

Figure 1

There is a reason why many nations take cybersecurity seriously, as it is closely related to plenty of crucial units in one country. Once this system collapse, it may lead to a severe consequence. Without cybersecurity systems, our websites and social media would make no difference with the dark web. After being intervened by the wrong parties, the censorship on the Internet might fail at once. Tweets and messages containing wrong values may spread on social media, which could work as agents for cybercrime and crimes in the real world. For example, information about serious crimes, such as organ trafficking and human trafficking,could no longer be regulated. Thus, factors of social instability eventually increase in the whole society. Also, countries may suffer a lot from cyberattacks because some top secrets would likely be stolen or tampered with during this period. Leaking important military information may put a country at a diplomatic disadvantage. Simultaneously, valuable databases from scientific research may be infected with a computer virus, which would then become invalid. Not to mention the economic system, the loss of a cyberattack can be measured in seconds. In addition, many internet-dependent communication systems may fail as well. In this case, the governors would not even be able to communicate.

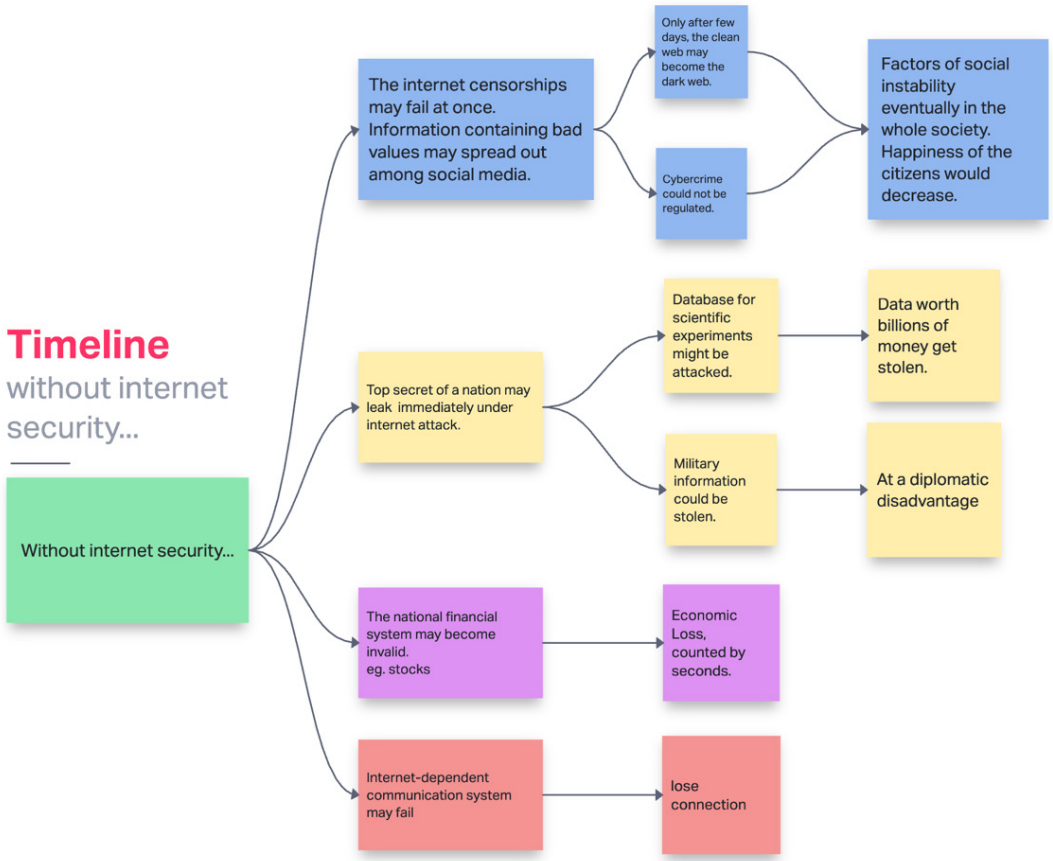

Figure 2

Interestingly, ordinary users do not usually pay attention to our web privacy. We often agree to use our data because we do not want to spend time reading lengthy Terms of Service. A 2017 report by Deloitte estimated that 91% of users do not read terms of service, rising to 97% amongst those under 35. The government collects CCTV data at the national level, especially for facial recognition technology, without consent. Machine learning can monitor data and pinpoint anomalies, but hackers can use it to increase the impact of their actual cyberattacks. To secure users' information and the database, the protection of the AI system is essential. If there is even a remote vulnerability in the "security and privacy by design" principle, the complete ecosystem could crumble if uncovered by attackers. (Reger, 2021) Therefore, every participant in the development and execution of AI must work toward interoperable and assessable security, and the encryption of communications and private data is essential. Besides, hardware should be protected from physical attacks as it is where the data is stored.

To protect many types of data, as it is precious, some policy proposal needs to be considered when AI is applied in our life. For the safety protection of individual data, the government should make relevant laws and policies to ensure that any relevant legal, security, and privacy risks are accounted for. Countries that have proposed or implemented security-focused policies for AI have emphasized

the importance of transparency, testing, and accountability for algorithms and their developers. In the United States, the National Security Commission on Artificial Intelligence (NSCAI) has highlighted the importance of building trustworthy AI systems that can be audited through a rigorous, standardized documentation system. To that end, the commission has recommended the development of an extensive design documentation process and standards for AI models, including what data is used by the model, what the model's parameters and weights are, how models are trained and tested, and what results they produce. These transparency recommendations speak to some of the security risks around AI technology. However, the commission has not yet extended them to explain how this documentation would be used for accountability or auditing purposes. (Wolff, 2022)

There is no doubt that AI benefits national security a lot. The increased use of computing techniques and the Internet have combined to boost a significant rise in data that can be analyzed. We benefit from the data, and our growing recognition of their value makes a tremendous growth in data storage. Data collection is all-embracing, and a massive volume of them is related to individuals: locations, shopping histories, travel histories, and Internet browsing histories, to name just a few. Therefore, data governance becomes an important question when we apply AI to society and consider its social impacts.

Ethic

AI is a promising technology for us as it provides chances to improve our lives. However, there is a risk that AI will only benefit people wealthier and live in more technologically advanced areas. For example, in the banking system in a middle-income country such as China, there are some developed cities and many backward areas in China. Suppose the government applies the AI defense system to banking. In that case, it is challenging to collect everyone's data in a short time due to the vast population in China, and people unfamiliar with the Internet would not be able to use the new technology. So, the new security method would only initially benefit people in progressive cities and affluent areas, which would make the people who are not using new AI security technology become the prime targets of cybercrime attacks because their data is less defensive. So, whether AI can benefit everyone in society is still a controversial problem. Therefore, people who are not used to customized AI systems or those who do not have access to it during their life might find it hard to adapt to it, as the system tend to be designed to incline to more affluent members. Last but not least, although the cookie policies of many websites suggest that they are not compulsory, peoplewho reject those options can be treated with restrictive functions of the website. In some cases, they might be forced offline only because they refuse to participate in data collection.

Conclusion

To sum up, in contemporary national cybersecurity, there are divergent controversies, introducing more uncertainty to our lives. AI and ML could be optimal solutions for current circumstances. Our answer might not be perfect, but it is an innovative attempt. We believe that AI and ML will be qualified for their job within the moral boundary.

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Oxford Global | Oxford Global Summit for Young Leaders (China)

Earthquake Prediction System based on machine learning technology

SHANGYUAN LI, YUXUAN FU and SHICHUAN WANG

Abstract

In recent years, the improvement of computer performance makes machine learning more and more widely used in geophysical research. The application of pan, especially in geophysical exploration, is progressing very rapidly. However, machine learning in the field of earthquake prediction is still in the early exploratory stage. This paper mainly discusses and designs an earthquake prediction system with Machine Learning. The system includes long - term and short - term forecasting. At the same time, machine learning can improve the accuracy of prediction.

Keywords: Machine Learning, Earthquake Prediction, Data Analysis

1 Introduction

1.1. Background

Earthquake is a type of highly destructive natural disaster. In China, earthquakes of magnitude five or more takes place more than twenty times every year, causing losses of billions of dollars. Thus, being able to predict and prepare for upcoming earthquakes is necessary to reduce the losses in terms of public health and the economy. Most of the current earthquake-predicting methods are based on the geomagnetic changes, the crustal deformations, the changes of chemicals in underground water, etc. Earthquakes at smaller scales can also indicate the patterns of the upcoming and probably more destructive ones. Having too many factors to consider makes predicting earthquakes a both time-consuming and experience-requiring task.

1.2. Innovation

The idea of introducing machine learning into earthquake prediction came from the fundamental features of machine learning. The omens of earthquakes have strong regularities. With massive data collected in the recent century, AI could study the pattern of the events that typically occur

before earthquakes. Compared to traditional methods of having experts analyzing collected data, using algorithms provides more precise and quantitative results. Also, introducing machine learning into earthquake prediction promotes the development of the field. The trained model can show the researchers how closely each factor is related to the earthquake, indicating directions for further studies. Knowing more about the mechanism of the formation of earthquakes can then help researchers train the model better, creating a positive feedback loop.

2 Tools

2.1. Long-term prediction tools

2.1.1 Google:
Historical seismic data for a specific area

2.1.2 C++ IDE:
To build Machine Learning system

2.2. short-term prediction tools

2.2.1 GPS:
GPS can be used to measure crustal deformation.

2.2.2 Digital level:
The digital level consists of a base, a level, a single telephoto and a data processing system. It can measure the change of inland water level per unit time.

2.2.3 Model 14 radon gas detector:
Natural stone materials containing radioactive elements are most likely to emit radon. Therefore, a significant increase in radon gas near natural stones could indicate a possible earthquake. The radon meter can give the results immediately, and is easy to operate and carry, so it is suitable for large-scale radon level investigation.

2.2.4 Geodetic conductometer:
Geoelectricity is the unstable natural electric current inside the Earth that can change significantly before an earthquake. The geodetic conductometer is used to monitor the resistivity of the surface soil.

2.2.5 Vector proton magnetometer:
The analysis of geomagnetic records shows that strong geomagnetic anomalies occur repeatedly before large earthquakes. The vector proton magnetometer is a special instrument for geomagnetic station, which is used to measure the total field F, horizontal component H and deflection angle D of the geomagnetic field. At the same time, the vector proton magnetometer uses an embedded PC104 computer system with a 5.7" color LCD display. The whole measuring process will be automatically controlled by the computer. Ethernet interfaces would be available for the transmission and inquiry of data.

2.2.6 FG high precision gravimeter and OSG type superconducting gravimeter:
Within days to hours before an earthquake, gravitational disturbances occur in the area. Therefore, sudden changes in gravity can be used as an important indicator to judge earthquakes. FG high precision gravimeter and OSG type superconducting gravimeter can directly measure the value of gravity acceleration, which is convenient for us to judge whether the area is likely to earthquake

2.2.7 Depth camera:
Since animals are more sensitive to vibrations, they flee from their burrows in large numbers before earthquakes. We want to put cameras in the holes of underground nesting animals to help predict earthquakes (because animal behavior is more complex, and burrowing animals may come out of the cave because of the invasion of predators). Such phenomena have an impact on earthquake prediction.)

2.3. Machine Learning

Machine learning can be divided into three categories according to the "feedback" nature of learning systems: supervised learning, unsupervised learning and reinforcement learning. Supervised learning is to learn the input-output mapping rules through the existing input and result data sets, mainly used for classification and regression. The representative classification methods include K-nearest neighbor algorithm, Decision tree, Naive Bayes model, Logistic Regression and Random Forest. The representative regression methods include Linear regression, Polynomial regression and Ridge regression; there are also support vector machines, Artificial Neural Network and Gradient boosting decision tree (GBDT) for classification or regression tasks. Unsupervised learning needs to learn corresponding representation or hidden patterns from unlabeled data, which is mainly used for clustering. Reinforcement learning is the process of improving learning through the repetition of values, strategies, or patterns through interaction and feedback.

3 Designing Scheme

3.1.

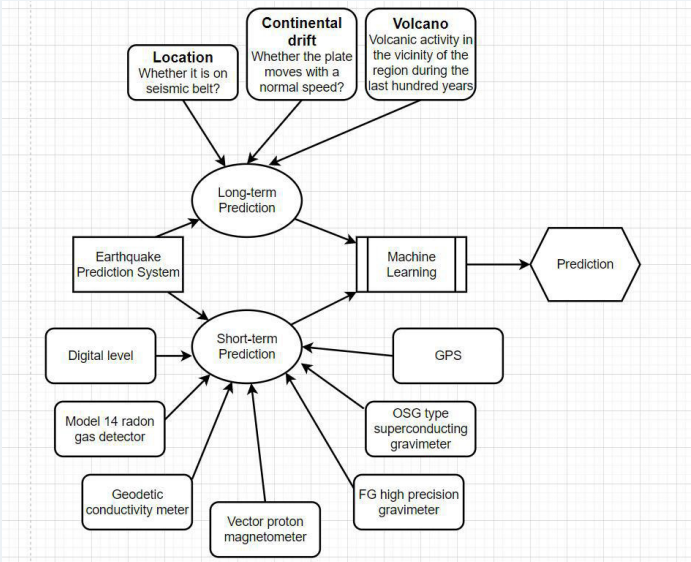

Figure 1

This is the basic flow chart of our earthquake prediction system. Our system is divided into long-term forecasts and short-term forecasts. The first is long-term prediction, which mainly detects three indicators, including Location data, Continental drift data and Volcano data; Short-term detection mainly detects seven indicators, including GPS data, gravimeter data magnetometer data, conductometer data, radon gas data and digital level data. And then machine learning to get the results. See Chapter 3.2 for the specific process of machine learning

3.2. Machine Learning Working-principal

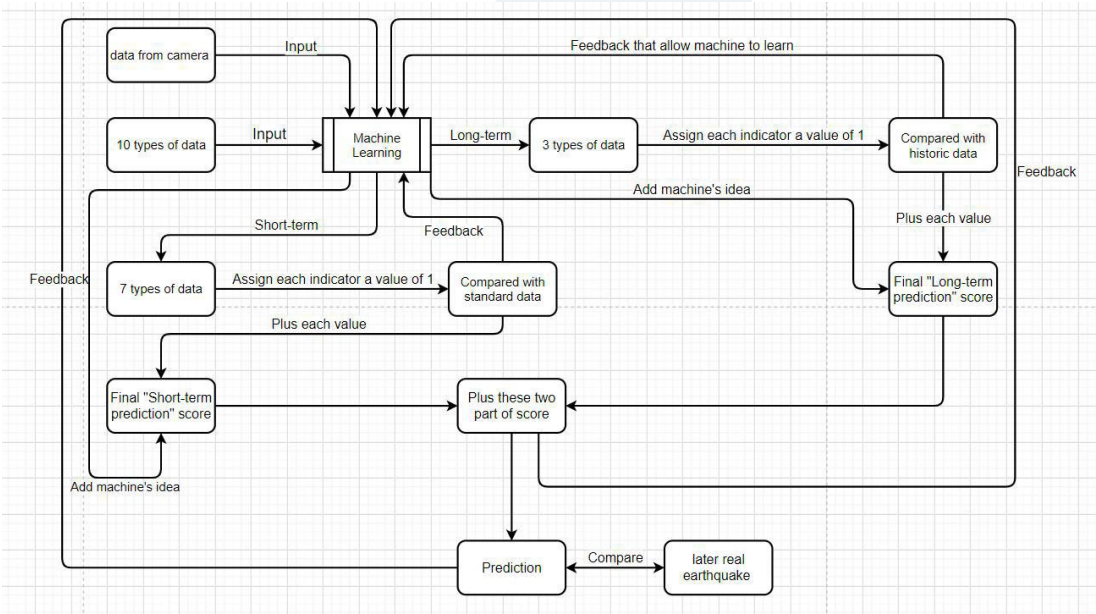

Figure 2

We are constantly monitoring changes in the data. The long-term forecast part of the test cycle is about a year to ten years. These three indicators are assigned a value of 1 respectively, that is, the normal long-term warning indicators combined is 3. When factors fluctuate, the absolute value of the percentage change of each of the factors can be calculated and added to the indicator of that factor. Thus, the sum of the 3 indicators would be larger than 3. Then the trained model would compare the current indicators with the ones of the abnormalities occurred before previous earthquakes. It can provide a factor between 0 and 1 to indicate how likely this abnormality forebodes an earthquake. By multiplying this factor and the sum of the three indicators, the model can obtain a final index for the Long-term prediction of the earthquake.

In addition, our short-term forecast will collect seven indicators, including GPS data, gravimeter data magnetometer data, conductometer data, radon gas data and digital level data. Similarly, like the long-term forecast, we assign a value of 1 to each of them, i.e. the normal short-term warning indicators add up to 7. The following process is the same as the long-term forecasting process, and finally the short-term forecasting results are obtained.

4 Influence and ethical problem

4.1. Negative influence

Even if the probability of making an accurate prediction is improved, mispredictions are likely to occur. The consequences of misprediction are twofold. The first is the harm to people's lives and property. After receiving the earthquake warning information, most people are more panicked, there may be stampedes causing casualties. There is also the possibility of damage to the surrounding facilities in the process of avoidance, resulting in property losses. The second aspect is the psychological impact on people. People may lose trust in the earthquake prediction system after a false warning. Therefore, after comprehensive consideration of the consequences of misprediction on the safety of people's lives and property, we believe that the time of issuing the prediction should be 15 minutes earlier than the earthquake prediction time, so as to reduce unnecessary casualties and property losses. We believe that when the system gives a possible earthquake of less than magnitude 6 on the Richter scale, we will send the most predictive information, including radio, TELEVISION and mobile phone text messages. At the same time, call on the public not to panic, try to find shelter in situ. When the prediction system results in an earthquake greater than 6 on the Richter scale, we call on citizens to try to open outdoor places for shelter.

4.2. Ethical problem

As for ethics, we haven't thought about the ethical implications of earthquake prediction systems. However, in subsequent studies, we will continue to pay attention to the humanistic moral aspects of the system.

5 Future Expectation

Because earthquake prediction is a very important thing that every country has to face. We can recommend this system to every country, because with the help of machine learning, this system can be relatively easily applied in most countries and regions.

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7 Acknowledgement

We would like to express our gratitude to all those who helped me during the writing of this essay.

Our deepest gratitude goes first and foremost to Course Leader Mehrsa Jafarpour, for her constant encouragement and guidance. She has walked us through all the stages of this essay. Without her consistent and illuminating instruction, this essay could not reach its present form.

Second, we would like to express our heartfelt gratitude to Course Facilitator Yijun Zhou, Jacqueline Murphy, Jirko Rubruck and Hunar Batra, who led us to discuss the topic and the relevant knowledge.

Last but not least, our thanks would go to our family members for their loving considerations and great confidence in our all through this several days. We also owe our sincere gratitude to our friends and our classmates who gave us their help and time in listening to us and helping us work out our problems during the difficult course of the essay.

03 Biomedicine

Oxford Global Summit for Young Leaders (China)

3 Biomedicine

Review of Parkinson's disease: Causes, diagnoses, and treatments

Emma, Flora, Nana and Sophia

Content

1. Introduction

Parkinson's disease (PD) is the second most common neurodegenerative disorder which is mainly associated with symptoms like tremor, rigidity, slowing movement and other complications including mental disabilities and cognitive problems.[1] The symptoms progress slowly. Initially, patients suffer from tremor on one side of the arms. As the disorder progresses, patients may find difficulties when talking or moving. However, no cure is currently available for Parkinson's disease. Treatments and medications are aimed to control the symptoms or slow down the progression.

Parkinson's disease is named after the surgeon James Parkinson. He firstly described this disorder as 'Shaking Palsy' in his essay in 1817.[2] Statistically, PD affects approximately 10 million people worldwide. The incidence of PD increases with age. Approximately 95% of people with PD are diagnosed over the age of 60.[3] PD is around 1.5 times more prevalent in males than in women, and developed nations have reported greater rates of the disease as a result of an aging population[4].

The pathology of Parkinson's disease is associated with the accumulation of protein and the loss of neurons in the substantia nigra. However, the causes of Parkinson's disease remained unclear. Hence it is categorised as heterogeneous, which means the disease has multiple root causes.

2. Anatomical location and causes

2.1 Pathology

The characteristics of Parkinson's disease include the loss of neurons in the substantia nigra of the basal ganglia structure and the aggregation of the protein[5]. The post-mortem of Parkinson's patients generally suggested the destruction of up to 70% of the neurons.

Within the cellular aspect, the disorder causes a select number of neuronal cytoskeletons to develop abnormalities.[6] This leads to the malfunction of neurons. Those afflicted neurons develop Lewy bodies and Lewy neurites in the neuronal process, whose main components include ubiquitin and α-synuclein. In the neurological system, α-synuclein is widely expressed and accounts for 1% of all cytosolic protein. Parkinson's disease is linked to the dysfunction of the ubiquitin-proteasome system that degrades α-synuclein[7] [8]. As a result, α-synuclein misfolds and forms intracellular inclusion[9]. This accumulation of α-synuclein leads to the selective vulnerability of neurons. The mechanism of this phenomenon was observed. During the process of fibril growth, α-synuclein fibrils release soluble oligomeric species which are capable of permeating through the membranes of neurons.[10] Fibril are neurotoxic and its rapid release of oligomers gives a rise to death of the dopaminergic neurons, which results in the loss of dopaminergic projection cells in the pars compacta in the substantia nigra.[11] [12]

2.2 Anatomical location

Based on the Braak model, the progression of Parkinson's disease is separated into six stages.

In stage 1, PD affects the peripheral nervous system, olfactory system and medulla. In stage 2, aside from the pathology of stage 1, it begins to affect pons and grey matter in the spinal cord. In stage 3, midbrain lesions are shown particularly in the substantia nigra. In stage 4, the lesions are shown in the limbic system, while in stage 5 and 6 multiple regions of the neocortex are affected.[13]

It is noticeable that the Braak staging is more of an evaluation or hypothesis of the progression. The validity of Braak staging is constantly debated. However, most studies (80%-100%) are incongruous with Braak staging.[14]

2.3 The genetic and environmental causes

The causes of PD are a combination of genetic factors and environmental (chemicals and brain damages) factors.

There are six main causative genes of PD -LRRK2, SNCA, VPS35, Parkin, PINKI, DJ1, and GBA- and we mainly focused on the mutation of the History Alpha-synuclein (SNCA) gene. The SNCA gene, which is located in chromosome 4 including 6 exons, is engaged in α-synuclein encoding. The mutation on this gene is important as[15] SNCA mutation is a highly heritable autosomal dominant inheritance. A point mutation on the A30P gene results in the abnormal interaction of lipid rafts[16] -domains that affect the fluidity of the plasma membrane with high concentrations of proteins or lipids such as cholesterol and glycosphingolipids.[17] A30P missense mutation affects lipid rafts to abnormally interact with α-synuclein. The mutant A30P gene changes the permeability of the neuron cell's plasma membrane, which results in the redistribution of α-synuclein in the synapse. Moreover, point mutations on A53T and E46K were considered as the parts that enhance the formation of protofibrils. These kinds of mutations in genes are inherited by offspring and affect the dopaminergic neurons which are related to PD.[18]

Furthermore, other environmental factors are non-negligible reasons for PD.[19] Head injury, occupations, exposure to pesticides, and so on are assumed as the factors related to PD.[20] Specific types of pesticides, such as 2,4-dichlorophenoxyacetic acid, paraquat, and permethrin- are already proven in vitro that they associate with the formation and functioning of dopamine[21]

3. Symptoms

The usual time for symptom progression is 15 to 20 years. However, individual circumstances may vary. [22]The principal symptoms of Parkinson's disease (PD) include motor and non-motor symptoms. These symptoms can be further divided into early symptoms, primary motor symptoms, secondary motor symptoms, primary non-motor symptoms, and secondary non-motor symptoms. Early signs of depression, soft speech, odd facial expressions, and minor tremors are difficult to spot and link to PD. The following motor symptoms are associated with slow movement: resting tremors (shaking of the hands, arms, and legs), the rigidity of the muscles that causes joint cramping, balance and coordination issues, speech problems, and rigid muscles. Additionally, non-motor symptoms include changes in gesture and expression (inability to convey the right messages or express their emotions), urine issues, perspiration, elevated blood pressure, and trouble sleeping (80 percent of the patients reported they suffer from nightmares and emotional dreams).[23]

4. Treatments

Under current medical conditions, mainly three categories of treatments are adopted to combat Parkinson's disease. This contains chemical treatments, physical treatments, and surgeries. Parkinson's disease results from the death of dopaminergic neurons in the substantia nigra (SN). [24]Consequently, medical treatments target whether preventing these neurons from dying or replenishing new dopaminergic neurons to the SN.

