Visualization of Coronavirus Disease 2019 Spread Based on Spread Index and Extinction Index

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In the winter of 2019, a serious public health event occurred, which was later recognized as a new virus outbreak by WHO and named Coronavirus Disease 2019 (COVID-19)
So far more than 70,000 people have been infected, and more than 2,000 have died.
Moreover, COVID-19 has already spread to 28 countries, and is causing new outbreaks in certain countries, such as Japan, Korea, Iran and Italy.
The influence of COVID-19 has already exceeded that of SARS in 2003. Its spread is **rapid** and extremely **unbalanced**, spanning **four orders of magnitude** in the number of infections in different cities.
While classical epidemiological modeling is clearly important, the spread of COVID-19 has been influenced by several factors such as:

- travel from Wuhan to other cities during the Spring Festival
- airborne transmission without contact
- blockade policies of governments

Such influences make it quite difficult to predict the spread of COVID-19. One chance event can lead to large consequences.
We design an intuitive visualization system which allows unprofessional members of the public to grasp the key ideas at a glance.

### End User
- The public not expert in data analysis
- Limited time to read the results

### Collected Data
- Source: Official release from Health Commission and Bureau of Statistics
- Type: the total number of and daily increasing in confirmed cases, the number cured, and the number who have died
- the resident population, area...
02 Method

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### Visualization System
- Some indices are proposed which reveal the essence from the raw data
- Basic statistical charts, ThemeRiver, and bubble charts with no more than 4 visual channels are used, coping well with high dynamic range data varying over 4 orders of magnitude
- The need for interaction should be avoided
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- Line charts
- ThemeRiver
- Bubble charts

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1. Spread Index and Extinction Index

In the early part of the epidemic spread model, the number of people infected $I(t)$ follows exponential growth.

If $I(t) = b a^t$ in a local domain

Spread Index: $F_s = \frac{I'}{I} = \ln(a)$

Discretely, $F_s(i) = \frac{I(i)}{I_t(i-1)}$

for day $i$

$I_t(i)$: the number of confirmed cases under treatment

$I_s(i)$: the total number of confirmed cases

$I(i)$: the number of new confirmed cases

$C(i)$ and $D(i)$: increasing in number of persons having been cured and having died
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Spread Index: $F_S(i) = \frac{I(i)}{I_t(i-1)}$

Extinction Index: $F_e(i) = \frac{C(i)+D(i)}{I_t(i-1)}$

for day $i$

$I_t(i)$: the number of confirmed cases under treatment

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$I(i)$: the number of new confirmed cases

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2. ThemeRiver

As noted, the distribution of COVID-19 is extremely unbalanced

We redesign ThemeRiver in three approaches.

Bar charts of the number of confirmed cases under treatment, cured and having died.

Sort in descending order by $I_s$.
3. Bubble chart

We use bubble chart animations with only four visual channels: horizontal axis, vertical axis, color and bubble area.

Logarithmic coordinates are used for the two axes and area of the bubble, to handle high dynamic range data.
1. New confirmed cases increasing while Spread Index is decreasing

Before 5 February, the number of new confirmed cases across the whole of China was increasing rapidly, causing public anxiety.
1. New confirmed cases increasing while Spread Index is decreasing

Indeed, the number of new confirmed cases has been on a downward path since 5th February, showing that the Spread Index was gradually decreasing, spreading slower and slower.
2. Balancing point of Spread Index and Extinction Index

The Spread Index curve is descending while the Extinction Index curve is ascending over time.
2. Balancing point of Spread Index and Extinction Index

The balancing point was reached on 7th February. Since that, the number of confirmed cases under treatment has been decreasing.
3. High risk of Ezhou from the bubble chart
4. The evolution of the epidemic is on the descending phase
5. Comparison of Hubei and outside Hubei by ThemeRiver

ThemeRiver for epidemic situation of COVID-19 in all provinces of China

New confirmed patients

Under treatment
Cured (cumulative)
Deaths (cumulative)

Hubei
Outside Hubei
This study introduced a system to analyze and visualize the COVID-19 epidemic situation. Using this system, daily reports have been published on the Tencent platforms, gaining high public attention with more than 10 million page views (PV).

Animations are recommended on the main page of TencenVideo

Positive comments on the daily reports
THANKS

武汉加油！ | 中国加油！