4.1 Stem-cell transplantation as an edge-cutting method in curing PD

Since Parkinson's disease occurs due to the dysfunction of one type of cell in a concentrated spot in the brain, it has been expected to be cured by stem-cell therapy. Stem cells have the capability to express different genes into various pathways. While mesenchymal stem cells are adult stem cells that have self-renewal, immunomodulatory, anti-inflammatory, signaling, and differentiation properties. [25] The advantages of using stem cells to cure Parkinson's disease have been found in a study conducted by Neelam K.Venkataramana and colleagues. Seven PD patients aged 22 to 62 years with a mean duration of 14.7 ± 7.56 years were enrolled in a prospective, uncontrolled pilot study of single-dose unilateral autologous bone marrow mesenchymal stem cell (BM-MSC) transplantation. Patients were followed up 36 months after transplantation, and unified Parkinson's Disease Rating Scales (UPDRS) improved significantly in three of the seven patients, at 38%. [26] However, current research cannot ensure that stem-cell therapy will become the best treatment for PD since how the stem cells differentiate cannot be controlled. While some patients would be improved by this method, others may experience severe adverse reactions. Because cell differentiation can lead to brain tumors, or it can differentiate in the opposite direction, worsening Parkinson's symptoms. Nevertheless, if techniques are ameliorated to regulate the division of the cells, this transplantation method would be the most fundamental treatment for PD.

4.2 Comparison

4.2.1 Chemical Treatments

Levodopa, a substance used in chemical treatments, is considered to be the most efficient drug. Originally, levodopa is quickly metabolized via decarboxylation in the extracerebral tissues when taken orally. Therefore, only a small proportion reaches the central nervous system. However, levodopa is now usually combined with an open-decarboxylase inhibitor (DDCI) to reduce its peripheral conversion to dopamine, thereby minimizing the predominant side effects of circulating dopamine.[27] Another method for improving the bioavailability of plasma levodopa and delivery to the brain is to inhibit the peripheral metabolism of levodopa via the catechol-O-methyltransferase (COMT) pathway. [28] The research carried out by Regina Katzenschlager and Andrew Lees has consistently shown that levodopa provides a better functional improvement in the first few years of treatment. [29] However, it is suggested that levodopa may be neurotoxic. It causes more severe damage to the movement if patients use it as a long-term medication and lose the effectiveness as the disease is aggravated.

4.2.2 The use of physical treatments

Rehabilitation training methods for Parkinson's disease patients are mainly aimed at the main motor symptoms of Parkinson's disease patients, including muscle rigidity, reduced movement, static tremor, abnormal posture, etc. No studies have shown that physical rehabilitation exercises are effective in stopping the progression of Parkinson's. Therefore, it can only be used as an adjunct to the patient's recovery, rather than as the main treatment.

4.3 Costs

Graph 1. Cost of using levodopa, physical treatment, DBS, and stem-cell to cure PD relatively

method	Cost (¥)
Levodopa	90-105 (per 120mg)
Physical treatment	30,000-50,000
Stem-cell transplantation	300,000-500,000

The average price level of levodopa in drug stores ranges from ¥90 to ¥105 in a product with 120mg of pure levodopa. As the most commonly used method against PD, the cost of this is the lowest among the four treatments discussed previously. We suggest that chemical treatments are the most approachable means for PD. The stem-cell transplantation cost the highest. However, researchers are still working hard on developing stem-cell transplantation methods. It would presumably have a lower price in the future when techniques are improved.

5. Detection and diagnostic method

Currently, there is no definitive test to diagnose Parkinson's disease. Neurologists generally diagnose the disease based on various factors including consultation and clinical checks. They ask patients' medical history and whether they show symptoms of PD[30].

Some of the symptoms of Parkinson's disease are common to other neurodegenerative diseases. In order to avoid misdiagnosis, doctors may carry out additional inspections. Tests like dopamine transporter scans or imaging tests (MRI, ultrasound, and PET scans) may be recommended. Additionally, doctors use rating scales to determine the severity of PD. The most commonly used scales are Hoehn and Yahr scale and Unified Parkinson's Disease Rating Scale (UPDRS).[31]

6.Conclusion

As addressed above chemical and physical treatments are the major therapies used currently. However, they will lose efficacy as the disease progresses. The stem-cell transplantation may trigger severe adverse reactions. Thus we need to explore other strategies for disease modification.

Genetic analysis has linked over 25 genes to PD. Among them, SNCA (synuclein, alpha) mutations are associated with familial and sporadic PD significantly[32]. It has been well accepted that accumulation and propagation of misfolded SNCA in the brain is integral to the disease pathogenesis, suggesting that impaired cellular handling of this protein likely plays a key role in PD.

A vast amount of evidence indicates that α-synuclein is a crucial pathogenic protein in both this disease and dementia with Lewy bodies, making it a prime treatment target. Pathologic α-Syn aggregates are found in the great majority of people with sporadic Parkinson's disease. Insights into the processes that cause the production of hazardous α-Syn species, as well as the demonstration of cell-to-cell transmission, have paved the path for a variety of treatment approaches to delay or stop disease progression.

Previously, it was considered that antibodies bind α-Syn aggregates extracellularly during transmission, but there is speculation that it may also clear intracellular α-Syn clumps. The worry is that antibodies against α-Syn may have unintended consequences, such as inducing nonselective autophagy. A more precise approach is to reduce α-Syn expression by decreasing α-Syn expression, which includes siRNA or shRNA. Another potential strategy for a disease-modifying therapy for Parkinson's disease is to improve α-Syn clearance and degradation. Both the proteasome system and the autophagy-lysosomal route destroy α-Syn. However, it has been found that aggregated synuclein binds to multiple proteasome subunits and blocks its activity, and the proteasome activator will be ineffective in degrading synuclein. Even though there are no proven safe and effective treatments to delay or cure Parkinson's Disease, it is recognized that degrading α-Syn accumulation in the brain is a key necessity.

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Oxford Global | Oxford Global Summit for Young Leaders (China)

A brief overview of Alzheimer's disease

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1. Introduction

Alzheimer's disease (AD) is a neurogenerative disease caused by both genetic and spontaneous factors. As the pathological changes progress, symptoms ranging from mild cognitive impairment to severe dementia could occur. Currently, there is no cure for AD, but several treatments have been developed to mitigate the symptoms and slow down the disease progression. Meanwhile, various testing methods have been developed to detect this disease. This essay aims to provide an overview of AD in terms of the anatomical location of pathological changes in the brain, the potential symptoms, detection methods, and available treatments. We will also present our evaluation of the detection and treatment methods.

2. The neurobiological basis

AD affects the whole brain. Apoptosis, autophagy, and necroptosis are the main cell death pathways. [1] The two main pathological changes that cause this are the A β aggregation and the occurrence of tau-containing neurofibrillary tangles.

2.1 A β O and A β plaques

The causes of A β aggregation include the overproduction of A β from APP (in familial early-onset AD) and the failure of A β clearance (in sporadic late-onset AD). A β is a kind of extracellular protein that naturally forms from the breakdown of amyloid precursor protein (APP). A β 1-42, the most toxic isoform of A β , is prone to self-assembly and forms A β oligomers (A β O) and A β plaques. Soluble A β O harms the neurons by creating Ca+ channels on the cell membranes, resulting in an inflow of Ca+ that interferes with the function of mitochondria. This produces toxic reactive oxygen species and eventually causes cell apoptosis. [2] The A β O also binds to many neurotransmitter receptors, leading to synaptic dysfunction.

The earlier amyloid cascade hypothesis states that large amounts of A β plaques cause neurodegeneration. Different from A β O, A β plaques are insoluble and neuroprotective. However, abnormally high amounts could trigger the inflammatory response of the microglia, in which overwhelmed microglial secretes toxins and cause neurodegeneration. The A β plaques also activate kinase, which phosphorylates tau protein into hyperphosphorylated tau. The impacts of abnormal tau protein will be explained in the following section.

As the AD progresses, Aβ plaques spread from the basal neocortex to the allocortex and the mid-brain, causing cell apoptosis on their way. They eventually colonize the whole brain. In preclinical stages, Aβ first collects in the perirhinal and entorhinal cortex and then passes on to the whole neocortex. Structures in the parietal and frontal gyrus required for visual and divided attention lose activity. This leaves only the medial frontal structures activated in attentive tasks. [3][4] In sequence, Aβ plaques invade the amygdala and hippocampus, which establish emotions and long-term memories. In the clinical stages, the presence of Aβ in the brainstem and cerebellum affects the patients more severely.

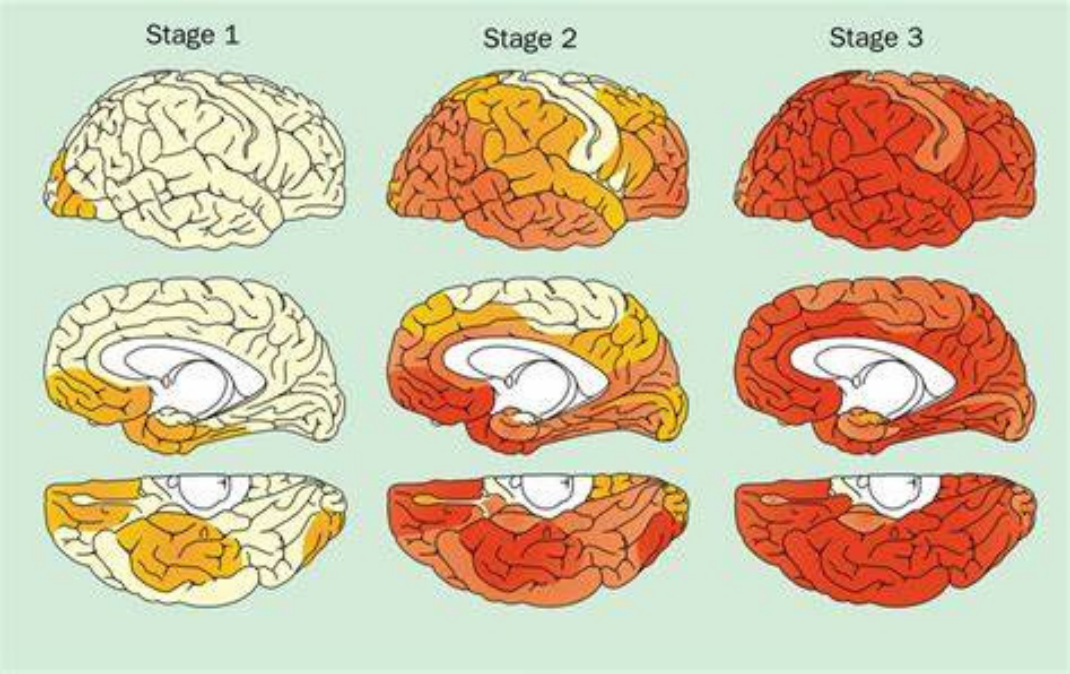

Fig. 1 PET imaging of amyloid in Alzheimer's disease (The Lancet Neurology, 2004) [5]

2.2 Tau-containing neurofibrillary tangles

Kinase converts natural tau into hyperphosphorylated tau, which causes cell autophagy. Normal tau binds and stabilizes microtubules in cells, but hyperphosphorylated tau lacks affinity to microtubules and self-assembly into neurofibrillary tangles. Without the support of tau, the microtubules become dysfunctional. The intracellular transport system and cytoskeleton collapse. Cell apoptosis happens and neurons false signals because vesicle transportation is affected.

Neurofibrillary tangles are transmitted in adjacent neurons, and they mainly affect the medial temporal lobes that the Aβ attack misses. They tend to spread from the medial entorhinal cortex to the subiculum and then to the dentate gyrus. [6] The subiculum is the output structure of the hippocampal formation (hippocampus and dentate gyrus)[7], and the dentate gyrus is responsible for processing spatial information. [8]

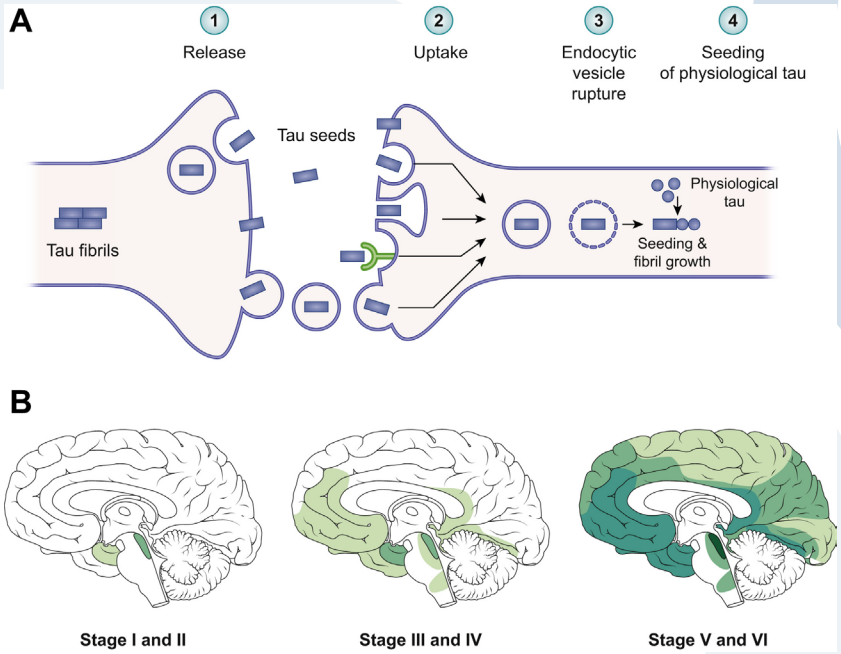

Fig. 2 Propagation of Tau Pathology: Integrating Insights From Postmortem and In Vivo Studies (2019 Society of Biological Psychiatry, 2020) [9]

2.3 Brain atrophy

On a larger scale, Aβ plaques and neurofibrillary tangles would still eventually lead to brain atrophy – the shrinking of the whole brain. Massive loss of neuronal connections and synaptic dysfunction is also considered endpoint incidents of AD. [10] The pathological progression of AD and the areas of the brain affected are closely related to its symptoms.

3. Symptoms

Many old people are afflicted by the symptoms of AD. Overall, AD has 3 stages, which are the preclinical stage, mild cognitive impairment (MCI) stage, and dementia stage.

The preclinical stage does not have any noticeable syndrome. It takes years before patients begin manifesting memory impairment that exceeds that of their age-peers, a prognostically worrisome stage termed MCI, and several more years before their cognitive skills decline to a functionally disabling degree heralding the clinical onset of dementia. [11].

However, imaging techniques, biomarkers, and genetic tests can diagnose AD in the preclinical phase. In the second stage, the patients may find their memory and thinking ability altered, and struggle to make decisions, reasoning, and judgments about time or numbers as usual. Unfortunately, AD brings irreversible damage to people's brains, and there are still no methods to cure AD completely, so the patients' syndrome will move to the dementia stage.

During this phase, patients have to suffer from more symptoms, including severe memory loss, change in personality, bad sleeping quality, and difficulties in expressing their thoughts. Moreover, it is common to see old people with dementia getting lost or struggling with logical thinking. Besides, patients cannot

communicate coherently, and assistance for daily activities is required, as a result of their loss of physical abilities. When dementia advances, patients with AD may start to have difficulty swallowing and lose interest in eating. Eating and swallowing impairments are well documented in late-stage AD. [12]

In the end, the patients' immune systems and organs start to fail, leading to suffering from dysphagia and pneumonia. Dysphagia and aspiration pneumonia are the 2 most serious and lethal medical conditions seen in late-stage AD patients, and pneumonia is the most common cause of death in end-stage AD. Pseudobulbar dysphagia is associated with weight loss, while pneumonia patients experience several syndromes including a reduced level of consciousness, dysphagia, loss of the gag reflex, and periodontal disease. [13]

4. Detection and diagnostic methods

4.1 Conduct testing

4.1.1 Mini-mental State Examination (MMSE)

The content is concise, the measurement time is short, and it is easily accepted by the elderly. It is the most common scale for clinical measurement of the degree of intellectual impairment of this disease [14], and the total score of this scale is related to educational level. If they have a score below a specific score, detailed neuropsychological tests should be carried out to assess various cognitive functions including memory, executive function, language, and operational abilities.

4.1.2 Behavioral and Psychiatric Symptoms Disease (BPSD)

It includes AD Behavior Pathology Scale and Neuropsychiatric (NPI) Questionnaire, etc. It often needs to evaluate according to the baseline information provided by the informed person. It not only finds whether the symptoms are present or not, but It is also possible to assess the frequency of symptoms, severity, and the burden on caregivers, and repeated assessments can monitor treatment effectiveness.

4.2 Clinical testing

The development of invasive and non-invasive diagnostic methods recently resulted in tests that detect the presence of Aβ amyloid plagues, in the living brain. [15]

4.2.1 PET scans

Patients are first injected with a radioactive tracer agent Cerebral Aβ deposition was visualized with the PET tracer. In 2012, specialists were able to diagnose the disease using this technique with up to 96% accuracy. [16]

4.2.2 Analyzation of cerebrospinal fluid (CSF)

AD is associated with a significant decrease in CSF beta-amyloid levels along with an increase in CSF tau neurofibrillary tangles levels [17]. As beta-amyloid 42 is deposited in the brain, the level of beta-amyloid 42 in CSF is decreased. These markers can be used to support the diagnosis of AD, but have low specificity in differentiating AD from other dementia diagnoses, and carries the risks such as a higher possibility for headaches, occasional back pain, and numbness. However, there is no difference in diagnostic accuracy between CSF Aβ42: p-tau ratio and amyloid PET imaging biomarkers, suggesting that the best test for individual patients depends upon patient preference and cost. [18]

4.2.3 Head Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) examination

It shows significant cortical atrophy, especially in the hippocampus and medial temporal lobe, supporting the clinical diagnosis of AD. MRI is more sensitive than CT to detect subcortical vascular changes (e.g., critical infarctions) and to indicate specific diseases (e.g., multiple sclerosis, progressive supranuclear palsy, frontotemporal dementia, etc.) [19]

4.2.4 Gene test

Linkage to chromosome 21 markers, there is a point mutation in the amyloid precursor protein (APP) gene that caused AD [20]. There are also presenilin 1 (PSEN1) and presenilin 2 (PSEN2) located in chromosomes 14 and 1 respectively. So genetic testing like DNA profiling can provide a reference for diagnosis.

4.3 Predicting the future test method

Although the mechanisms and symptoms of AD are now understood, it is still difficult to detect AD in the early stages of the disease. And some tests can be difficult to determine accurately whether a patient has AD because of diseases with similar characteristics.

There may be many other ways to detect AD in addition to these tests. Because Aβ and Tau proteins can cause abnormal brain waves, measuring brain waves might be a future test for AD. The realization of this hypothesis still needs to be verified by further experiments.

5. Treatments

Early-onset Alzheimer's disease currently has no cure, but healthcare specialists have been successful in slowing the progress of the disease, with medicines prescribed to target the maintenance of mental function. The most common prescriptions recently focused on Tau Proteins, aiming to inhibit the phosphorylation and/or aggregation of Tau protein.

5.1 Kinase inhibitors

Tau Hyperphosphorylation can be inhibited. Tau proteins are a result of alternative splicing of a microtubule-associated protein Tau (MAPT) gene. Phosphorylation is the primary mechanism that regulates Tau binding to the microtubule. In AD, uncontrolled hyperphosphorylation occurs as a result of an imbalance between the catalytic activity of kinases and phosphatases. [21] As a result, it is

recognized that the development of kinase inhibitors can be a possible treatment strategy for AD. [22]

5.2 Paclitaxel

Microtubule stabilization may potentially achieve a similar end result as that seen with the inhibitors of Tau hyperphosphorylation and aggregation. Paclitaxel is a drug that basically carries out the same function as Tau proteins in microtubule-stabilizing. Unfortunately, this compound cannot cross the blood-brain barrier and its use is associated with serious adverse events, which limits its utility in AD. [23]

5.3 Methylene blue

Hyperphosphorylated Tau aggregates contribute to neurotoxicity observed in the patient's brain, and it can be inhibited by methylene blue dye derivatives. Methylene blue disrupts the aggregation of Tau, has the ability to inhibit amyloid aggregation, improves the efficiency of the mitochondrial electron transport chain, reduces oxidative stress, prevents mitochondrial damage, and is also a modulator of autophagy.[24],[25]A purified compound of methylene blue, TRx0237 not only inhibits Tau protein aggregation but also dissolves brain aggregates of Tau.[26] According to information, this compound had gone through several clinical trials, but their results are not available.

6. Conclusion

Based on the understanding of the neurobiological progression of AD, we can identify some promising detection and treatment methods.

We regard gene sequencing targeting mutative genes in AD as a reliable way to detect familial early-onset AD. For sporadic late-onset AD, CT and MRI are recommended for analysis of CSF, considering that the process of collecting CSF could be painful and expensive, especially for the elderly, despite their high accuracy.

From our perspective, methylene blue is a promising and upcoming drug for treating AD. In theory, the effect of methylene blue in improving mitochondria function is essential in both early-onset and late-onset AD, implicating that the drug is widely applicable. Unlike the commonly used Cholinesterase inhibitors, methylene blue tackles AD from the roots and prevents the aggregation of harmful molecules in the first place. In addition, methylene blue is a tried and tested drug that has been used in the treatment of malaria for decades, so it is proven to be safer than alternative treatments such as the kinase inhibitor.

List of abbreviations

AD = Alzheimer's disease

Aβ = beta-amyloid

AβO = beta-amyloid oligomer

MCI = mild cognitive impairment

MMSE = Mini-mental State Examination

BPSD = Behavioral and Psychiatric Symptoms Disease

CSF = cerebrospinal fluid

CT = Head Computed Tomography

MRI = Magnetic Resonance Imaging

MAPT=microtubule-associated protein Tau

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04 Analytical Chemistry

Oxford Global Summit for Young Leaders (China)

4 Analytical Chemistry

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An Investigation Into The Techniques In Drug Analysis

YUNUO HUA, CHANG HE, ELSA SMITH, and ANGZE LI

Introduction

When developing a new drug, it is critical to possess a comprehensive understanding of the drug itself, including its composition, properties, and effects, to determine if it can be suitable for human use. This essay will go on to explore the most appropriate techniques to use when understanding a drug designed to target lung cancer, and their corresponding benefits.

Methods

To understand a drug from a compositional perspective, gas chromatography, mass spectrometry, and nuclear magnetic resonance spectroscopy are the ideal techniques to use. We can use the separation of colour layers by gas chromatography (GC) to determine the properties of the drug. This is carried out by measuring molecular weighing scale and identification of molecules (Science and Technology China). The vaporized sample is carried into the column by a carrier gas. The components flow out of the column at different times and are separated from each other. A chromatogram showing the time and concentration of different components of different drug flow columns can be produced using an appropriate identification and recording system. The drug compound can be qualitatively analyzed according to the peak time and sequence shown in the figure; the drug compound can be quantitatively analyzed according to the peak height and area size. GC has the benefits of high efficiency, high sensitivity, high selectivity, fast analysis speed, wide application and easy operation.

Mass spectrometry (MS) is an analytical technique that can be used to identify and quantify unknown components within a substance. For example, it can determine whether the drug contains any harmful substances, making it unsuitable to use on the human body. This is extremely useful in drug analysis as it allows us to develop a better understanding of the structural and chemical properties of the drug[1] . A brief overview of its working principles is as follows: the sample is first vapourised, and the molecules are ionised by an electron beam. These ions are then separated according to their specific mass-to-charge ratio. A detector system records the relative abundance[2] of the ions and converts them into electrical signals, producing a mass spectrum. This data is then compared to reference libraries by a computer to determine the identities of the compounds. A major advantage of mass spectrometry,

compared to other techniques, is that it is extremely sensitive when identifying compounds, making it a valuable tool in quantitative and qualitative chemical analysis[3]. Its limitations include being unable to tell the difference between optical and geometrical isomers, as well as not being the most precise when identifying hydrocarbons that produce similar ions, but these can be compensated for by gas chromatography.

Nuclear magnetic resonance (NMR) spectroscopy is a commonly used technique in the field of analytical chemistry, in which physical, chemical, and structural information can be obtained. There are various types of NMR spectroscopy, ranging from continuous-wave spectroscopy[4] and Fourier-transform spectroscopy[5] to solid-state NMR spectroscopy[6]. In NMR spectroscopy, the most frequently used nuclei are 1H and 13C, although many other elements can be studied by high-field NMR spectroscopy as well[6]. The principle of NMR spectroscopy is more complex than other common techniques, such as mass spectroscopy. However, generally, certain atoms in different chemical environments can be detected by showing the chemical shifts in the test, and hence the structure and physical and chemical properties can be revealed. This technique is widely accepted and utilized in medication studies, for not only can it show the structure of medicine, but also it indicates the purity of the drug. While NMR spectroscopy is applied to medicine, the information of how many chemical environments of, say hydrogen or carbon, there are, and the number of them. Therefore, we may conclude the structure and electron density of the tested drugs non-destructively. Moreover, the purification can also be determined of a certain drug, with the structure and molecular weight provided[6]. The most obvious advantage of NMR spectroscopy is that the information can be detected without breaking the structure of the drugs[7]. Other than that, an established library with data stored in it can be directly used and compared to identify the structure.

Fluorescence resonance energy transfer (FRET) explores the drug by investigating the interactions between molecules. It can also be applied to detect the location and density of tumours, or to locate labels within the body. This process takes place between two light- sensitive molecules. A donor molecule, which is excited initially, may transfer energy to an acceptor molecule through electronic wave. The efficiency of energy transfer depends on the distance between the donor molecule and the acceptor molecule. Normally, the distance is between 10 angstrom and 100 angstrom, which means that FRET is extremely sensitive to small changes in distance. FRET can be used to test interactions between molecules within the sample, since interactions mean that the distance between donor and acceptor is close enough to transmit signals. As a result of the high ductility of FRET, it can be combined with other techniques to fulfill certain requirements in analysis, such as UV- visible spectrophotometry (UV-Vis). UV-Vis can be considered as a supplement to FRET, in order to complete the testing ranges (Misra, Prabhakar; Dubinskii, Mark, eds, 2002). The Beer- Lambert Law states that the absorbance of solution is directly proportional to the concentration of the absorbing species in the solution. Thus, for a fixed path length, it is able to determine the concentration of the absorber in a solution (Berberan-Santos, M. N., 1990). Another principle of FRET is that it is based on fluorophores, or molecules labelled with fluorescence. By triggering one fluorophore with laser beams, there will be feedback due to the absorption of electrons from the laser beam, changing the structure of the targeted fluorescence sample. Fluorescence is used in many proven technologies, such as PCR. FRET can be used to study the fluidity of membrane and protein-protein interactions, due to its versatile

methodology in analyzing biological molecules in living cells. There are several advantages of using FRET, including it being a relatively simple and accessible technique, as well as being useful for rapid dynamic experiments[8].

Cryo-electron microscopy (Cryo-EM) can also help explore interactions between the drug and other molecules. It is a technique that allows even individual atoms to be studied. Biological samples are rapidly frozen, becoming vitrified[9]. This slows down the deterioration of the sample, making it possible to be examined using transmission electron microscopy (TEM) after undergoing a thinning process by an ion beam. The electron microscope creates a 3D image of the sample at atomic resolution for further investigation. Intricate interactions between the drug and receptor cells can now be accurately visualized[10], which provides information on the effects of the drug on the body and the targeted lung cancer. The benefits of using Cryo-EM are that it does not require crystals, as opposed to X-ray crystallography, can be applied to proteins and their complexes of large molecular weight, and allows the study of biological samples at a much smaller scale. However, it should also be noted that there are limitations, such as the requirement of advanced computational techniques.

Conclusion

In order to develop an overall understanding of the drug, investigations need to be conducted that study the drug from various different aspects. These include its composition, properties, effects, and interactions with other molecules. Setting off from these particular aspects, suitable techniques for investigation can then be determined, namely gas chromatography, mass spectrometry, nuclear magnetic resonance spectroscopy, Fluorescence resonance energy transfer, and cryo-electron microscopy. The combination of these techniques will ultimately produce a comprehensive understanding of the drug.

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Oxford Global | Oxford Global Summit for Young Leaders (China)

The Report of The Advanced Analytical Technologies For The New Drug

DANZHUO CHANG, PEIQI ZHOU, XIANYANG CHENG and YUEWEN ZHAO

1 Introduction

Lung cancer is a malignant tumor originating from the bronchial mucosa or glands of the lung. Smoking is one of the most common causes of lung cancer, and 80% - 90% of smokers will suffer from such malignant tumors [1]. It remains a major worldwide health problem, accounting for more than a sixth of cancer deaths [2]. The high morbidity and mortality rates make it one of the most dangerous tumors diagnosed. Therefore, the treatment for lung cancer is highly researched.

Our team of researchers has synthesized a new drug molecule which shows activity against cancerous bronchial mucosa cell line. To understand the effectiveness of this new drug we will run multiple experiments to understand its structure and mode of action. Firstly, to characterize the drug molecules we will analyze the mass and structure respectively by using mass spectrometry, gas chromatography-mass spectrometry (GC-MS), nuclear magnetic resonance (NMR) and X-ray crystallography. After that, confocal microscope will be used to determine the drug's interaction with the cells and polymerase chain reaction (PCR) will also be used to further understand the new drug.

2 The description of GC-MS

2.1. The Introduction ofBenefits

Gas chromatography-mass spectrometry (GC-MS) will initially be used to determine the mass of the molecule. GC-MS is an analytical technique used to separate the chemical components of a sample mixture and then to measure the mass of its components [3]. There are five reasons for choosing a mass spectrometer. First of all, it has the ability to accurately determine the molecular weight, which is its most outstanding advantage compared with other methods. Furthermore, GC-MS is highly sensitivity to 10-7- 10-8 m/z. If a single ion is detected, it can even reach up to 10-12 m/z. Thirdly, it works fast and only takes minutes or even seconds to get results. Besides, GC-MS facilitates mixture analysis, which is particularly effective for mixtures that are difficult to isolates such as seen in Chinese herbal medicine. Lastly, it's multifunctional and widely applicable to all kinds of compounds [4].

2.2. The Principle of GC-MS

Identification of trace active components can also be carried out. The preparation steps of the sample before using gas chromatography-mass spectrum are injecting the sample, vaporizing it and making sure it is in gas form. After that, the molecules of the sample enter the GC column which is coiled in a heated oven. Next, the molecules pass through the MS, and the electron beam source sends electrons to ionize the heated sample to become positively charged. The charged ions are then accelerated. These ions pass through the lens and the mass analyzer respectively. At last, the ions are detected by the electron multiplier detector, which is linked with the computer that can show the results as mass spectrum [4]. The mass spectrum illustrates the ions with various mass to their charge ratio and relative abundance. Therefore, GC-MS can be used to analyze the mass of the new drug molecules effectively.

3 The description of NMR

3.1. The Background Introduction

Nuclear magnetic resonance (NMR) will be used after GC-MS to determine the structure and purity of the sample molecules. NMR is a physical process in which nuclear energy levels with non-zero spin quantum number undergo Zeeman splitting under the action of external magnetic field. Resonance absorbs radio frequency radiation at a specific frequency and transitions from low energy state to high energy state [5]. Since 1946, the research teams at Stanford University and Harvard University have discovered NMR signals in water and paraffin. NMR technology has developed rapidly from the past few decades to the present. From the original NMR instruments using continuous waves of electromagnets or permanent magnets, to the ultra-high field NMR spectrometers used in the 1990s with improved sensitivity and resolution of NMR detection, NMR technology has become the primary and the most effective tool for drug discovery and analysis.

3.2. The Benefits of NMR

NMR is one of the most common methods to analyze the structure of organic molecules, which can provide relatively structural information of organic compounds. Especially for complex polymer drugs, conventional detection methods are difficult to identify the subtle differences in their fine structures, while NMR spectra can accurately reflect the organic molecular structures by 1H-NMR and 13C- NMR [5]. Our team will use NMR to characterize the new drug molecule we have synthesized.

In addition, the safety and quality of drugs have always been a concern of the public and drug users, so testing the purity of drugs is one of the essential links to verify the quality and effect of drugs. NMR is an effective tool to solve the qualitative and quantitative challenges of impurity spectra, because NMR can be used for qualitative and quantitative analysis of various impurities in some drugs at the same time. It can also provide the most comprehensive structural information, including the plane structure, relative structure and three-dimensional structure of compounds [5]. Therefore, NMR can play a very important role in the analysis of impurities in drugs.

4 The Summary of Other Technologies

4.1. X-ray Crystallography

X-ray crystallography will be used to determine the absolute structure of the molecules which NMR is unable to provide. X-ray crystallography is a tool for determining the atomic and molecular structure of crystals. Its basic principle is that crystal atoms diffract X-ray beams in many specific directions [6]. By measuring the angle and intensity of these diffracted beams, the crystallizer can generate a three-dimensional image of the electron density in the crystal [7]. From this electron density image, we can determine the average position of atoms in the crystal, as well as their chemical bonds, disorder and various other information.

4.2. Confocal Microscopy

After determining the structure of the drug molecules, we would like to test where on the cell does the drug binds to. To study this, confocal microscopy is being used. Confocal microscopy uses a laser scanning beam to form point light source through the pinhole of the grating and scans point by point on the focal plane of the fluorescent labeled specimen [8]. After that, the emission signal is processed to form an image on the computer monitor screen.

Confocal microscopy can be used on live cell, which is very helpful for testing the properties and effectiveness of drugs. Here we will take the cancerous cell line, and then add our drug molecules which are labelled with a fluorescence probe to view where on cell does the drug binds to. This study can shed some light on how the drug works. The benefits of this technique is that it can scan living cells. So the technique can be done without killing the cell, which means that it can be scanned for many times. Also, confocal microscopy can measure cell membrane fluidity, intercellular communication, cell fusion, cytoskeleton elasticity and so on [9]. The last advantage is that comparing to the traditional optical microscope, confocal microscopy can give a higher resolution since the stray light is removed due to point-to-point scanning.

5 Briefly Introducing PCR Test

Polymerase chain reaction (PCR) is an effective method to further understand the new drug. An organism's genome is stored inside the DNA molecule, but analyzing this genetic information requires a lot of DNA. In 1985, Kary Mullis developed an method for making large amounts of DNA in a short period of time. The two strands of the DNA molecules are separated after being heated, and the added DNA building blocks bind to each strand. With the help of the enzyme DNA polymerase, new strands of DNA can be formed, and the process can be repeated [10].

PCR is very important in medical research. Several steps should be operated to understand the chemicals in the drugs. The denaturing stage is the first step. When the mixture is heated, the hydrogen bond between the two strands melts, and the DNA strands separate. The next stage is annealing stage. The mixture cools down, and then the primers stick to the DNA. Since the primers are smaller, they can float up and bond to the DNA while the DNA strands will not stick to each other.

The final stage is the extending stage and many DNA chains are produced in this step [10]. The benefit of this method is that it has strong specificity and high sensitivity, and it is also simple to operate.

6 Conclusion

Although the lung cancer is one of the deadliest cancers, it can also be regarded as one of the most controllable ones as the most common cause of the lung cancer is due to bad addictions such as smoking. However, we still cannot ignore its morbidity and mortality since thay are still on the rise. In order to find ways and means to fight against the lung cancer and save more lives, many scientists and researchers are working tirelessly to develop new drugs and treatment technologies. In order to save time, labor and funds, good and reliable instruments are crucial. The five instruments we've discussed above are commonly used by scientists to analyze drugs in different aspects, they are currently at the top of their field, and we believe that with the development of various technologies, they will help scientists to create new heights of scientific technology.

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05 Psychology

Oxford Global Summit for Young Leaders (China)

5 Psychology

Is it possible to become addicted to social media and why?

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Addiction refers to a chronic brain disorder with biological, psychological, social and environmental factors influencing its development and maintenance (American psychological association). The criteria for addiction are various. However, withdrawal and tolerance suggested clinical addiction overall. Withdrawal is the syndrome caused by the cessation of a substance. The common syndrome includes nausea, insomnia and anxiety. Tolerance refers to the significant reducing effect of the substance after continuous substance use. Patients need to increase the dose to achieve the same desired effect (American psychological association). Social media is a virtual community where people can post their daily lives, thoughts, and comments (Dollarhide, 2021). Admittedly, social media benefit people, but spending too much time on social media triggers many problems. It seems similar to an addiction process since people can't help but stop using it, so some scientists regard this new phenomenon as an addiction (Young, 1996 and Kuss&Griffiths, 2017). Nevertheless, others argue that it is impossible to become addicted to social media because aberration in clinical addiction is not seen in excessive internet users (Kardefelt-Winther et al., 2016). In this essay, we are going to argue that it is impossible to become addicted to social media from the perspective of the essential difference between overused social media and other addictive disorders, flaws in the studies that argue overused social media is an addiction, as well as explaining why people overused social media by instrumental conditioning. Finally, we will conclude that people won't become addicted to social media and propose a direction for further investigation.

First, essential differences exist between overused social media and other addictive disorders. Addictive disorders pose a far more serious threat to patients' health compared to overused social media. According to the disease model of addiction based on the medical paradigm, addiction is a primary, progressive, and final terminal illness. It will lead to premature death if left untreated (Kardefelt-Winther, 2016). Compared to drug addictions— can directly or indirectly cause death during the intoxicated state— overuse of social media cannot, at least in the early stage (Block, 2008). Many researchers suggested that overuse of social media is an addiction since social media similarly stimulates the brain as drugs. When stimulated by social media or drugs, the brain gets more dopamine than it normally does. Too much dopamine kills neurons and reduces the brain's ability to produce dopamine. At the same time, the brain becomes less sensitive to dopamine. Hence, the brain

needs more dopamine from the outside and becomes addicted to it (Lustig, 2018). We admitted there are some similarities, but it cannot prove that they are the same thing. The decrease in dopamine is distinctive with and without drugs, but it is much less distinction between the average population to the addicted to social media (Wielgosz, 2018). We can infer that compared to addictive disorder, overuse of social media poses far less threat from both physical health and brain aspects.

Rather than describing this phenomenon as addiction, we think the term overuse is more proper. There is the main difference between overuse and addiction. Overuse emphasizes quantity while the quantity has nothing to do with addiction. People tend to show addiction symptoms after intake of addictive substances for the first time, but it is unlikely to happen on social media. Also, people won't completely lose a sense of control facing social media in general, but with an addictive disorder patients are unable to control or stop the behaviour at all (Davies, 1998). Hence, people will not become addicted to social media. Instead, it is overused.

Second, the limitations of previous studies may have influenced their assessment of addiction. Neuroimaging studies suggested that internet gaming disorder (IGD) shows a pattern similar to substance addictive disorders at the molecular, neurophysiological and cognitive levels (Pontes, Kuss, &Griffiths, 2012; Kuss, &Griffiths, 2017). Also, IGD often has high levels of distress and negative academic, professional, and personal consequences similar to substance addiction (Kuss & Griffiths, 2015). Thus, it might be a type of addiction. However, we think it doesn't show the whole scene. A significant limitation exists in these studies; confounding variables play an indispensable role in it. As a result, it is difficult to prove whether similar patterns and symptoms appeared due to social media or other factors. For example, underlying disorders may influence the results. Kratzer and Hegel (2008) did a study on PIU (pathological internet use) subjects in German, and the results showed that 27 out of 30 subjects had some underlying psychological disorder, such as obsessive-compulsive disorder, anxiety disorder, and major depression. While in the control group (no PIU), only 7 of 31 have psychiatric disorders. The result suggested internet addiction may not be an independent disease, and the source of symptoms is ambiguous. In addition, Starcevic and Aboujaoude (2017) found that the similarities between IGD and OCD (obsessive-compulsive disorder) were higher than those with substance addiction. Thus, we think the distress feelings may be due to other disorders or factors. It is inappropriate to judge an addiction basis on similar symptoms when other potential variables cannot be controlled.

Third, overuse is not necessarily because of addiction although many studies have highlighted the dreadful consequences, which seems like an addiction. Instead, we think overused social media might be normal instrumental conditioning; a form of learning process build-up by associating behaviour with reinforcement or punishment The only possible difference, in this case, is that the reward is more attractive than other tasks. Armstrong et al. (2000) did a study on internet addiction (IA) patients, and they found that IA is positively correlated to low self-esteem. They suggested that heavier internet

users use the internet as an escape. Therefore, we infer that overused social media can be explained by a coping process of instrumental conditioning. Social media meets people's needs that cannot be met in reality. Users can build an unrealistic perfect self to avoid loneliness and inferiority on social media. It is easy to gain a sense of social achievement since building friendships on social media is much easier than in reality. All of these build up users' self-esteem. In a word, using social media lead to a positive outcome, which is rewarding, so people tend to use it more and more. However, addiction may not take part in the process.

In conclusion, it is impossible to become addicted to social media, instead, overuse illustrates the phenomenon better. On the one hand, different from overuse, clinical addiction can be a fatal disease. The patient will completely lose control regardless of the amount of usage. On the other hand, while overused social media shows similar symptoms to other addiction disorders, with the uncontrolled underlying variables, it is difficult to prove that these symptoms are due to social media use. Finally, addiction is not the only way to explain why people overused it. Normal instrumental conditioning works as well. People learned to use social media since they receive positive outcomes after using it. Although we think it is impossible to become addicted, overused social media still harms people, and it still matters. Nevertheless, conceptualizing the overuse of social media as a new type of disorder rather than expanding the scope of traditional addiction may be a better solution. The main reason for debate on whether it is an addiction or not is to provide more effective treatments. If researchers apply the original addiction framework to these new issues, they tend to be limited by the established framework and are unable to provide to fully understand the whole scene. Instead, more studies should start from the etiology of overused social media and lead to an innovative solution. In addition, current studies focus on pathological internet use in general, or internet gaming disorders. A few studies specify overused social media. Future researchers can investigate specific on this field since more people are using and suffering from social media now.

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Which model best generalize how people start using social media, applying evidence from age groups?

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Social media, a newly developed technology that allows users to create and share comments, pictures, or videos, or to participate in the social network, has become a significant part of people's lives (Dollarhide, 2021). According to statistics from Digital 2022: China: as of 2022, out of 1.02 billion mobile phone users in mainland China, 983 million were social media users, occupying 68% of the total population (Kemp, 2022). This large amount of users mainly resulted from not only an increase in occupational stress and social mobility but also the development and persuasion of large technology companies (Michael, 2002). Though the wide use of social media provides a highly convenient space for building online relationships, negative behavior such as violence and cyber-bullying still sometimes occur. The complexity of this platform makes some traditional theories cumbersome, which hinders the conduct of relevant research. Therefore, the purpose of this paper is to briefly introduce three models that can be used to understand social media usage: the Com-B model, the situated action cycle, and the theory of planned behavior, and evaluate why the third one is the best, applying evidence from age groups.

One way to model this process is the Com-B model. This model, developed by Michie et al. in 2011, suggested that capability, motivation, and opportunity are the three contributing factors to behavioral change. Opportunity relates to all the environmental factors that allow the behavior to occur, while motivation determines one's willingness to perform it. Capability, most importantly, refers to an individual's internal abilities, both physical and psychological, to take part in a certain activity. Barker, Atkins, and de Lusignan (2016), using structured interviews in their research, discovered that those audiologists who were capable, motivated, and had the chance to create a behavioral plan, were more likely to do so. This showed that the Com-B model is, to some extent, applicable in real-life contexts. However, regarding the use of social media, this model cannot be generalized to elder users, who might not possess the full capacity of using these applications but are still able to perform this behavior through other approaches. For instance, many elder users do not know how to type or use writing pads, but they can still communicate with people online using voicemails or video calls. They can also check on other people's updates or watch fun videos without having to know how to post them. In fact, in 2020, approximately 45% of people aged over 65 in the United States are using

social media (Pew Research Center, 2021). Moreover, during the pandemic of COVID-19, Chinese people are all required to use health codes on WeChat to transport to different places. According to the Fourth Quarter and Annual Results of Tencent in 2021 (Kong, 2022), the total number of health code users reached 1.3 billion, almost equivalent to the gross population in China (around 1.4 billion people). Therefore, the elders that cannot operate these complex systems have to learn them, which is a process missing in the Com-B model. One might argue that some capability like downloading the applications or opening the webpages is still required for one to be able to start using social media. However, many of these operations can be done by asking others for help, for instance, old people usually rely on their offspring for the set-ups and critical manipulations of social applications. Thus, this model might not be completely generalizable to the whole population and in all contexts.

A second approach to understanding why people start using social media is the situated action cycle. Unlike other models, it identifies that behavior emerges from "interactions between the body, the physical environment, and the social environment" instead of pure cognition (Barsalou, 2020). Thus, the habit formation of using social media should not be studied in isolation, since before this there must have been an "illuminating incident" from society to expose people to the technology, whether it was reading about WeChat in the news or hearing others talking about it. The next step of this model is self-relevance. A new program must meet some of our Maslow needs, which include physiological: the need for food and shelter; safety: law and protection from dangerous conditions; belonging: interaction and intimacy with others; esteem: gain status and feel respected; self-actualization: pursuing dreams and seeking happiness (CFI team, 2022). Social media applications meet many of these needs. They build a sense of belonging by helping users to contact friends; confidence by allowing the mass public to like and follow users; and self-actualization by letting users build a unique, genuine identity. This motivates more and more people to use social media. When using the platform turns out to have a good outcome, such as attracting many followers, the user's belief that social media will benefit him is reinforced. This explains the reason why there are "currently 4.48 billion people worldwide using social media," and the number is continuing to grow (Backlinco, 2022). However, this model fails to generalize the usage of social media by young people. Though many of them also have needs for communication and self-esteem, their flexibility enabled them to switch between multiple solutions other than social media. For instance, almost all young men know about social media, but some of them play video games with friends and achieve a high ranking instead. This also gives them a sense of belonging and achievement. Even if in some places, social media is the only option to satisfy both needs, users are the ultimate ones to decide whether or not to use it, which is not mentioned in the model. In addition, not all young people have adequate financial resources to access social media. According to a survey, "the official poverty rate in 2020 is 11.6%" (CensusGov, 2020). These groups of people, mostly under age 20, have an annual personal budget of $4,750 or less, so they scarcely have enough money to support an internet installation after spendings on life necessities. Even if they are motivated to use social media, their economic position does not allow them to do so. These circumstances prove that the situated action cycle is probably not the best model to generalize the start of using social media.

The last model that we are going to introduce, and the best by far, is the theory of planned behavior. What differentiates this model from others are two aspects, attitude towards behavior, and perceived behavioral control. Attitude is defined as "a learned tendency to evaluate things in a certain way" (Cherry, 2021). It is a composition of experience, social factors, learning, conditioning, and observation. Attitudes are important because they capture "how much effort will be exerted" (Ajzen, 1991). Since users have to catch up with multiple conversations and do not have much time to think when using social media, they often behave very subjectively using the System 1 (fast with many shortcuts) thinking style in the Dual-Processing Model. Thus, the firmer the attitude, the stronger the efforts, which increases the probability that the behavior will be performed. The next aspect, perceived behavioral control, refers to "people's perception of the ease or difficulty of performing the behavior of interest." (Ajzen, 1991) The higher people perceive their ability, the more likely they will perform a behavior. These two aspects together form the subject norm, which generalizes the trend of habit formation in social media. Unlike the situated action cycle, the theory of planned behavior places importance on attitude, which is much wider than just social context and self-relevance. It admits that people "are not rational creatures" (Goldhill, 2017), as many behaviors are not so simple and reflect people's emotions and beliefs. Unlike the Com-B model, this model dictates that perceived capability is more influential than real skills in decision-making. People are not perfect machines, and we may sometimes incorrectly gauge our capabilities. However, most times we do not realize the impact until later and continue performing the behavior. For instance, if a user is confident that he will attract many followers on social media, he will likely spend much time on the platform at first even if he has little capability. By adding an allowance for inaccuracy and subjectivity, instead of setting fixed parameters, this model performs much better than its two counterparts.

In conclusion, the Com-B model emphasizes one's willingness, ability, and opportunity to perform a behavior, but neglects the process of elderly people being forced to learn and adapt to a new environment due to societal pressure. The situated action cycle, although stating that environmental triggers and self-relevance are required for a behavior to occur, does not reflect on socioeconomic background, and young people's flexibility and subjectivity to choose the activity they like. In comparison, the theory of planned behavior is the most adequate model for starting social media usage because it considers an individual's attitudinal factors for starting a behavior. This is far more deterministic than hypothesizing that people make decisions simply on their living conditions and actual abilities, as human cognitive processes are complex, and admittedly, irrational sometimes. At the same time, there are still difficulties unresolved with this model, such as finding ways of accurately scaling users' attitude towards social media, but this does not affect how it generalizes habit formation, as a British statistician once said, "All models are wrong, nonetheless, some are useful" (Box, 1970).

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06 Economics

Oxford Global Summit for Young Leaders (China)

6 Economics

Oxford Global | Oxford Global Summit for Young Leaders (China)

Is fiat money dead? An economic report investigating the rise and rise of digital money in 2022

HOUCHENG LIU, CHULIN XU and YINI DU

Abstract

Globalization and digitalization has become the main theme of the current global development, people demand for improvements to make things more rapid, more convenient, more user friendly, and more equal. As fiat money was designed thousands of years ago, it's hard for this system to satisfied the current need of development. Technological developments are pushing the financial system to evolve itself and new types of currencies seem to have the possibilities of replacing the money system that haven't change for thousands of years. Cryptocurrencies have taken places and become well accepted in some industries and Central Banks have also published Central Banks Digital Assets and these are both strong competitors for the leading currencies in the future. Is fiat money dead, what will the future currency system works like, these are questions that this report is trying to figure out.

Introduction

Money is a crucial system used all around the globe. It has a great significance not just in the field of economics, but also in the history of mankind. It is the essential part of trade, present in every transaction ever made. In a wider scale, it also contributes hugely to the distribution of resources in our capitalist society. However, "money" is definitely not a fixed concept, as the system of money is constantly evolving and changing to fit our needs in trading.

In this report, we will discuss the evolution of currency, from bartering to commodity money, then to fiat money and now crypto. We will analyze our current and future economic environment, explore the different forms of money and come to the conclusion for the question "is fiat money dead?"

1. The Concept of Money

Before we jump into the analysis for our topic, the definition of money must be cleared up. Some may associate money with paper cash, while others might think of it as numbers and values shown in the exchange rate. However, money, or the currency, is a system in the society which satisfies three primary functions.

The first function is for money to serve as a medium of exchange. In a transaction, the seller will accept money from the buyer as a form of payment. Since money can be exchanged for something else, this makes the money a medium of trade between buyers and sellers. Because of the presence of money in trade, the "double coincidence of wants" will also be avoided (Ross M. Starr, 1989). The double coincidence of wants is an economic phenomenon that is present in bartering, the method of trade before money was invented.

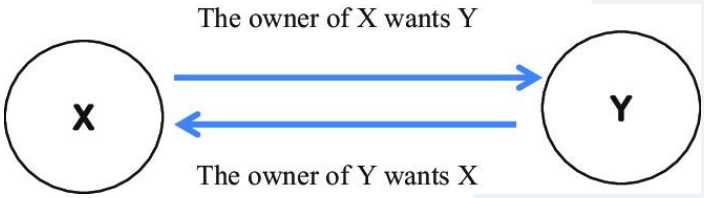


Fig.1 "Double coincidence of wants" in direct bartering

When bartering, each trader has to have something that the other trader wanted. For example, A is hoping to trade an apple with a banana to B, but B might not want the apple, thus the trade will be invalid. However, with money as the medium, this "double coincidence of wants" will no longer exist and trade will much efficient.

After that, the second function of money is to have the mechanism of storing value. Money must have the ability to store wealth from one point in time to another. They must not wear out easily and holds up to inflation or deflation. In the case of inflation, the purchasing value of the currency falls, while the price of goods will increase. In some cases, inflation may become so severe that it becomes hyper-inflation, which in turn leads to monetary meltdown (Judy Shelton, 1998).

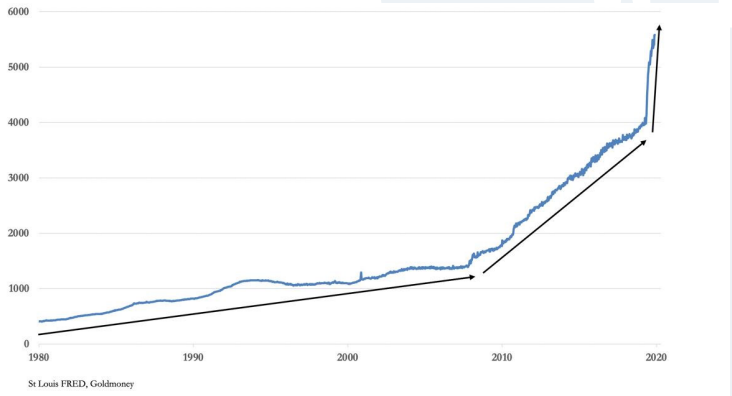


Fig.2 Example of Hyperinflation: US M1, Quantity of Money in Bn

On the other hand, deflation will also negatively affect the currency's ability to store value, as money becomes more relatively scarce and prices going down. If too much inflation or deflation happens to the money, the participants of economy will loose their confidence and trust on it's value, making this function fail. The most ideal form of economy should have a stable and low rate of inflation. For example, the Bank of England claims that they "are responsible for keeping inflation low and stable"

they are doing this by having "a target of keeping inflation at 2%". From keeping this inflation at small rise, individuals will have the incentive to spend money sooner, stimulating the economy.

Other than the impact of inflation, the characteristic of the money itself also determines its ability to store value. For example, we cannot use apples as currency, as it will spoil over time, causing it's value to be gone. In contrast, gold and other precious metals are great stores of values, considering their essentially perpetual shelf lives.

Lastly, money serves as an unit of account. It measures the relative value of goods and services by assigning and stating prices. By representing this value in numerical form, individuals will have the power of to record and measure cost, profit, prices, and performance. This form of standardization is even more important in the modern era. As massive amounts of transaction are made daily, it would be impossible to manage or record them without the unit of account. Other than these three main functions, there are also four desirable qualities of money. These qualities are scarcity, portability, divisibility and the difficulty to counterfeit or fake. From these functions and qualities, participants in the economy will develop trust in the money's value, and thus help it retain the value.

Forms of Currency

The history of money can be seen as the development to provide these functions, meet these qualities, and the history to perfecting this system. Throughout this history, three main types of money were invented and applied. The commodity money, fiat money, and crypto currency.

Commodity money is a form of physical currency which has intrinsic value. Aside from it's role as being currency, commodity money has alternative, non-monetary uses. Some historic examples of commodity money includes alcohol, salt, copper, gold, silver, tea, and tobacco. The most well-known popular example of commodity money throughout human civilization is the gold standard. As it's name suggests, gold is chosen to back up the government's monetary system.

It was so successful because of the four following properties of gold. Firstly, aside from acting as a medium of exchange, gold also has a multitude of non-monetary uses, thus it helps the currency retain a minimum level of demand. After that, because of it's physical properties, gold is divisible and will not spoil over time, loosing it's value. Next, there is a fixed stock of gold, and inflation will be limited by the speed of mining, this gold is very scarce. Lastly, gold is also impossible to perfectly counterfeit. In fact, counterfeiting gold was the main incentive for historical individuals to study alchemy, and yet there was no success. Nevertheless, gold is not portable and carrying large masses of gold can be a high risk. Thus, fiat money was developed.

Being the main form of currency our modern day society, fiat money can come in the form of paper cash, coins, credit cards, or online pay. It has no intrinsic value, and is much less physical than commodity money. Fiat money is issued by the government through the central bank, and thus it has an unlimited supply. Nevertheless, the production and distribution of fiat money are being strictly regulated by the central bank so that it holds value. In other words, it is centralized.

However, because of it's lack of scarcity and no intrinsic value, the monetary system of fiat money is

extremely vulnerable to inflation and the loss of value. For example, the American financer George Soros took advantage of this characteristic and launched speculative attacks on multiple international central banks. These attacks managed to make households loose confidence in their fiat money, breaking the economy of multiple central banks and making profit to himself.

Fig.3 Soros' attack on the Bank of England in 1992

Lastly, the characteristics of crypto currency will be further explored in the following parts of this report.

2. Crypto Currency and Mechanisms

As the progress of network technology develops in our fourth industrial revolution, a large number of tools and places of network services. The mature stage of virtual economy appears. Virtual economy is an extension of the real economy. Virtual economy is conducive to promoting the capital formation of the real economy, reducing the cost of the real economy, and reorganizing the risks of the real economy.

A cryptocurrency is a digital or virtual currency that is encrypted. Many cryptocurrencies are decentralized networks built on blockchain technology, which is a distributed ledger enforced by a distributed network. One distinguishing feature of cryptocurrencies is that they are not often issued by any central body. Each coin claims a unique function and specification. Ethereum's ether, for example, is marketed as gas for the underlying smart contract platform. Banks utilize Ripple's XRP to expedite transfers between different locations. (Jake Frankenfield, 2022)

As the Internet expands and merges as an essential tool in daily life, the use of digital currency is increasing. Additionally enhancing the security surrounding customers is the ability to stay anonymous thanks to digital currencies like Bitcoin. Digital money can be used to make payments anywhere in the world. Users can exchange digital cash with one another. We are protected from fraud because it doesn't require any kind of personal information for transactions. We are able to purchase digital currency from anywhere in the world. All we need is a reliable internet connection and a phone. Transaction fees for digital money are quite low. The decentralized nature of P2P and the algorithms themselves ensure that the currency cannot be artificially manipulated by churning out

bitcoins. Cryptographic-based designs allow bitcoin to be transferred or paid only by real owners. This also ensures the anonymity of money ownership and transactions in circulation. Notwithstanding this, some people think that digital currency is truly a tool for money laundering and other illicit acts. Since digital currency is decentralized, its value cannot be decided by the country's government.

Blockchain

The decentralized nature of blockchain, which serves as the foundation for cryptocurrencies, has proved crucial to their ascent. The fundamental idea behind blockchain technology is decentralization. Since nobody has access to the data, transactions cannot be changed, decreasing the likelihood of a system failure. Blockchain does this to create trustworthy data that can be independently validated, unchangeable, and nearly hack-proof.

A public blockchain is a distributed ledger system that anybody may join and use. It is an open version in which each peer has a copy of the ledger. This also implies that anyone with a connection to the internet may view the public blockchain. (Gwyneth Iredale, 2021)

Bitcoin was one of the first cryptocurrencies to use blockchain technology to enable peer-to-peer payments. By exploiting a decentralized network, Bitcoin can provide significantly cheaper transaction costs than well-known payment platforms. A private blockchain is a blockchain that operates in a restricted context.

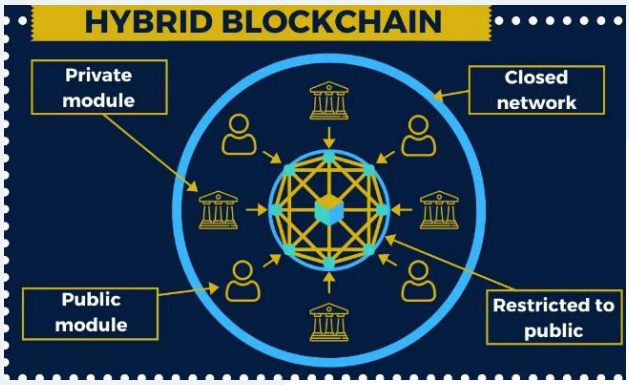
A consortium blockchain (also known as Federated blockchains) is a solution to meeting the needs of companies who want both public and private blockchain functionality.

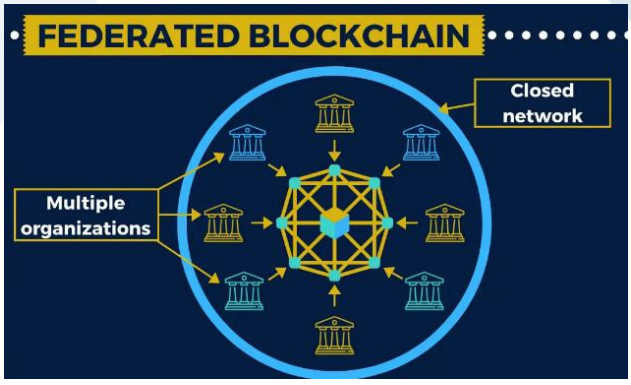
In a hybrid blockchain, it combines the advantages of both private and public blockchains.

3. Crypto Currency and Fiat Money

From the explanation of the mechanisms and examples of applications above, we can now compare and contrast the usage of digital crypto money with traditional fiat money.

The main difference between fiat money and crypto currency is the source in which they are coming from. In the case of fiat money, the central bank produces and regulates it. Different political powers will have different forms of fiat money and each fiat currency will have different purchasing value. It is this value from the legal tender that will cause inflation and deflation.





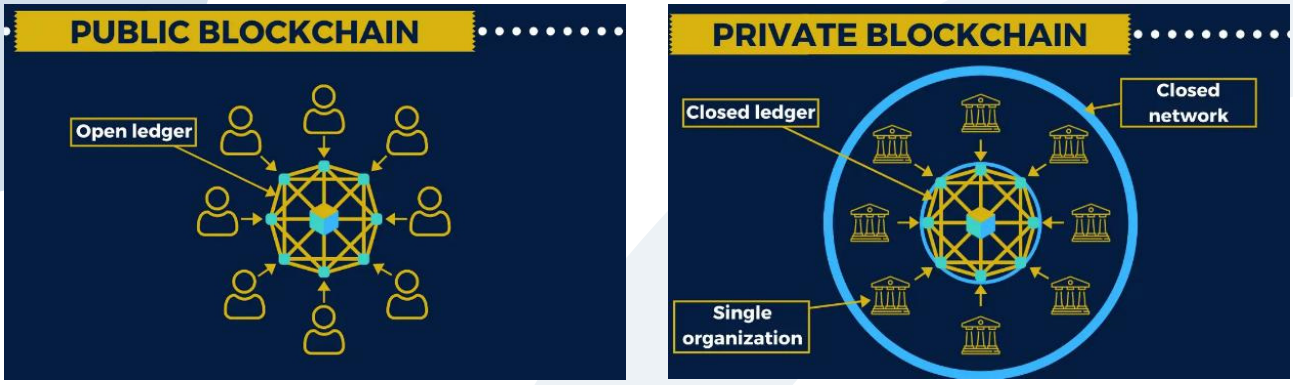


Fig.4 Four types of blockchain (cropped poster)

Crypto currency, on the other hand, are de-centralized and not regulated. Being an entirely digital form of currency generated by computers, they also do not need to print more money to adjust and adapt to the economic environment. Even though fluctuations happen within the market, the total amount of bitcoin will remain constant (Zach Wheeler, 2019). This makes inflation or deflation impossible to happen, as there is always a fixed amount.

Even though it may be vulnerable to inflation, fiat money is relatively much more safe due the regulations of the government and central bank. Most popular crypto currencies use public blockchains, the data of each transaction will be encrypted into each member of the blockchain. Since the data is encrypted, crypto can protect the trader’s privacy. However, the same feature may cause some illegal activities such as money laundry, drug trade and theft. Traders will also not be able to get a refund as transactions are irreversible. The reason for is that right after the purchase had been made, all members of the blockchain will receive the encrypted data of the purchase and it takes a lot of time to process. Fiat money, on the other hand, can allow for the centralized power to trace back the transaction. Thus, they will have much more chance in stopping these crime.

However, fist money is that it is not very assessable. Banks mostly closes at 5 pm and investments will also be disrupted by national holidays. In some counties, women, members of the LGBTQ community and homeless people are also not qualified to open a bank account. Crypto, in contrast, is extremely assessable, can provide service to anyone with no bias, and works all around the clock.

Some may argue that the usage of crypto can be hard for elder people or people who are not familiar to technology. This is even more applicable in the countries with less development, because it is mainly these same countries that are setting the limitations onto crypto.

In theory, although both crypto and fiat money have their pros and cons, considering the process of globalization, crypto has much more chance of bring applied in the future. Crypto is much more accessible, can avoid inflation, protects the privacy of users. Even though it may be a dangerous legally due to the lack of regulations caused by decentralization, crime is always a constant part of any society.

However, we do not see any sign that crypto will replace fiat money and become the main system of currency in the current society yet. The specific cause stopping crypto from replacing it, is that the

new form of currency is not yet trusted by society. We rarely see crypto being used as payment or being the medium of trade, but rather only an investment. Individuals often only buy and sell crypto to earn the return. There are two main reason behind this lack of confidence in crypto's value. First, it's volatility of is too high. The price of crypto currency it is extremely unstable, as a functioning currency requires stability. The following graph exactly shows this volatility.

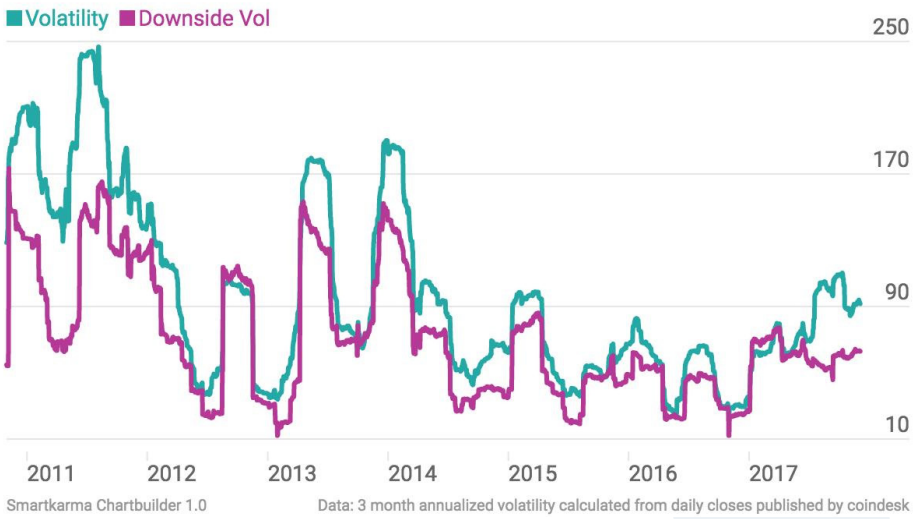


Fig.5 Volatility of bitcoin from 2011 to 2017

In just 6 years, the worth of bitcoin went through 10 periods, with extremely high changes of value.

Second, crypto's de-centralized approach also means that it has a lack of regulations to back it up. Thus, this again contributes to the instability.

However, I argue that even though there is a massive issue regarding crypto's ability to keep it's value and stabilize, it still has a lot of potential. In the short term, crypto will definitely not have the ability to replace fiat money. Nevertheless, in the long term, I believe that there is still a long way ahead for crypto, as regulations can be applied and lessen it's volatility.

4. Is Fiat Money Dead?

The fiat currency has been used for thousands of years. Ever since Ancient Rome, people had always been working on perfecting this system. However, there are still unsolved problems causing dramatic losses which can lead to the fall of the system. Due to hyper inflation, war, misdirected policies and such, fiat money can not maintain its functions perfectly, bringing the loss in its value.

Roman Denarius was the first fiat currency that have been used in the human history. It firstly appeared in the form of commodity money and it's 100% made of silver. But due to the massive amount of users, Rome had to reduce the share of sliver in the coin to 0.05% in 244CE, therefore no one use it because it lost its physical commodity value and it's not trusted since the Rome was about to fall. The same thing happens currently in Brazil, people doubting whether the financial system can maintain BRL's value, so people tend to spend all the money once they get paid.

In countries that are witnessing a hyper inflation, and for those which lost national trust on its financial system, fiat currency system's power is weakening.

Apart from internal problems, external issues is worth to concern. War has token over 20% of the total values contained in fiat money world widely (2018 Resource Investor), the destruction occurred in German during World War I and China when having a war with Mongols. The most wealthiest cities are occupied which brings a huge burden on the financial system, the spending during war daily was a huge number which worsen the case. To solve the problem, China and Germany government both chose to produce extra cash in order to cover debts and pay for workers. The denomination of cash in 1923 peaks up to 1 Trillion units Burning the currency even tended to be more efficient than using it to buy things in that period. (Dinar Dirham, 2019)

Fig 6. General overview of the Brazilian inflation rate

Hostile attack also becomes a problem, George Soros once made a huge damage to British Pounds, Thai Baht by short-selling and weaken the trust people have towards their financial system through a large scale of negative publicity. Apart from this, OPEC once published an Oil Embargo to Argentina which was one of the Top 10 Economies. Since then, Argentina is facing with a severe economic recession, the solution of it by the government is to print huge amount of cash and ultimately result in hyper inflation.

Fiat money's value can be destroyed, the system is now falling and it becomes extremely severe in some countries such as Zimbabwe.

The existence of crypto currency covers the problem fiat money has in some extent. It's value remain stable and the only influential factors to its value are market forces and users' willingness to accept the payment, in another words, it will not be influenced by supply and demand like the normal currencies do. Apart from that, crypto currencies' decentralized design makes it unregulated and bringing benefits but also failures. Code is a commonly used language, transactions in crypto currency can be an instantaneous process without any border, it can happen in any time. It's also hard for governments to regulate due to the decentralized design, the trade-off process can be easily done without central bank or any official financial organization. Meaning that every individuals can use an encrypted identity for a transaction, there is no bias in the system since every data is unreadable and no one knows who is behind the screen, but that also gives convenience to crimes, money laundry, drug dealing for instance.

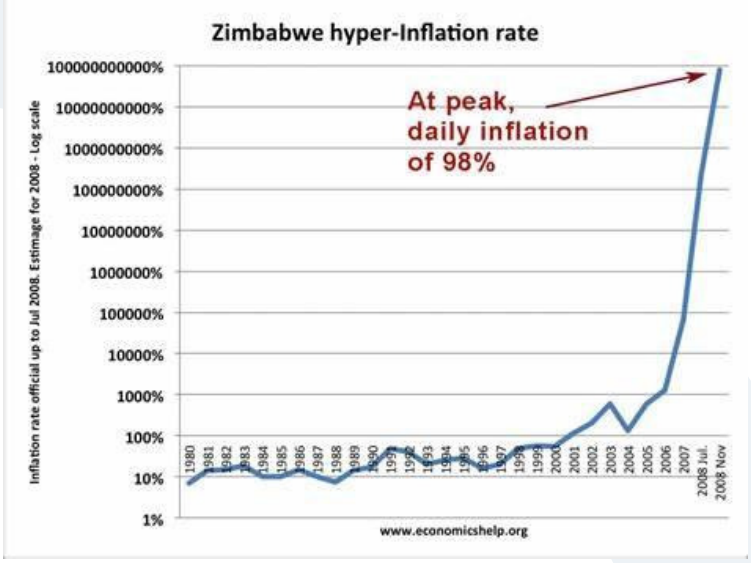


Fig 7. Hyperinflation in Zimbabwe

Fiat currency was created back in the age when globalization does not happen, so it is not designed for a cross-broad trade off.

The government came up with an idea to combine the benefits that crypto currency contains with government's regulation. Trying to make a legal, user friendly, digital form of currency and users don't need to create a bank account to be able to use it. The process has been done by some countries. China has piloted Digital RMB, Britain has its own Britcoins, plenty of countries is now making their CBDC prototype.

In order to fit well with the globalization, it may not be surprised that governments and central banks work together in order to create a global commonly used CBDC, since the world is well connected and CBDC is going to use data, the globally used language as its foundation, different financial systems may united into one single digital financial system.

Meanwhile CBDC may some how solved the problems in fiat money system, but it still a contradiction decision when CBDC will follow the similar pattern like crypto currency has—Decentralization, meanwhile, the central bank seeks for controls. That is part of the reason why governments have also been supporting some stable and scalable cryptocurrencies to develop and support the CBDC system, like Ethereum2.0. But it's hard to be a long term plan since Ethereum is still a cryptocurrency which is hard to be controlled by the government.

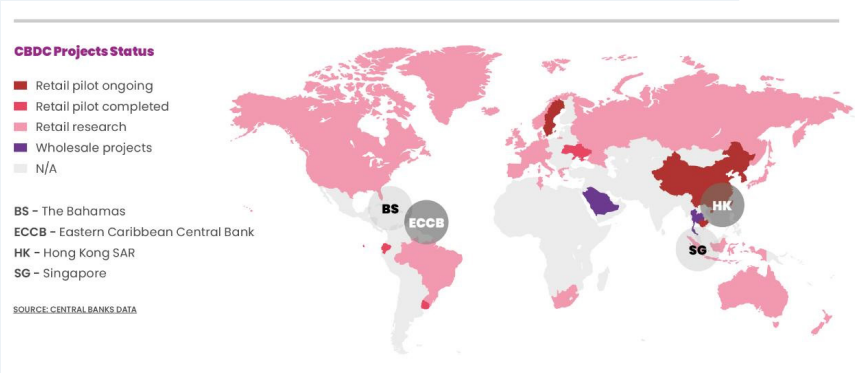


Fig 8. CBDC Project Status

Keeping up with the digitalized trend of development, fiat money also needs advancement to suit with the evolvement. According to research, their is a growing need of digital currency, people tend to rely on this system due to it's convenience. Even more, some private firm is also investing in the project which brings more competition in the market and leading to a greater prototype after all.

Conclusion

From our extensive research, we can clearly see that the crypto currency, other known as digital money, holds a unimaginable potential as it can eliminate the issue of, cope with the ever-growing trend globalization. The financial support to Ethereum2.0 is a transition until the CBDC technology goes to its mature stage. Fiat money isn't dead but still, it has to keep up with the trend of development and possibly evolve in to a digitalized form — Digital Currency, a currency that contains both advantages from fiat money and crypto currency.

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Fig No.	APA Citation
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Oxford Global | Oxford Global Summit for Young Leaders (China)

07 Testimonial

Oxford Global Summit for Young Leaders (China)

YING YAN (Chloe)

After participating in this summit, I have acquired a lot in different aspects. One of the most significant change is that I have gotten into a new field which I seldom touch—Mathematical modeling. To be honest, it is not as easy as I think. Instead, it really requires many skills including logical and critical thinking skills. However, after the courses that taught by instructors and my own after-class researches, I could gradually grasp and digest the knowledge. Overall, I really appreciate the opportunity given and I'm glad to obtain the award of essay excellence. All of this really play a vital role for my future study and help strengthening my future choices and directions.

YIHANG XIAO (Simon)

It's interesting to work on a project relevant to our lives, a great opportunity to use technology, computer soft-wares, and math.

JINER DAI (Jessica)

In this essay, we chose the topic of social media addiction. After the tutor explained the current academic disputes on this issue, I became very interested in this topic. After the group discussion, my team members also agreed to research it. The essay is my main task at the summit. I was full of confidence at first, but when I started, I found that there were still many difficulties. The information about clinical addiction criteria was difficult to understand, and the related experiments were also profound. Therefore, I read more relevant literature and essays and actively used critical thinking to evaluate the studies. Finally, I produced some of my own ideas as an essay. The whole summit made me have a deeper understanding and stronger enthusiasm for the issues related to social media and psychology. I am happy to receive this honour. Thank my teacher for answering my questions and for my team members' trust in me. I know that there are many problems in this essay that can be improved, which also motivates me to continue to study psychology and strive to finish essays of higher quality in the future.

HOUCHENG LIU (Troye)

In this ever changing world, everyone needs to seek for their balance. To find who we are, so just take a leap of faith and JUST DO!

HAOYU WANG (Alan)

本峰会中来自牛剑的导师与毕业生对于或是专业或是平时生活上的分享，人工智能的初步课程以及老师和助教们对应我们所有问题的认真回应都让我受益良多。本次课程的结业作品（让高中生组队自主 research 然后写 essay）是一个挑战。虽然我上过 AP 课程中的 seminar，对于 research 和写 report 有一定的了解。但是时间上的紧张还是给了我很大的压力，我们组从开始 research 到开始 presentation 一共就用了三天大概。我峰会中遇到的最大困难是在最终展演的时候家里停电了，然后最后是用手机在外面讲的。总而言之，峰会给了我一个机会去锻炼自己能力的机会并为我的未来发展打开思路。

SHANGYUAN LI (Paul)

在这八天的活动中，我受益匪浅。我跟随 Mehrsa 导师和四位助教学习了关于 CS 机械学习的相关知识。我们小组利用三天的时间写出了 final essay 并在最后一天出色地完成了展示。这其中离不开每一个人的努力。同时我要感谢所有支持这个项目的老师，同学和家长。谢谢！

LIUHAICHEN YANG (Ocean)

此次活动让我结识了来自全国各地的朋友以及来自全球各地并且在牛津大学学习、做研究的老师，很荣幸与他们一起学习机器学习的相关知识。项目中的小组任务提升了我与队友沟通的能力，让我学会如何让 essay 更具有逻辑性。牛津式的 lecture+tutorial 学习模式让我受益匪浅，与 facilitator 的讨论解决了我在 lecture 中的问题，也让我更好地理解 lecture 的内容。

更重要的是，在这次活动后我坚定了学习计算机科学的决心，也将牛津大学作为第一选择。

JIANYUAN REN (William)

在参加这次活动之前，我仅仅只是了解了关于数学建模的一些定义，并没有对建模深入学习，但在这一次的牛津学术云峰会中，在老师的教导和指导下，我们以小组为单位，共同建模了关于 2050 年世界人口预测的模型，在准备论文和最终演讲的时候，TA 也针对我们写的提纲进行了修改建议，并告知了我们一些论文编写的要点。因为我们是以小组为单位进行论文编写的，而且我们每个人负责的部分是不一样的但每个部分又是紧密联系的，所以在上课和小组讨论的时候，我熟悉了团队合作的一些要领。在课后时间，我们也通过 zoom 会议关于我们的课题进行小组讨论，每个人都进行了思维上的碰撞，最后我们取其精华，去其糟粕，并通过我们个人的学术能力，如我通过编程来简便我的计算，并绘制图表，其他人通过函数建模，文献搜索阅读也各自贡献了很多，最终我们也赢得了 Essay Excellence Award 和 presentation Excellence Award 。 牛津学术云峰会每天早上都会有助教来分享学习的经验，也有申请的经验，这些课程对我来说都是非常有用的，同时下午的课程是以牛津的小班课形式进行的，这也让我提前接触了大学中上课的形式，同样的，这次的论文编写也让我积累了很多的经验。我相信这次牛津学术云峰会的经历将会成为我人生中一次深刻的记忆，并且我相信这次经历对我未来大学生活甚至工作有很大的帮助。

YINI DU (Lily)

我很荣幸能拿到这个论文奖，和组里的朋友们讨论主题，这样更清楚地分配了任务还能在不同领域学到各种各样的知识。一分耕耘一分收获，同时也非常感谢朋友们的指教，这为我以后学习中奠定了更好的基础和经验。

YUXUAN FU (Henry)

谢谢各位老师的帮助与鼓励。很荣幸能够有机会参加此次活动，并且个人也非常荣幸有机会可以发表论文，感谢项各位老师和项目负责人的指导帮助和肯定。谢谢！

HAO LI (January)

老师和助教真的超级用心 ~ 不管有没有基础 , 都是可以来尝试的 ~ 满分推荐 ~

08 Appendix

Oxford Global Summit for Young Leaders (China)

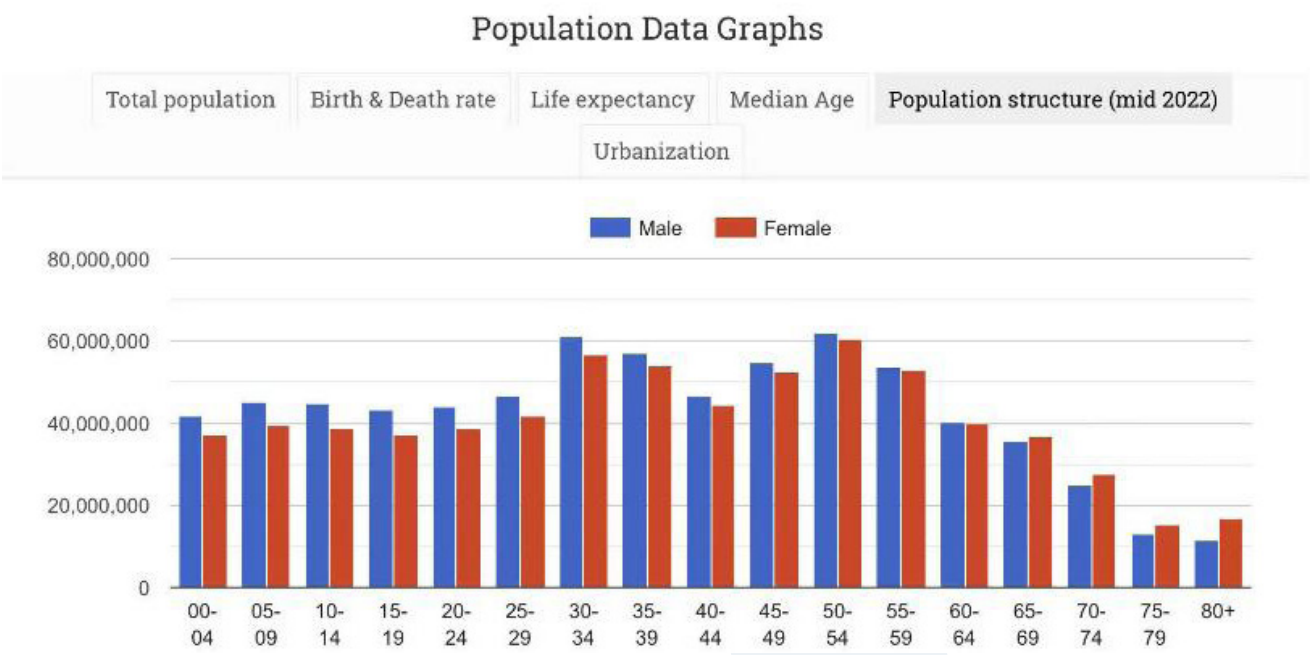


Figure 1

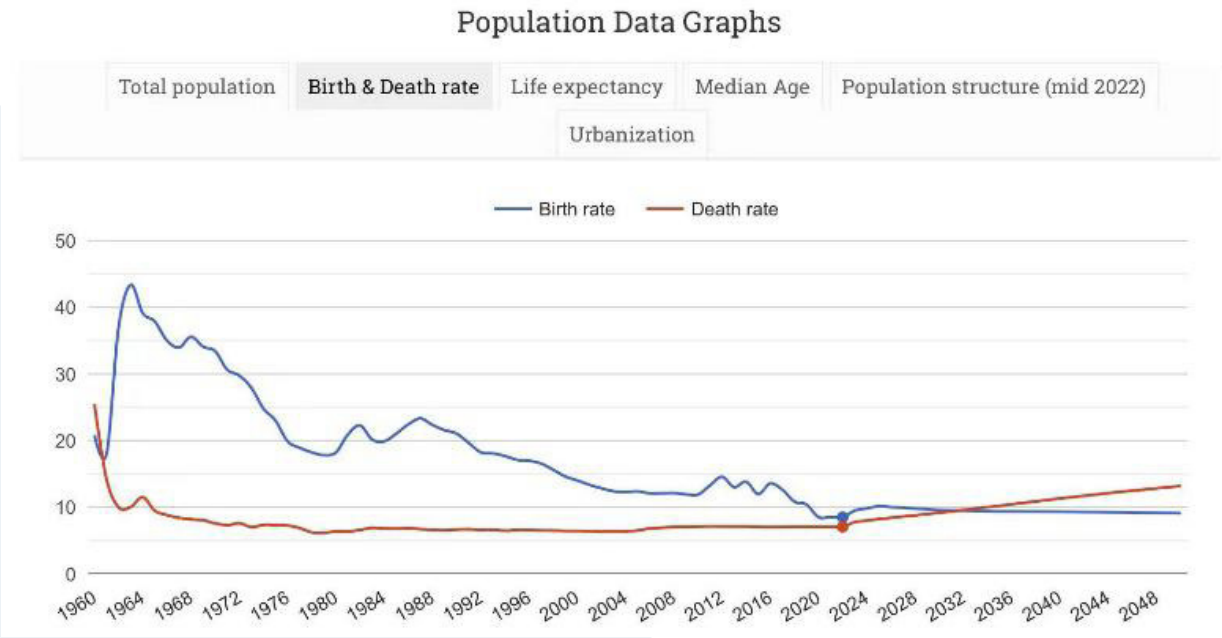


Figure 2

China Population History

Show by | 10 years | 5 years | 1 year | main data | all data

YEAR	TOTAL	MALE	FEMALE	SEX RATIO	GROWTH RATE	BIRTH RATE	DEATH RATE	FERTILITY RATE	LIFE EXP., TOTAL	LIFE EXP., MALE	LIFE EXP., FEMALE	MEDIAN AGE	URBANIZATION
2022	1416 M	726 M	690 M	1.05	0.21%	8.52	7.07	1.70	77.10	74.95	79.41	38.12	63.56%
2020	1411 M	724 M	687 M	1.05	0.21%	8.52	7.07	1.70	77.10	74.95	79.41	37.42	61.43%
2015	1380 M	709 M	671 M	1.06	0.70%	11.99	7.07	1.67	75.93	73.79	78.29	35.70	55.50%
2010	1338 M	687 M	650 M	1.06	0.67%	11.90	7.11	1.63	74.41	72.48	76.57	34.03	49.23%
2005	1304 M	670 M	634 M	1.06	0.90%	12.40	6.51	1.61	72.99	71.30	74.85	31.57	42.52%
2000	1263 M	648 M	615 M	1.05	1.18%	14.03	6.45	1.60	71.40	69.60	73.41	28.98	35.88%
1995	1205 M	618 M	587 M	1.05	1.61%	17.12	6.57	1.66	69.89	67.92	72.10	26.35	30.96%
1990	1135 M	582 M	553 M	1.05	2.16%	21.06	6.67	2.31	69.15	67.45	71.00	23.86	26.44%
1985	1051 M	539 M	512 M	1.05	2.10%	21.04	6.78	2.65	68.47	67.00	70.02	22.55	22.87%
1980	981 M	504 M	478 M	1.05	1.87%	18.21	6.34	2.61	66.84	65.43	68.30	20.86	19.36%
1975	916 M	470 M	446 M	1.05	2.14%	23.01	7.32	3.86	63.92	62.53	65.32	19.28	17.40%
1970	818 M	420 M	398 M	1.05	3.40%	33.43	7.60	5.73	59.09	57.33	60.90	18.26	17.40%
1965	715 M	368 M	347 M	1.06	2.99%	37.88	9.50	6.39	49.55	47.96	51.26	18.76	18.09%
1960	667 M	344 M	323 M	1.06	-0.18%	20.86	25.43	5.76	43.73	42.43	45.19	20.26	16.20%

Figure 3

Population Data Graphs

Total population | Birth & Death rate | Life expectancy | Median Age | Population structure (mid 2022) | Urbanization

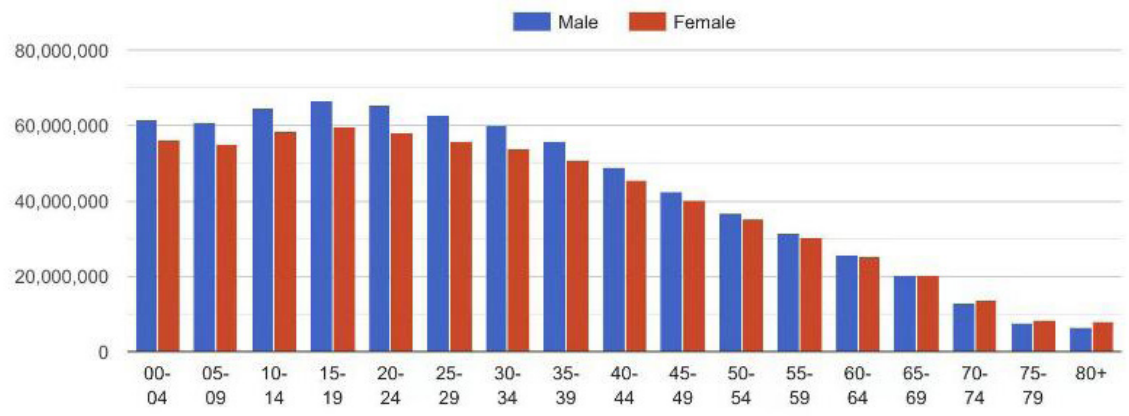


Figure 4

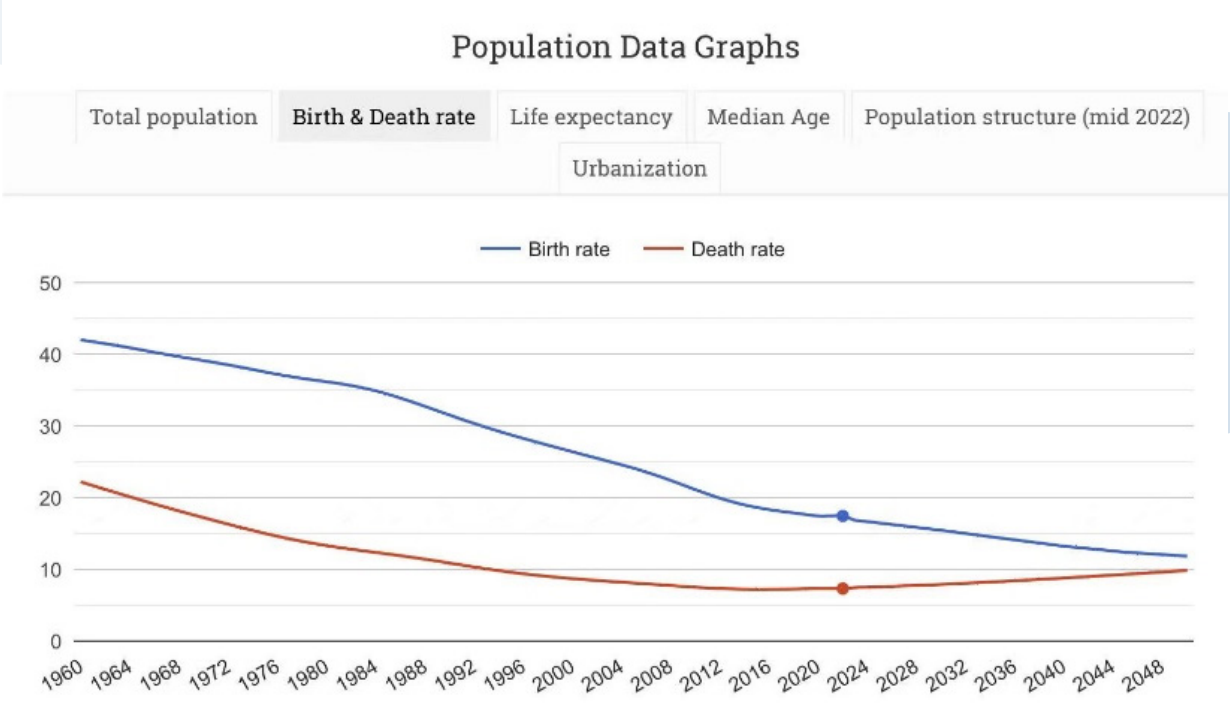


Figure 5

India Population History

Show by 10 years | 5 years | 1 year | main data | all data

YEAR	TOTAL	MALE	FEMALE	SEX RATIO	GROWTH RATE	BIRTH RATE	DEATH RATE	FERTI-LITY RATE	LIFE EXP., TOTAL	LIFE EXP., MALE	LIFE EXP., FEMALE	MEDIAN AGE	URBANI-ZATION
1960	451 M	233 M	218 M	1.07	0.89%	42.00	22.18	5.91	41.42	42.27	40.53	19.18	17.92%
1970	555 M	287 M	268 M	1.07	1.28%	39.11	17.19	5.59	47.74	48.35	47.10	18.32	19.76%
1980	699 M	362 M	337 M	1.08	1.72%	36.17	13.29	4.83	53.81	53.76	53.91	19.20	23.10%
1990	873 M	453 M	420 M	1.08	1.90%	31.52	10.86	4.05	57.87	57.54	58.23	20.09	25.55%
2000	1057 M	549 M	507 M	1.08	2.04%	26.40	8.69	3.31	62.51	61.73	63.33	21.71	27.67%
2010	1234 M	642 M	592 M	1.08	1.82%	21.11	7.49	2.58	66.69	65.72	67.73	24.10	30.93%
2020	1380 M	717 M	663 M	1.08	1.39%	17.44	7.30	2.18	69.89	68.68	71.20	27.43	34.93%
2022	1407 M	731 M	676 M	1.08	1.39%	17.44	7.30	2.18	69.89	68.68	71.20	28.05	35.87%

Figure 6

Population Data Graphs

Total population | Birth & Death rate | Life expectancy | Median Age | Population structure (mid 2022) | Urbanization

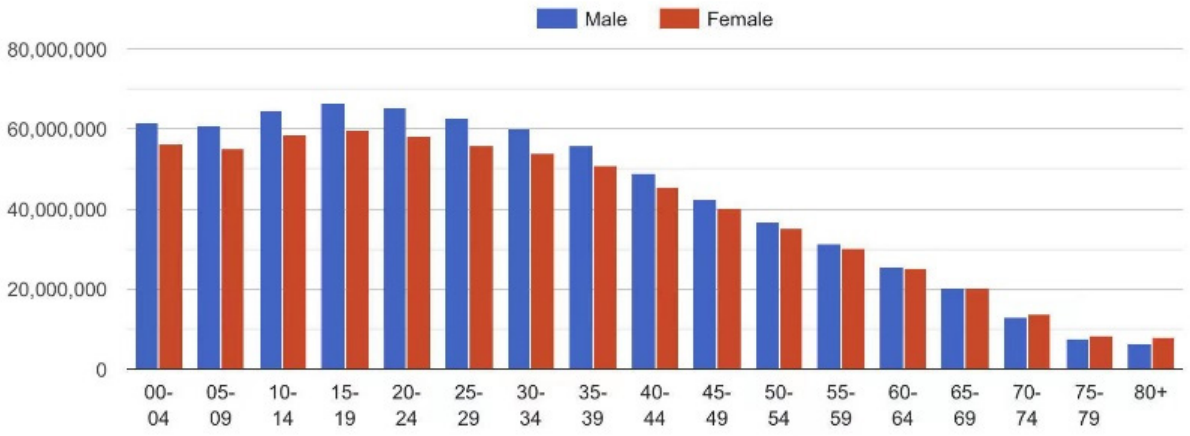


Figure 7

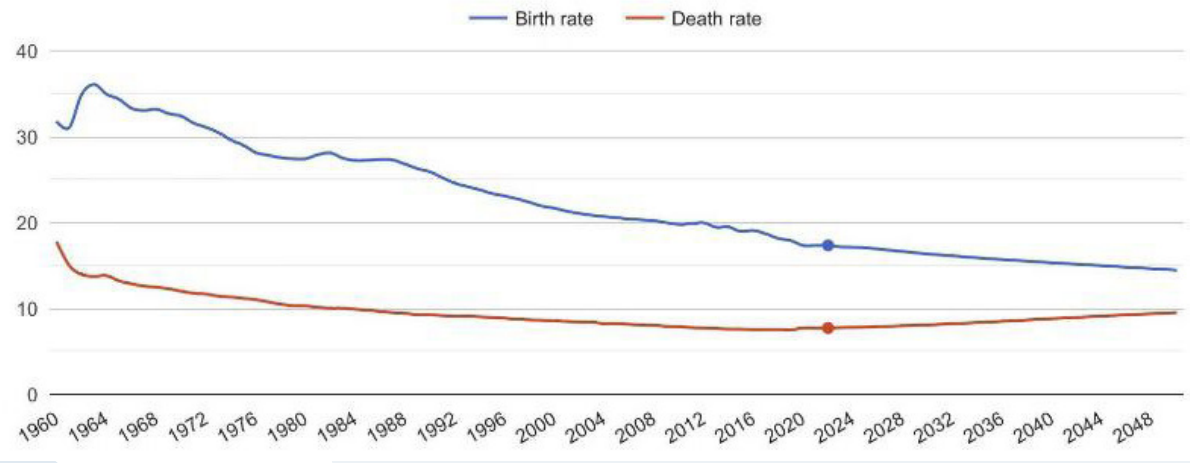


Figure 8

World Population History

Show by 10 years | 5 years | 1 year | main data | all data

YEAR	TOTAL	MALE	FEMALE	SEX RATIO	GROWTH RATE	BIRTH RATE	DEATH RATE	FERTILITY RATE	LIFE EXP., TOTAL	LIFE EXP., MALE	LIFE EXP., FEMALE	MEDIAN AGE	URBANIZATION
1960	3032 M	1516 M	1514 M	1	0.79%	31.75	17.71	4.98	52.58	50.74	54.61	21.65	33.62%
1970	3682 M	1845 M	1835 M	1.01	1.70%	32.38	11.99	4.78	58.58	56.58	60.75	20.52	36.55%
1980	4433 M	2226 M	2205 M	1.01	1.67%	27.42	10.27	3.71	62.84	60.77	65.09	21.60	39.35%
1990	5280 M	2655 M	2622 M	1.01	1.80%	25.88	9.23	3.25	65.43	63.29	67.75	23.04	43.03%
2000	6114 M	3077 M	3035 M	1.01	1.53%	21.65	8.55	2.70	67.55	65.41	69.87	25.33	46.69%
2010	6922 M	3488 M	3431 M	1.02	1.52%	19.78	7.85	2.52	70.56	68.43	72.84	27.46	51.65%
2020	7764 M	3913 M	3848 M	1.02	1.25%	17.33	7.71	2.39	72.75	70.57	75.06	29.88	56.16%
2022	7914 M	3988 M	3923 M	1.02	1.25%	17.33	7.71	2.39	72.75	70.57	75.06	30.33	57.01%

Figure 9

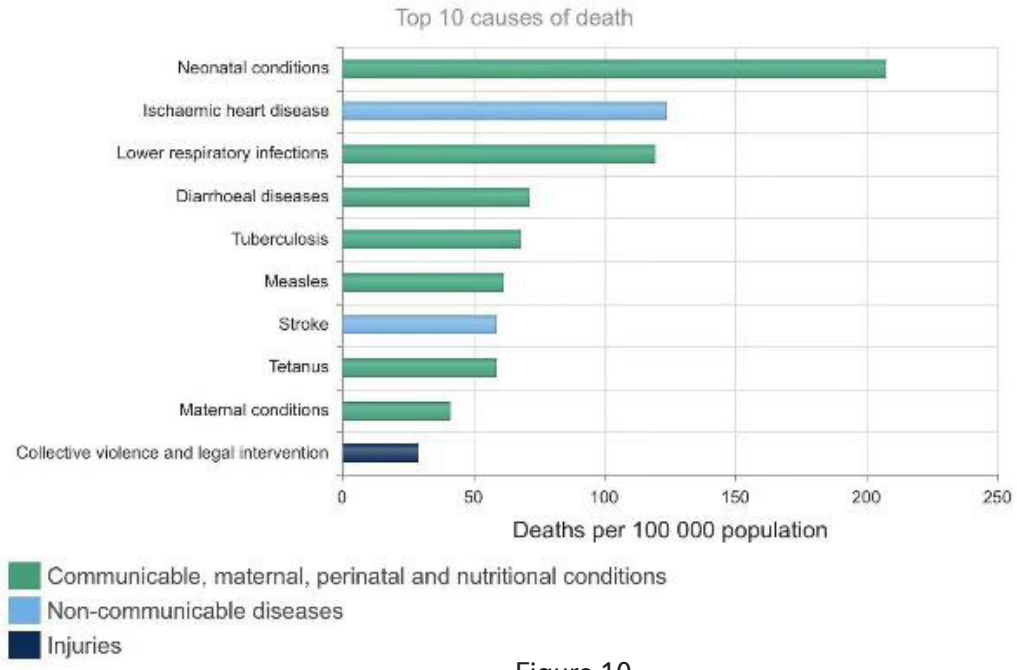


Figure 10

Chapter 1.2

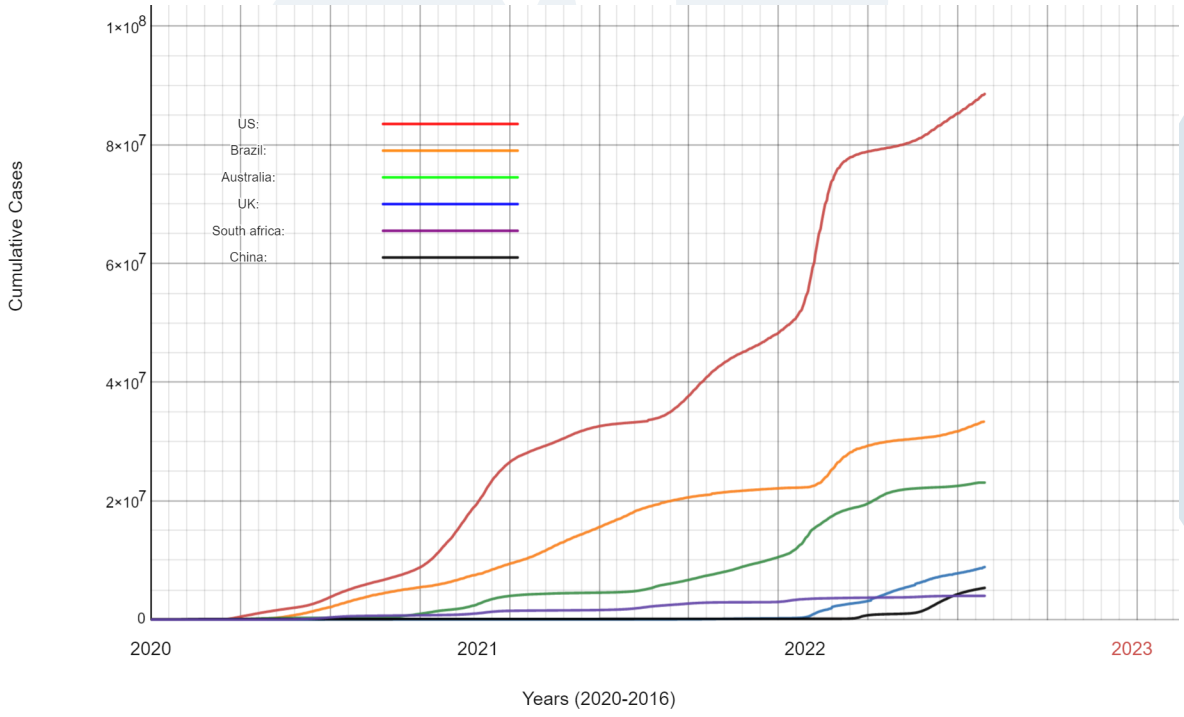
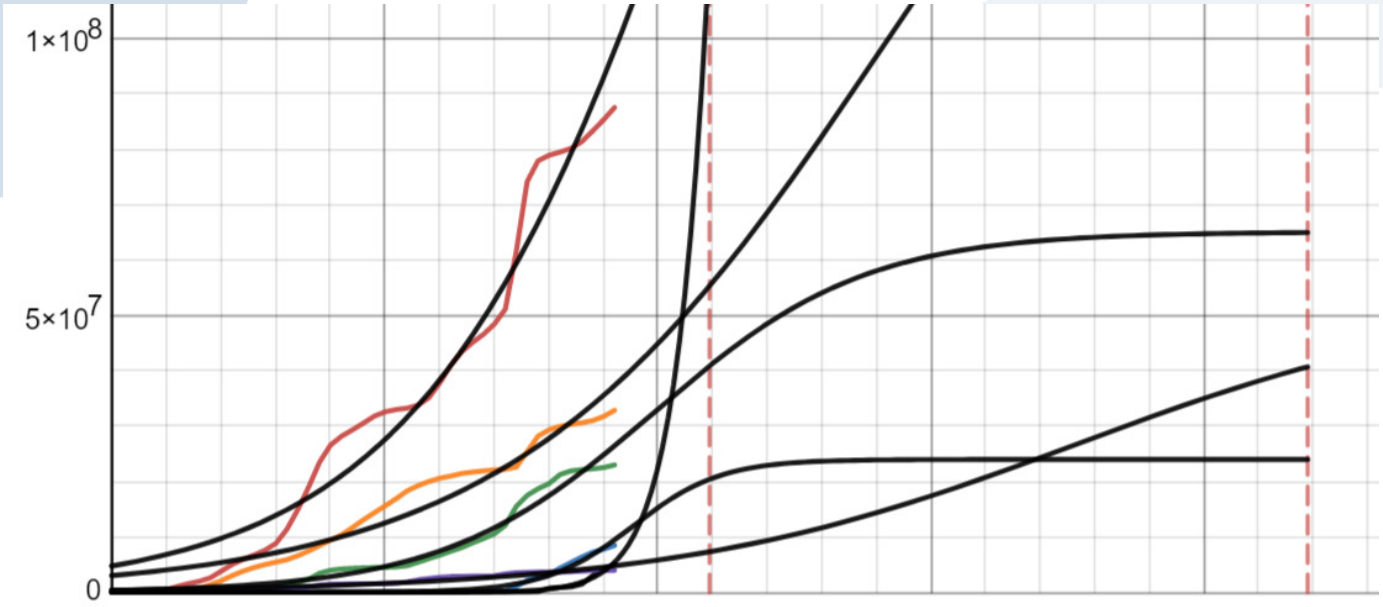


Figure 1



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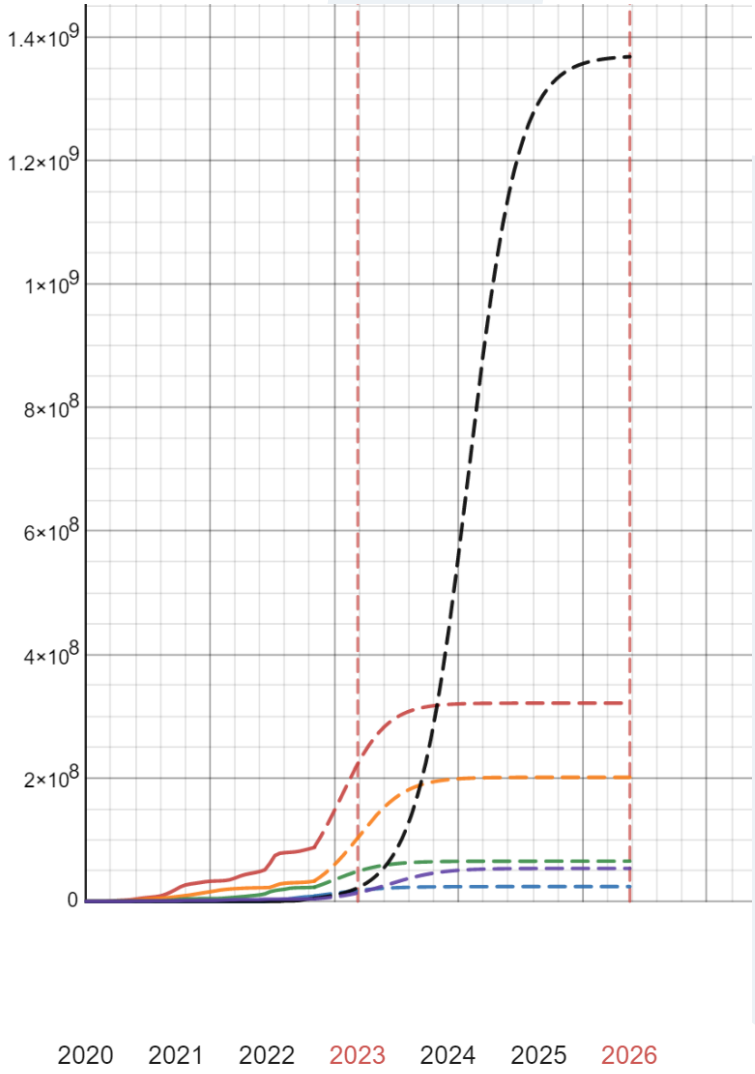

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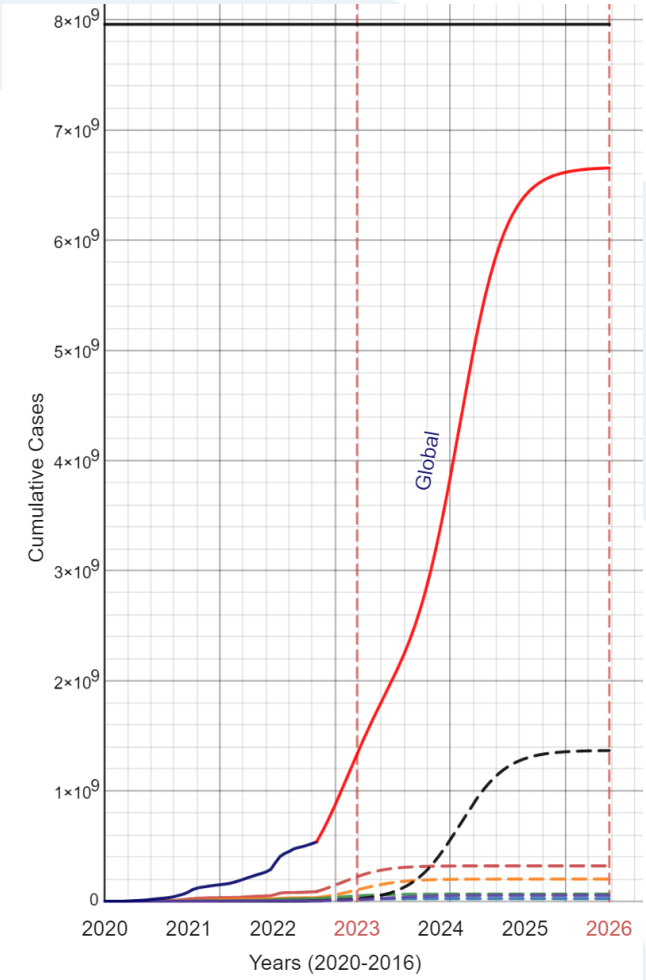

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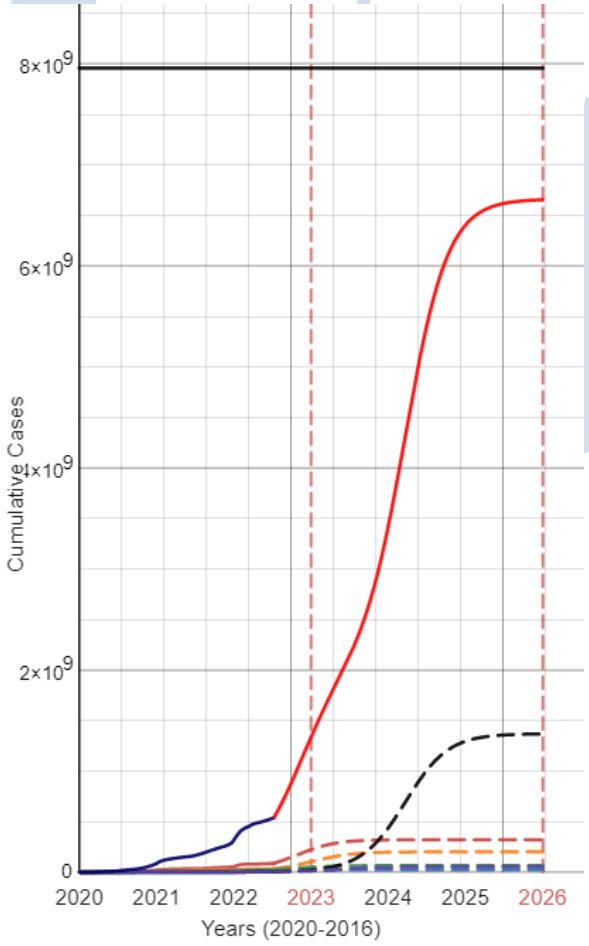


Figure 5

Chapter 1.3

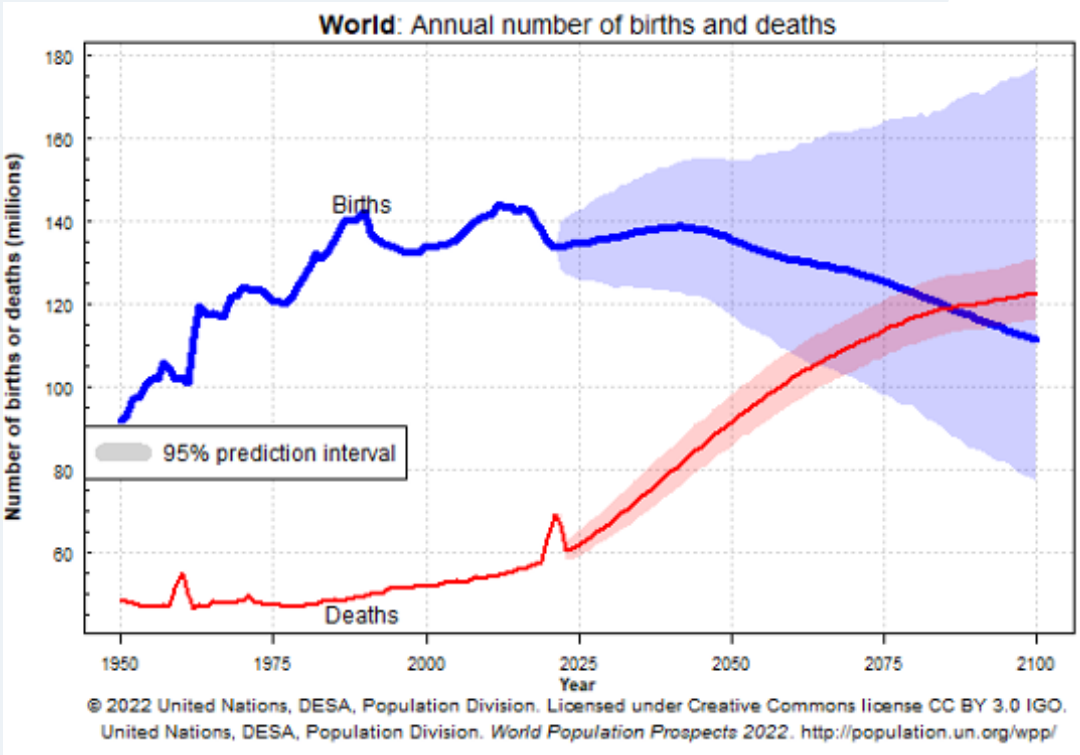
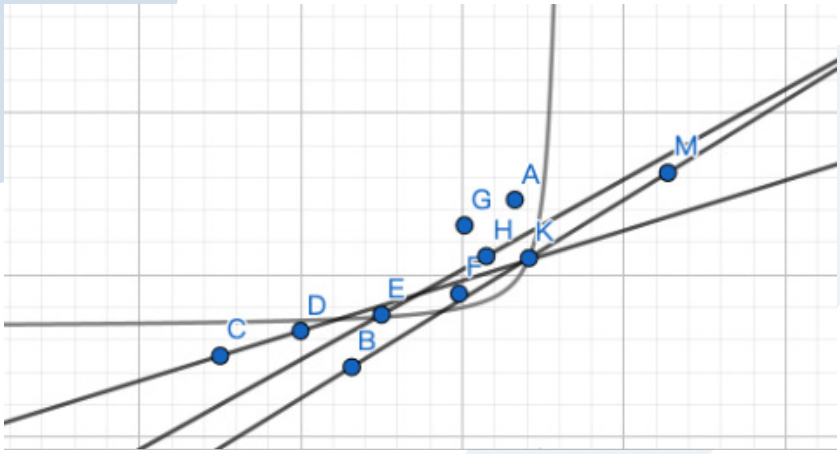


Figure 1



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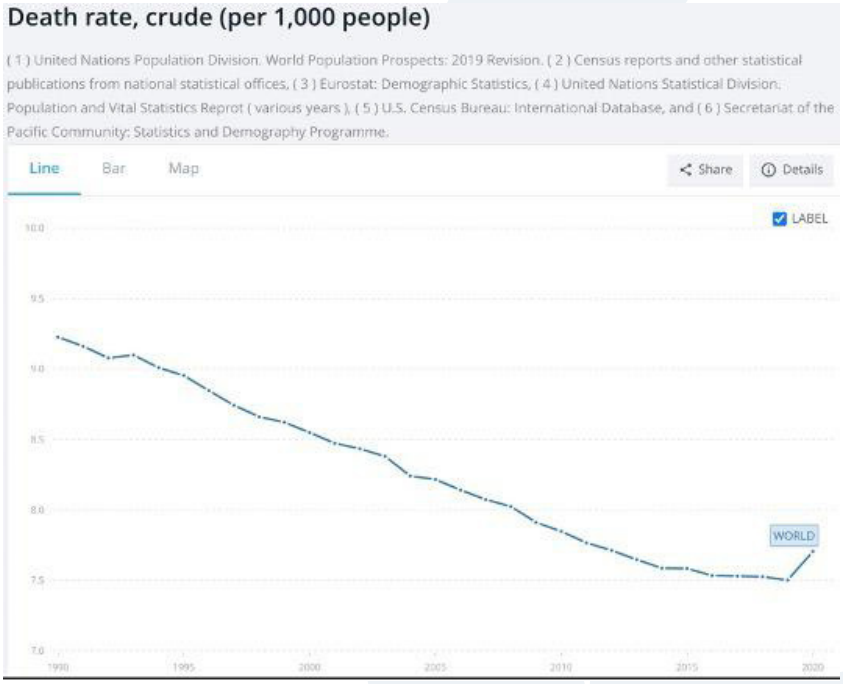

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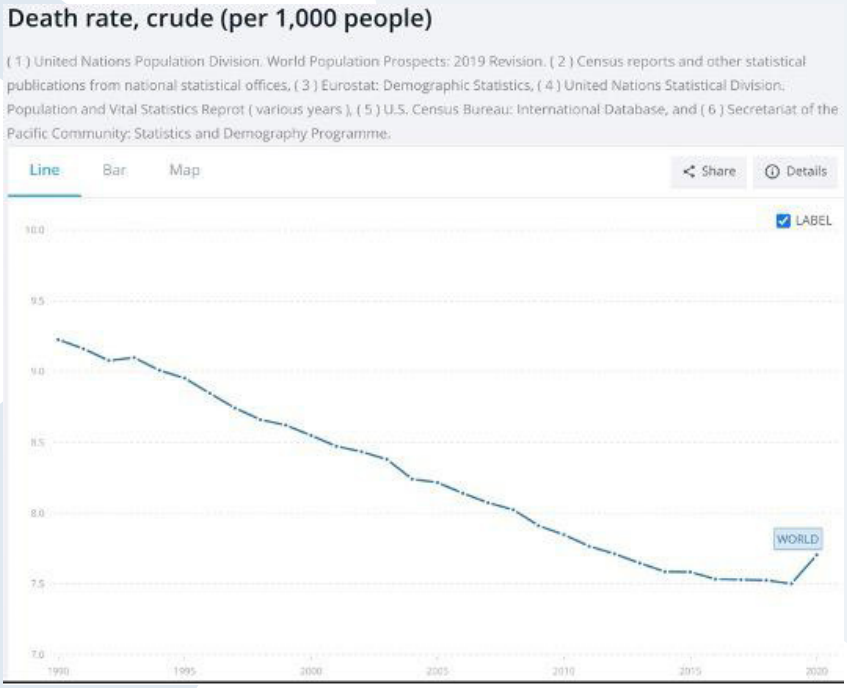

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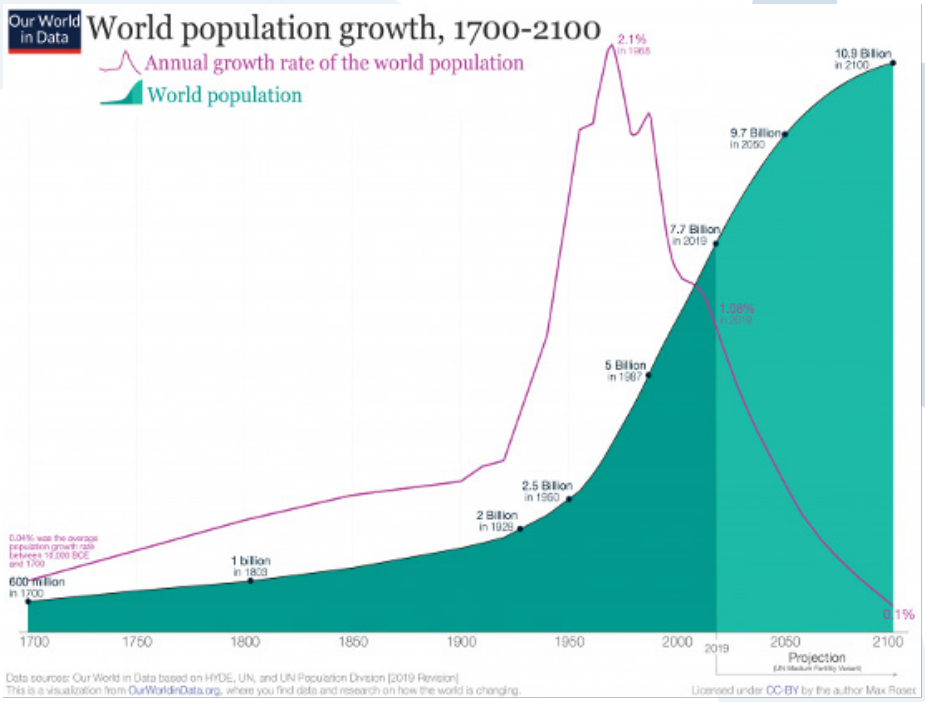

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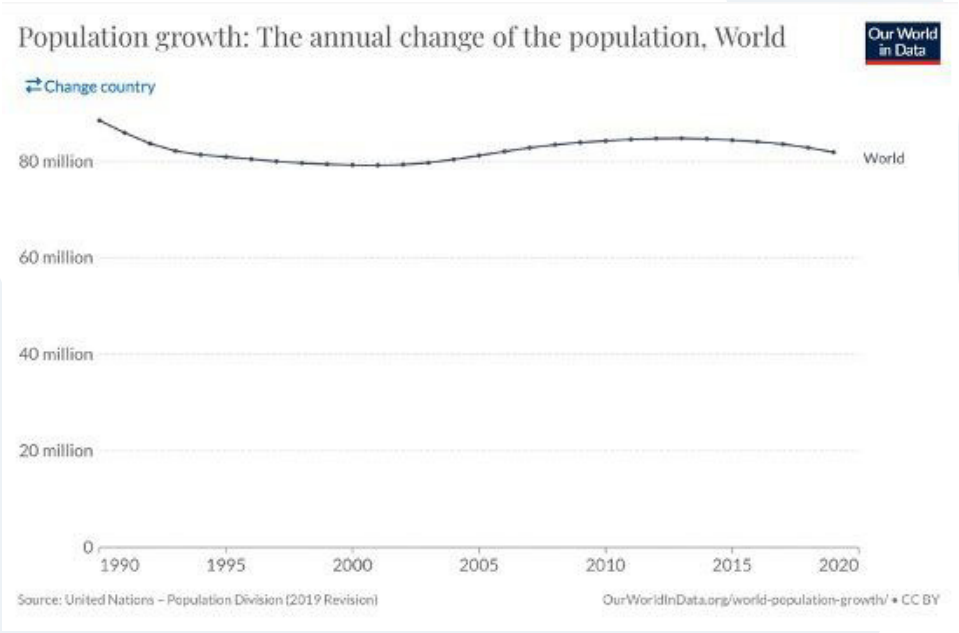


Figure 6

year(July 1)	population
2020	7794798739
2019	7713468100
2018	7631091040
2017	7547858925
2016	7464022049
2015	7379797139
2010	6956823603
2005	6541907027
2000	6143493823
1995	5744212979
1990	5327231061

Figure 7

year(July 1)	Yearly(%) Change)
2020	1.05%
2019	1.08%
2018	1.10%
2017	1.12%
2016	1.14%
2015	1.19%
2010	1.24%
2005	1.26%
2000	1.35%
1995	1.52%
1990	1.81%

Figure 8

year(July 1)	Yearly Change
2020	81330639
2019	82377060
2018	83232115
2017	83836876
2016	84224910
2015	84594707
2010	82983315
2005	79682641
2000	79856169
1995	83396384
1990	91261864

Figure 9

year(July 1)	Median Age
2020	30.9
2019	29.8
2018	29.8
2017	29.8
2016	29.8
2015	30
2010	28
2005	27
2000	26
1995	25
1990	24

Figure 10

year(July 1)	Fertility Rate
2020	2.47%
2019	2.51%
2018	2.51%
2017	2.51%
2016	2.51%
2015	2.52%
2010	2.58%
2005	2.65%
2000	2.78%
1995	3.01%
1990	3.44%

Figure 11

```
function data_reshape = getCsvData(filename)
%GETCSVDATA load the csv data into cell array

    fileID = fopen(filename,'r');
    % Start row is 1 since the first line is the heading (name of the columns)
    startRow = 1;
    data = textscan(fileID, '%d %d\n', 'Delimiter', ';',...
        'HeaderLines', startRow,'ReturnOnError', false);
    fclose(fileID);

    [M N] = size(data{1,1});
    data_reshape = cell(M,2);

    for i=1:M
        data_reshape{i, 1} = data{1,1}(i);
        data_reshape{i, 2} = data{1,2}(i);
    end
end
```

Figure 12

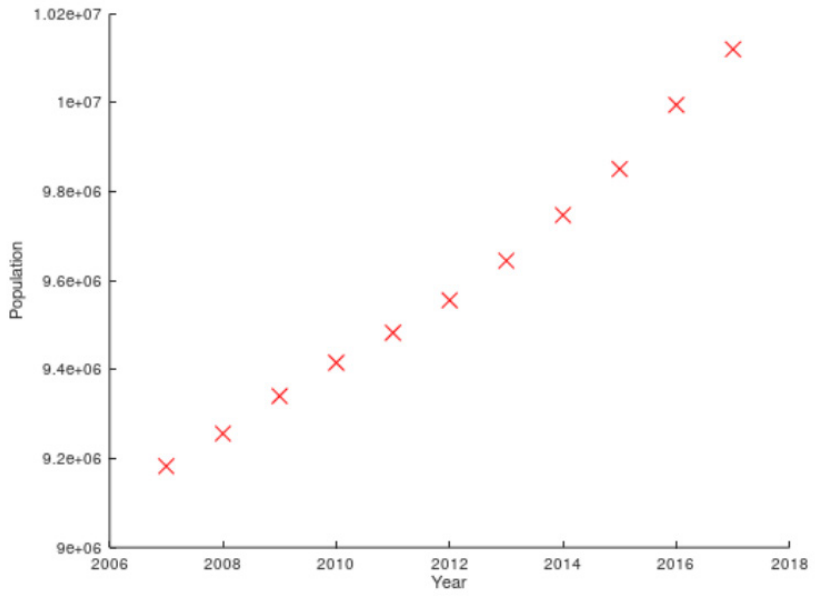


Figure 13

```
1   function theta = gradientDescent(X, y, theta, alpha, num_iters)
2   %GRADIENTDESCENT Performs gradient descent to learn theta
3   % by making num_iters number of iterations with step alpha
4
5   % Initialize variables
6   m = length(y);
7
8   for iter = 1:num_iters
9       % Calculate step by formula
10      step = (alpha/m);
11      % Calculate difference between expected and predicted values
12      matrix = (X * theta) - y;
13      % Adjust the theta values
14      theta = theta - (step * (X' * matrix)) ;
15  end
16  end
```

Figure 14

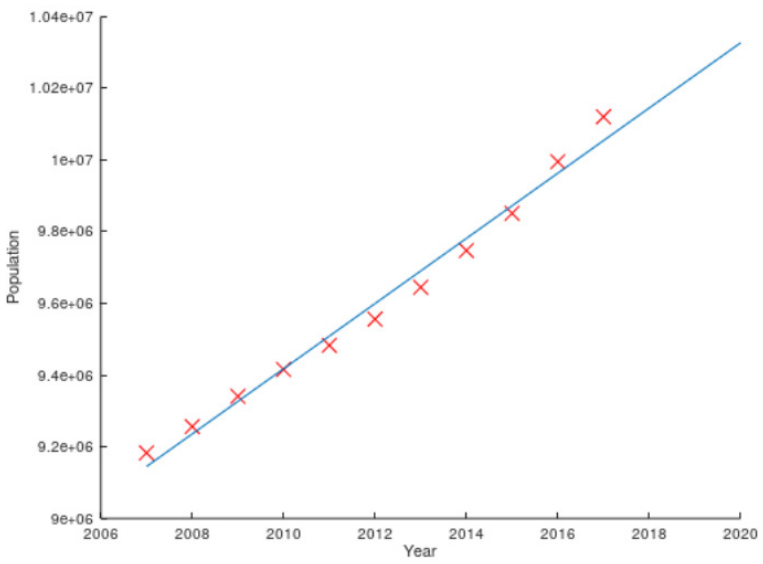


Figure 15

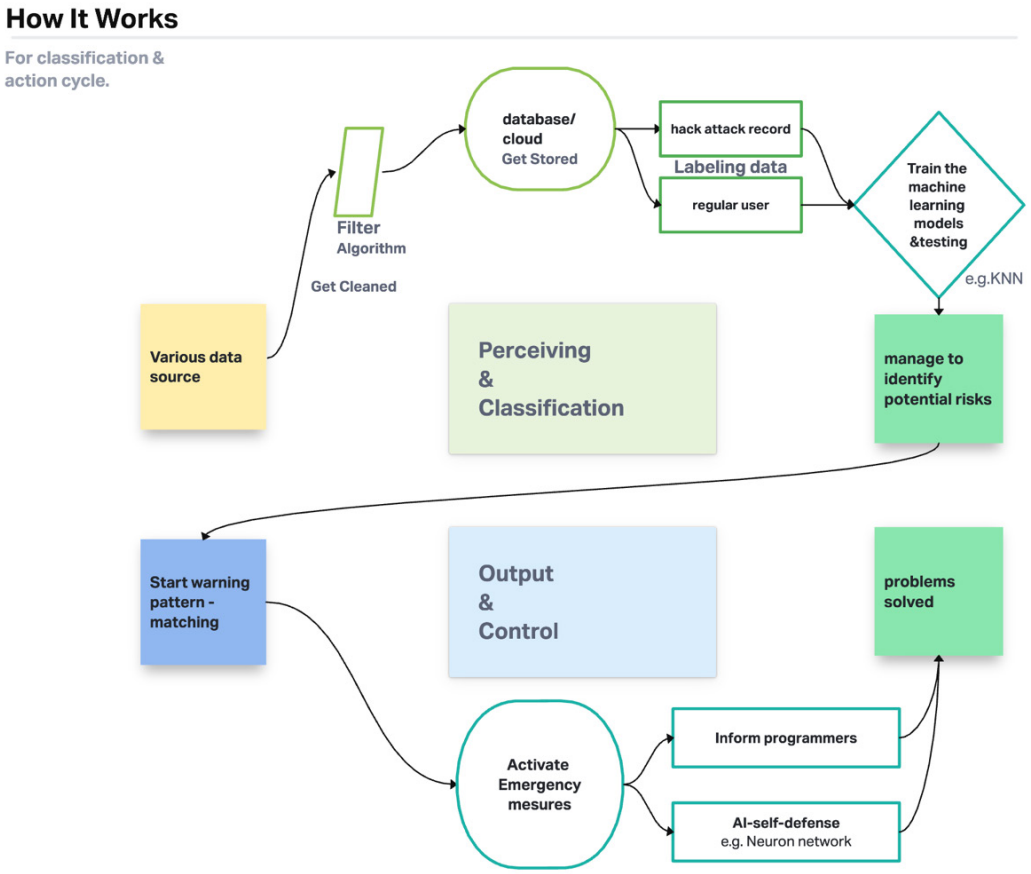


Figure 1

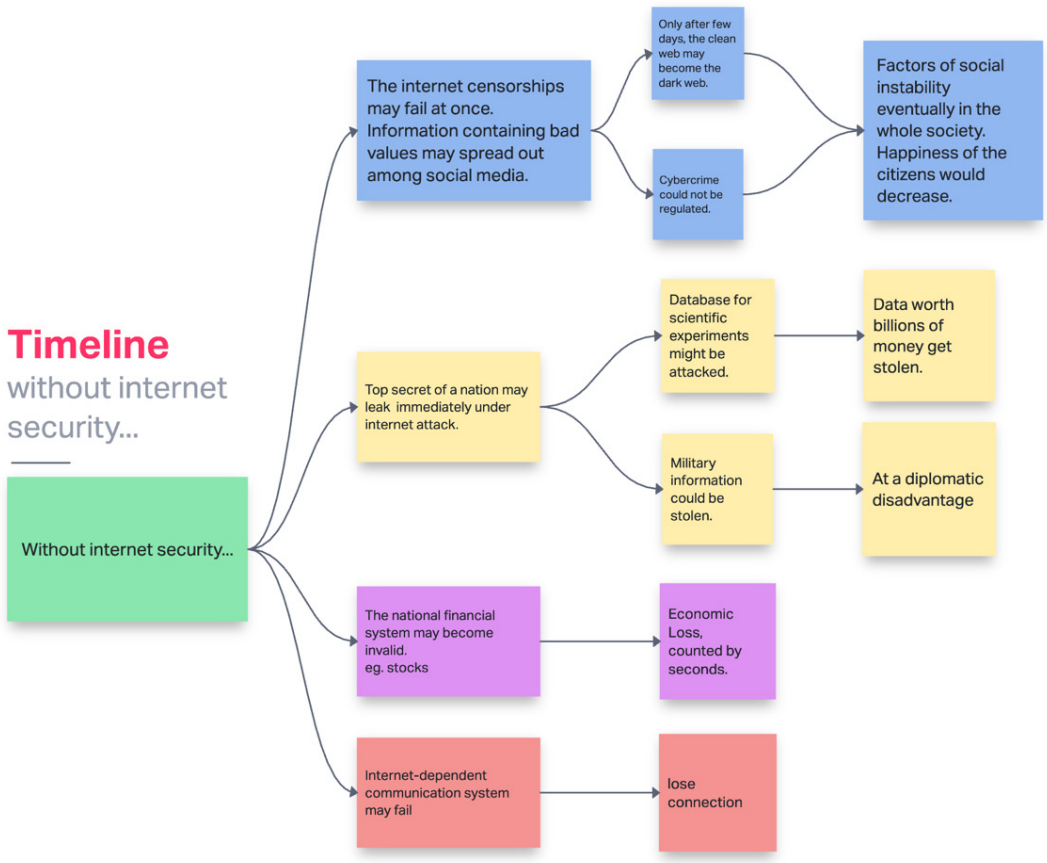


Figure 2

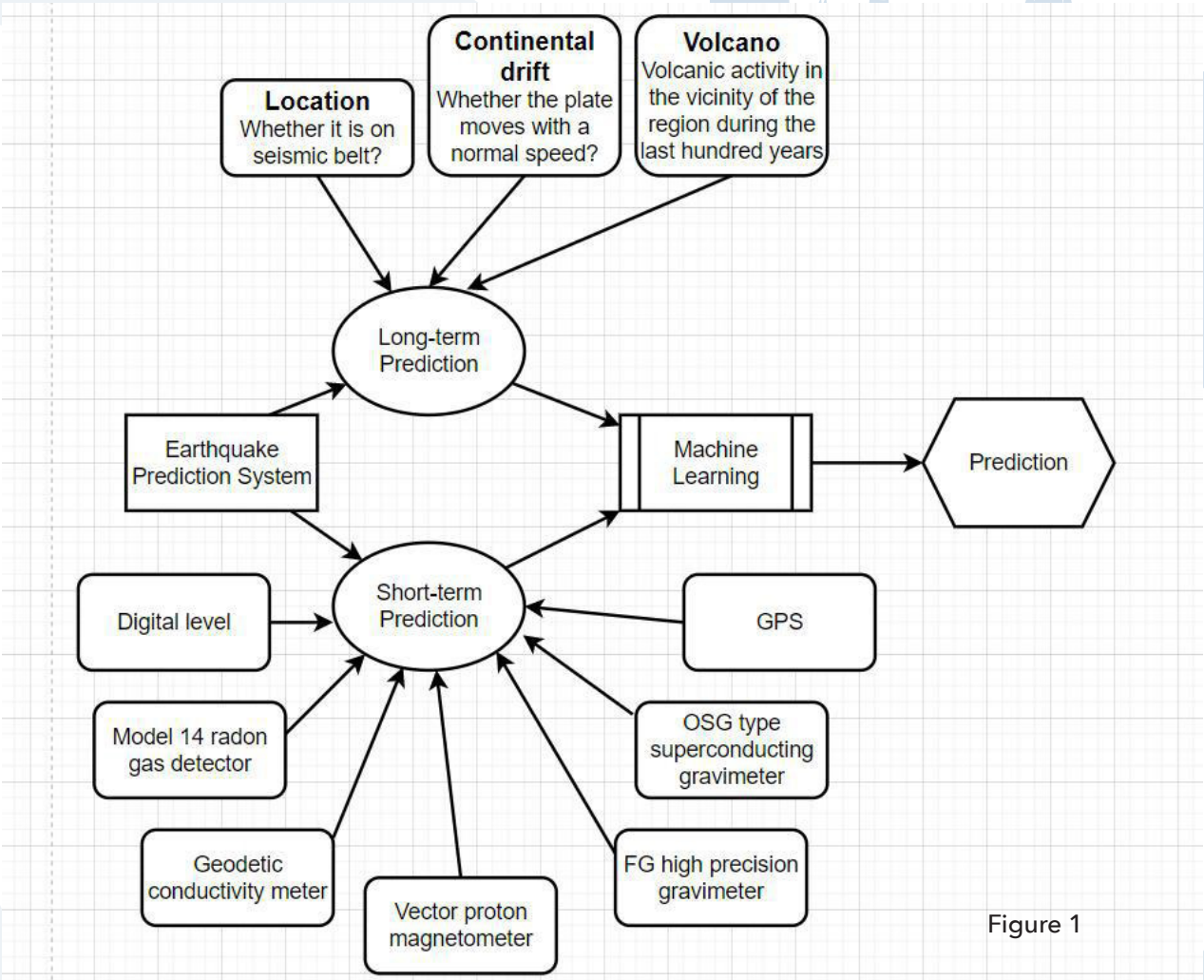


Figure 1

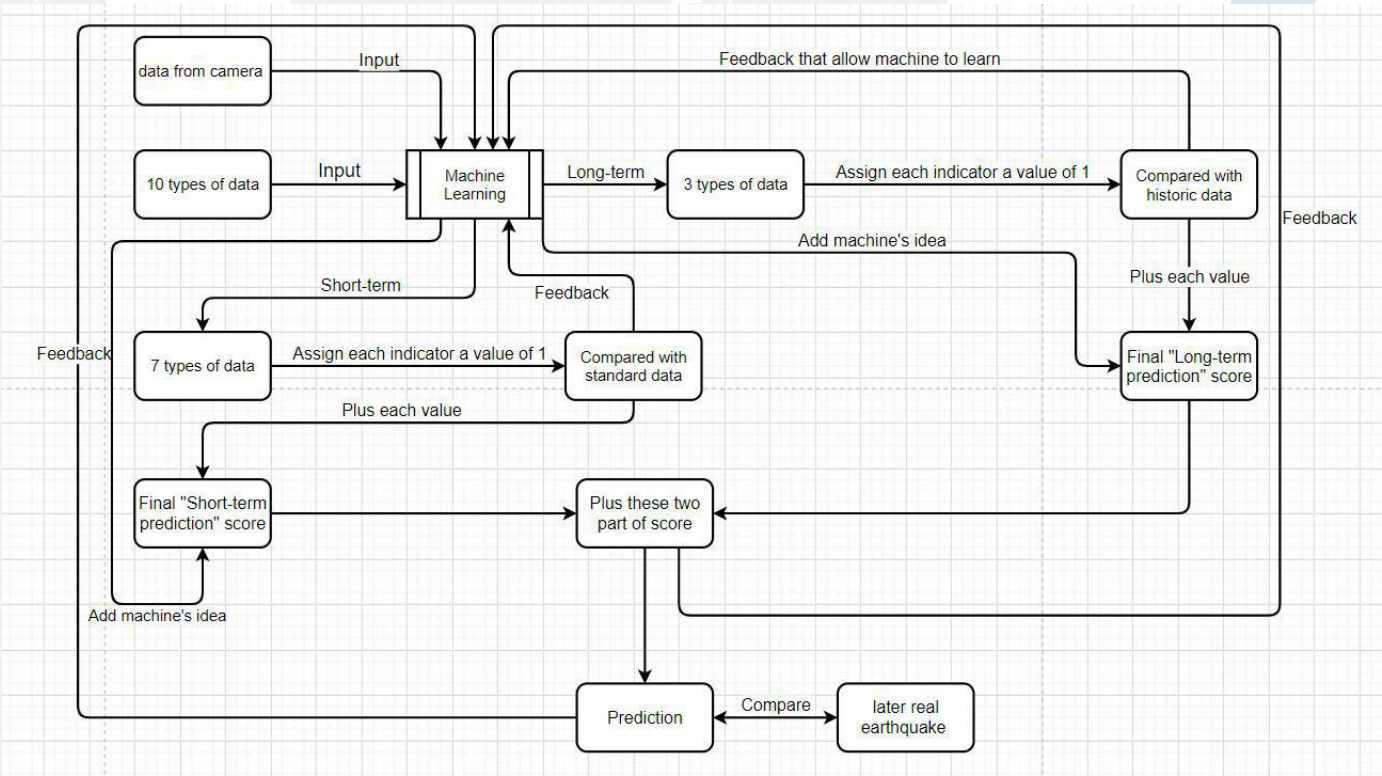


Figure 2

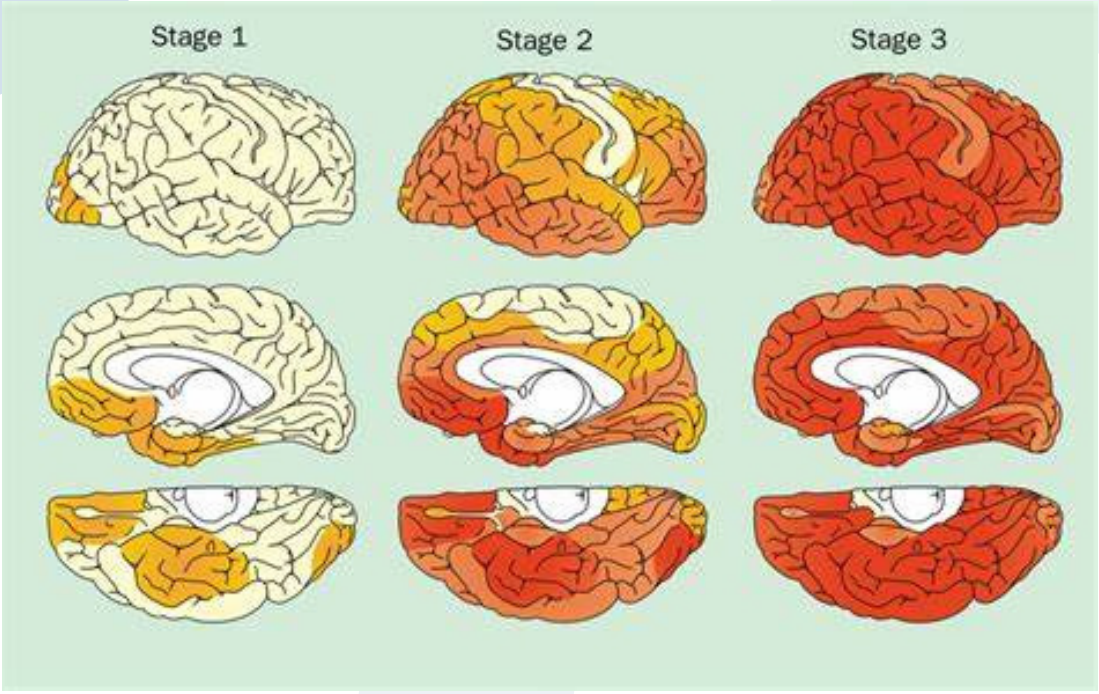


Figure 1

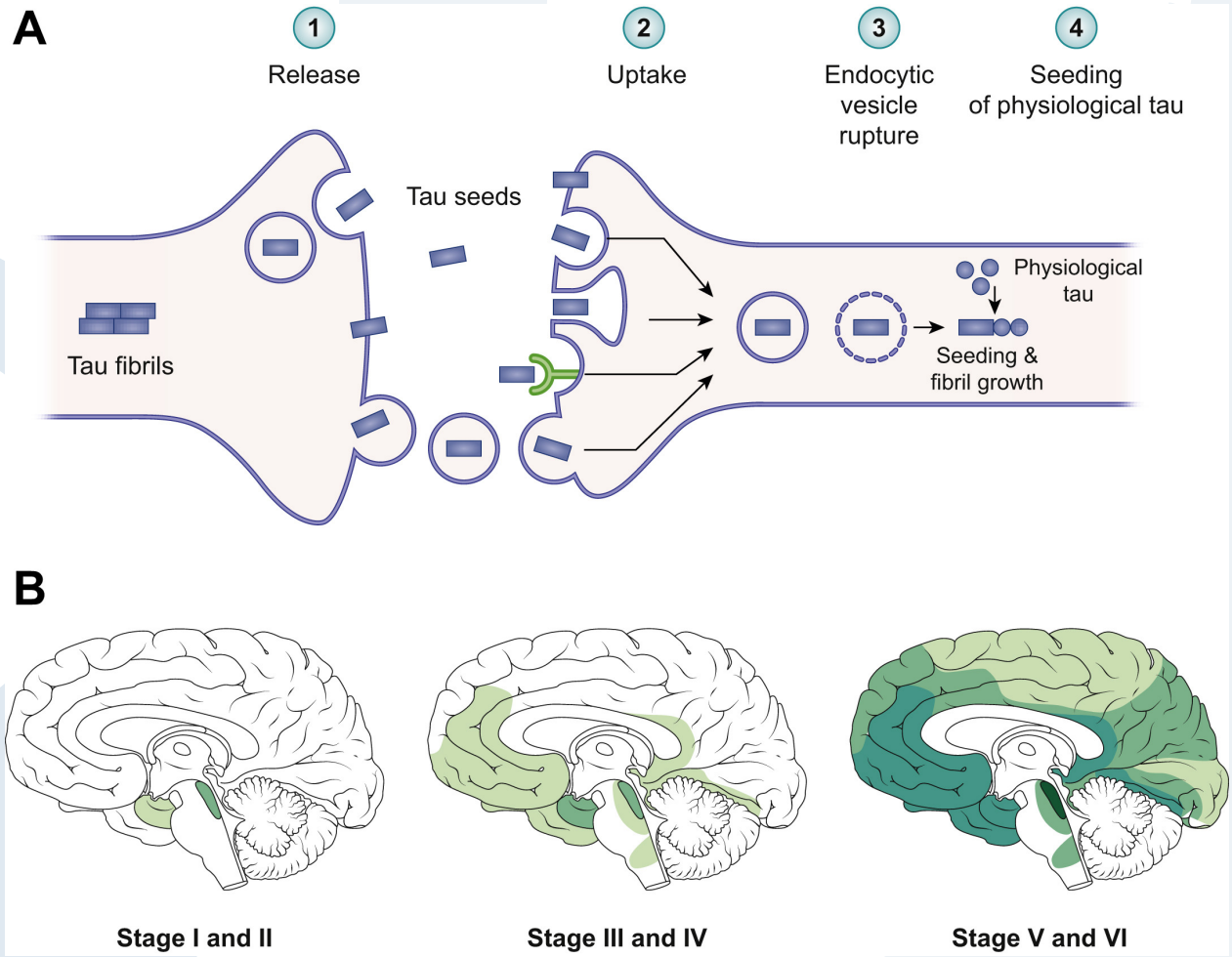


Figure 2

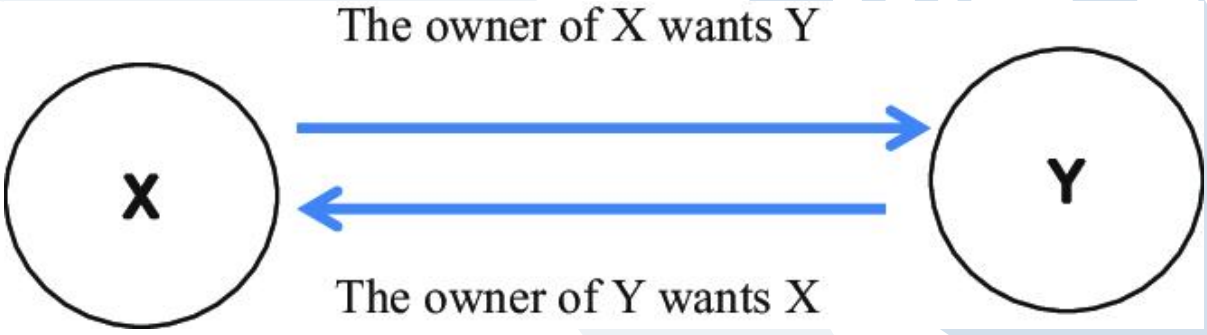


Figure 1

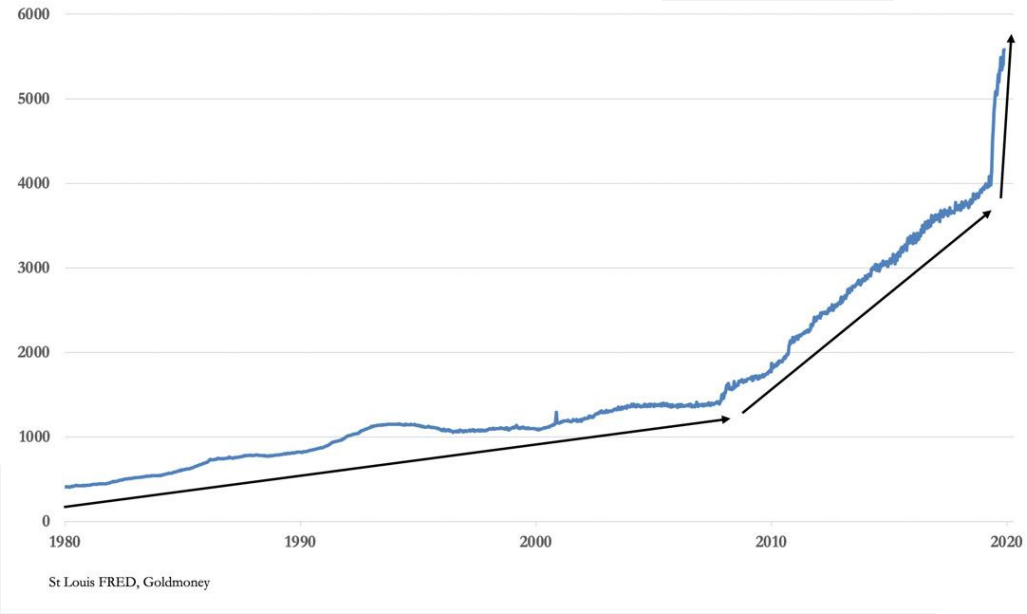
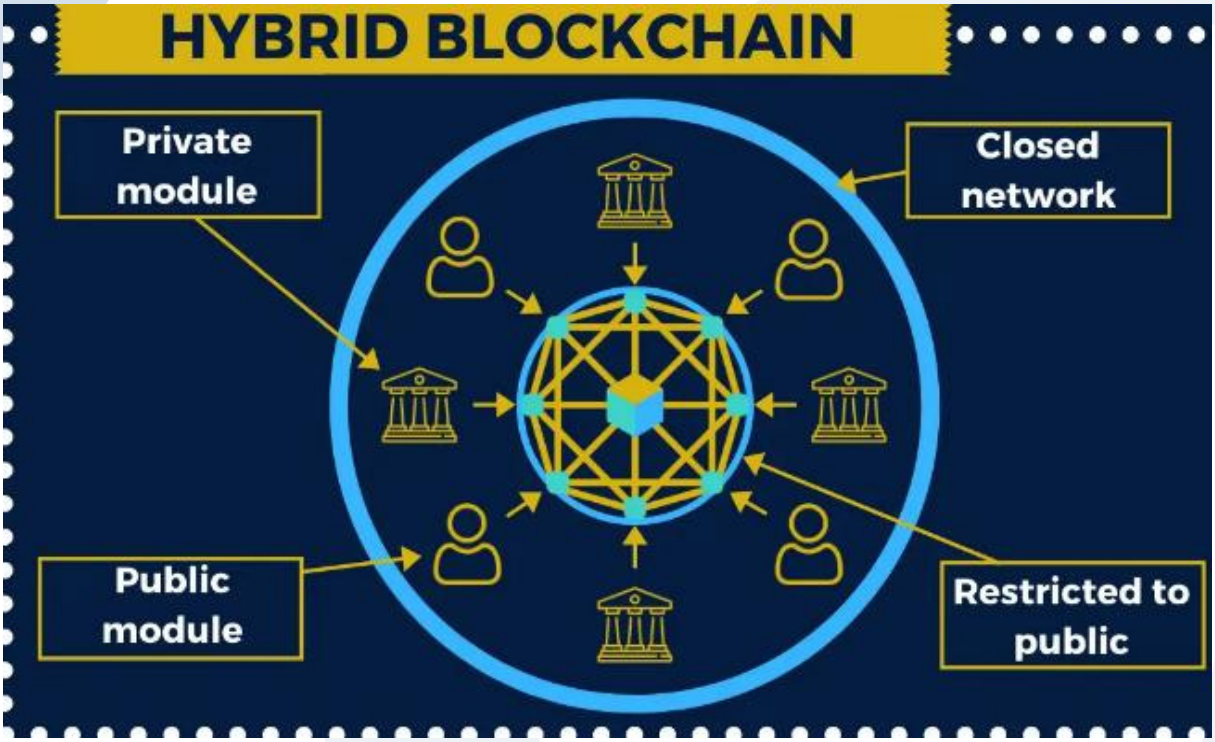
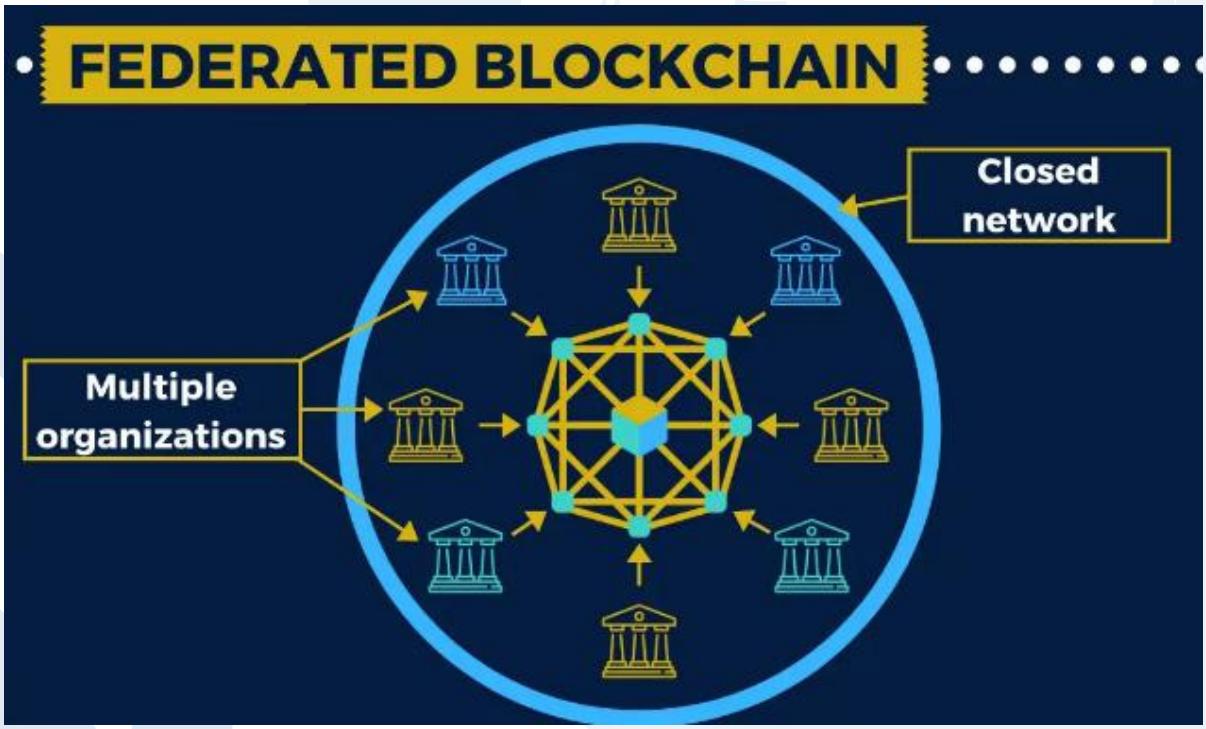
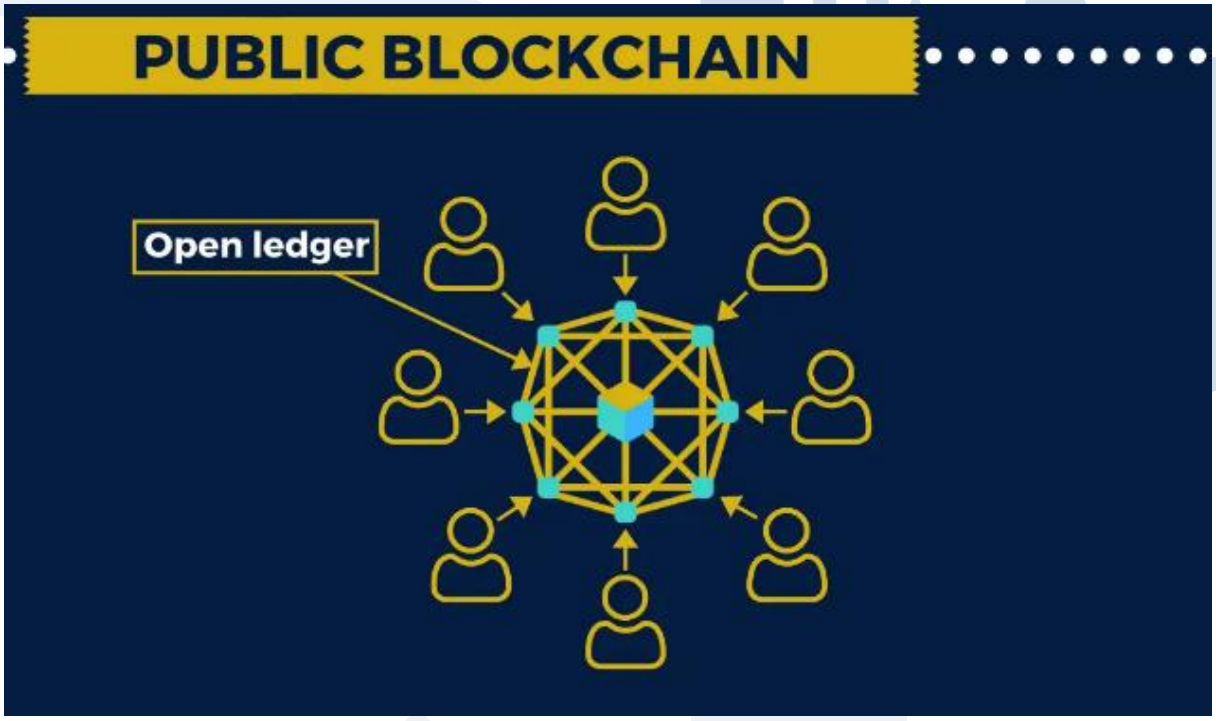


Figure 2

Figure 3


HYBRID BLOCKCHAIN
Private module
Closed network
Public module
Restricted to public


FEDERATED BLOCKCHAIN
Closed network
Multiple organizations


PUBLIC BLOCKCHAIN
Open ledger

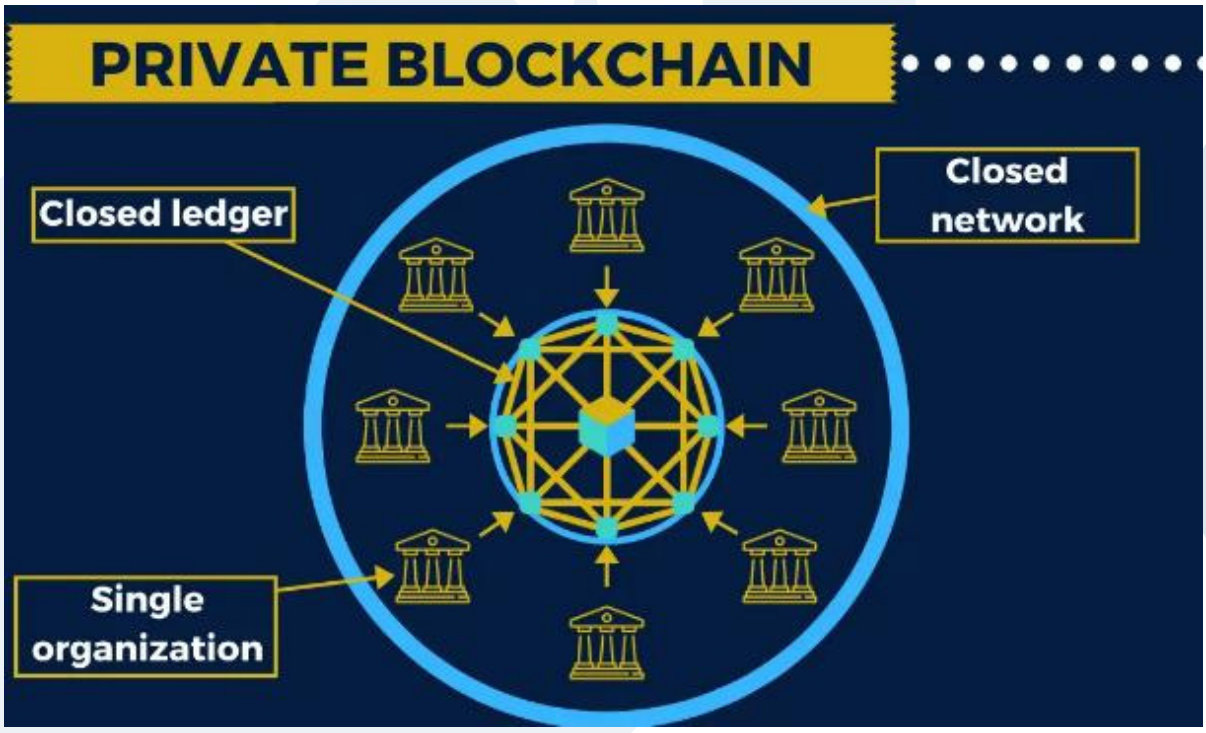

PRIVATE BLOCKCHAIN
Closed ledger
Closed network
Single organization

Figure 4

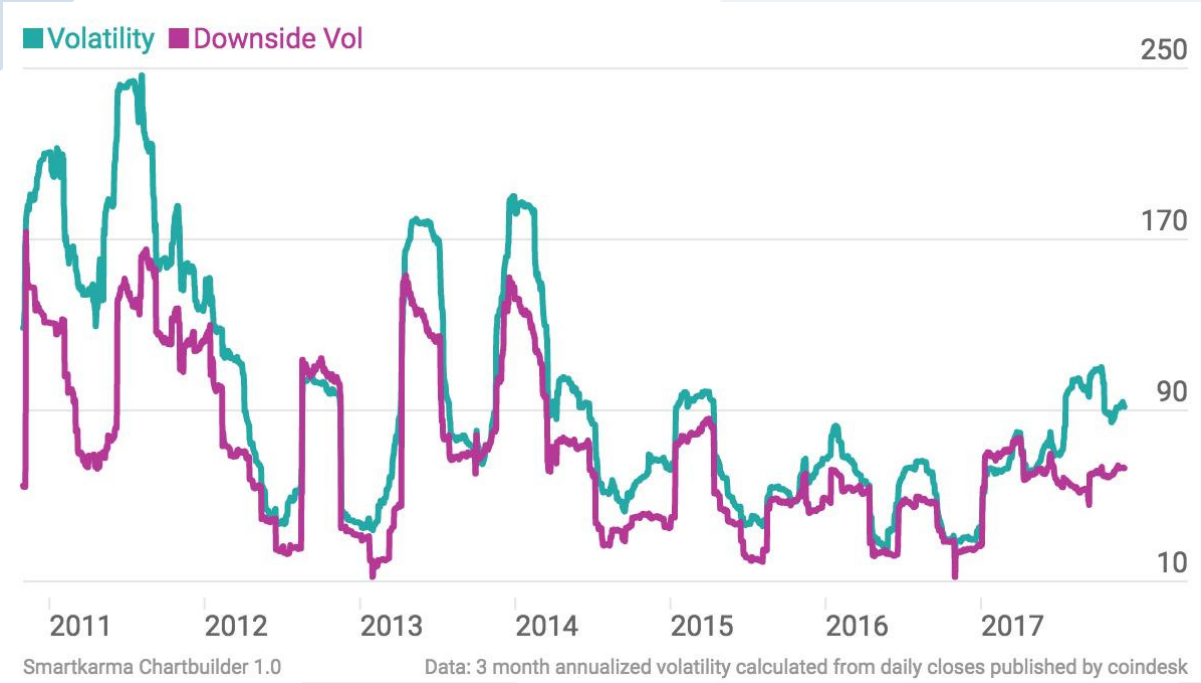


Figure 5

Figure 6

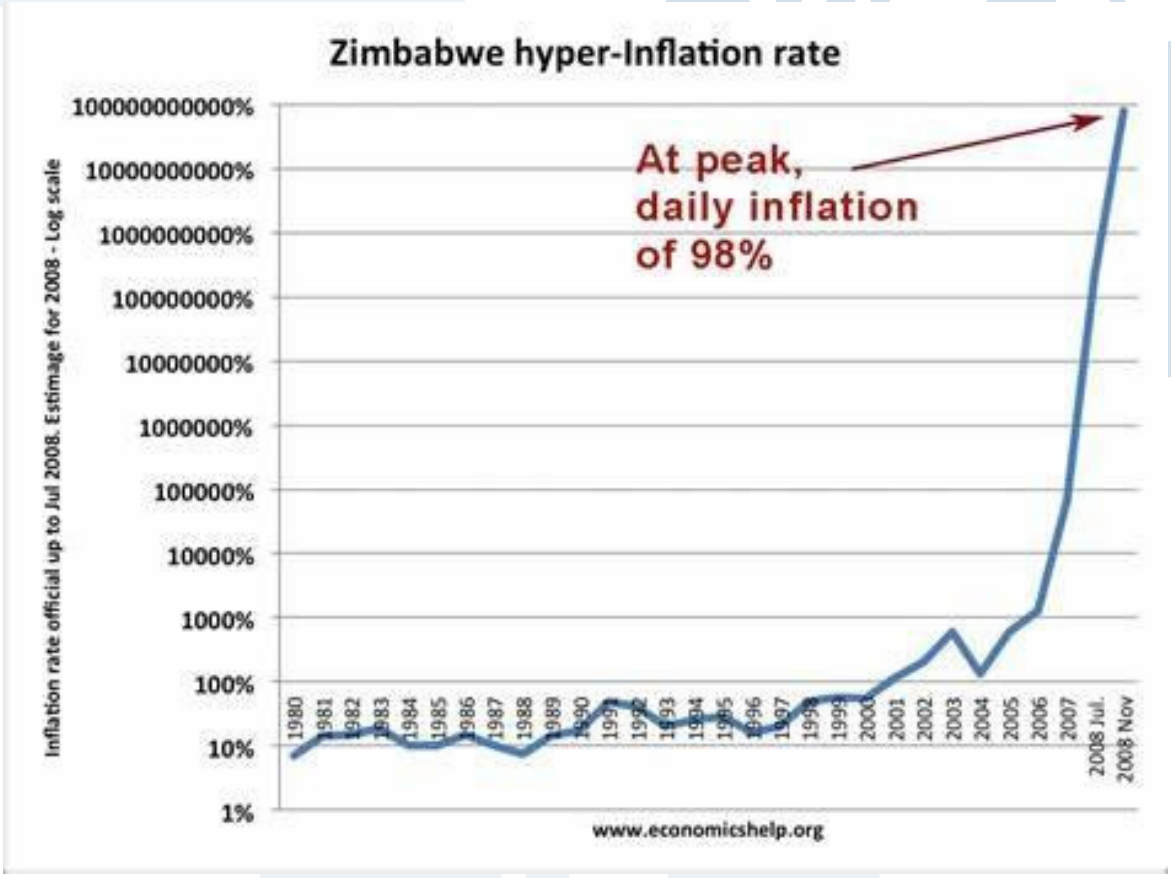


Figure 7

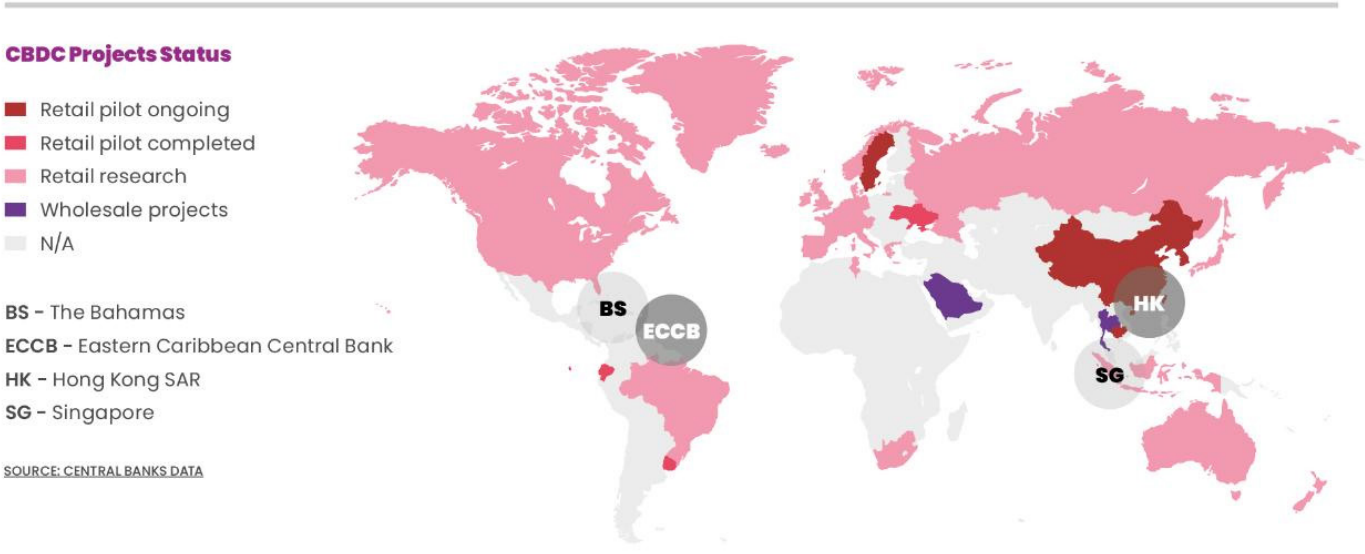


Figure 8

Oxford Global

Oxford Global Summit for Young Leaders (China)

阿思丹 ASDAN China