2024年度
大学院理工学研究科【環境共生工学専攻】
博士後期課程　一般選抜試験(第Ⅱ期)問題

英　　語

開始時刻　午前10時00分
終了時刻　午前11時00分

【注意事項】
1． 解答用紙には受験番号、氏名を必ず記入してください。
Be sure to write your examination number and name on the answer sheet.
2． 試験終了後、答案用紙は必ず提出してください（問題用紙は提出しなくてよい）。
After the examination, the answer sheet must be submitted (question papers need not be submitted).
3． 答案用紙を使用し、解答してください。
Please use the answer sheet to answer the questions.

[1] Answer all questions following a passage on the basis of what is stated or implied in that passage, either in Japanese or English.

From "Law and Order" to "CSI,"(*) not to mention real life, investigators have used fingerprints as the gold standard for linking criminals to a crime. But if a perpetrator leaves prints from different fingers in two different crime scenes, these scenes are very difficult to link, and the trace can go cold.

It's a well-accepted fact in the forensics community that fingerprints of different fingers of the same person—"intra-person fingerprints"—are unique and, therefore, unmatchable.

A team led by Columbia Engineering undergraduate senior Gabe Guo challenged this widely held presumption. Guo, who had no prior knowledge of forensics, found a public U.S. government database of some 60,000 fingerprints and fed them in pairs into an artificial intelligence-based system known as a deep contrastive network. Sometimes the pairs belonged to the same person (but different fingers), and sometimes they belonged to different people.

Over time, the AI system, which the team designed by modifying a state-of-the-art framework, got better at telling when seemingly unique fingerprints belonged to the same person and when they didn't. The accuracy for a single pair reached 77%. When multiple pairs were presented, the accuracy shot significantly higher, potentially increasing current forensic efficiency by more than tenfold.

Once the team verified their results, they quickly sent the findings to a well-established forensics journal, only to receive a rejection a few months later. The anonymous expert reviewer and editor concluded that "It is well known that every fingerprint is unique," and therefore, it would not be possible to detect similarities even if the fingerprints came from the same person.

The team did not give up. They doubled down on the lead, fed their AI system even more data, and the system kept improving. Aware of the forensics community's skepticism, the team opted to submit their manuscript to a more general audience. The paper was rejected again, but Lipson, who is the James and Sally Scapa Professor of Innovation in the Department of Mechanical Engineering and co-director of the Makerspace Facility, appealed.

"I don't normally argue editorial decisions, but this finding was too important to ignore," he said. "If this information tips the balance, then I imagine that cold cases(**) could be revived and even that innocent people could be acquitted."

While the system's accuracy is insufficient to decide a case officially, it can help prioritize leads in ambiguous situations. After more back and forth, the paper was finally accepted for publication by Science Advances.

One of the sticking points was the following question: What alternative information was the AI actually using that has evaded decades of forensic analysis? After carefully visualizing the AI system's decision process, the team concluded that the AI was using a new forensic marker.

"The AI was not using 'minutiae,' which are the branchings and endpoints in fingerprint ridges—the patterns used in traditional fingerprint comparison," said Guo, who began the study as a first-year student at Columbia Engineering in 2021. "Instead, it was using something else, related to the angles and curvatures of the swirls and loops in the center of the fingerprint."

Columbia Engineering senior Aniv Ray and Ph.D. student Judah Goldfeder, who helped analyze the data, noted that their results are just the beginning. "Just imagine how well this will perform once it's trained on millions instead of thousands of fingerprints," said Ray.

The team is aware of potential biases in the data. The authors present evidence that indicates that the AI performs similarly across genders and races where samples were available. However, they note that more careful validation needs to be done using datasets with broader coverage if this technique is to be used in practice.

This discovery is an example of more surprising things to come from AI, notes Lipson, "Many people think that AI cannot really make new discoveries – that it just regurgitates knowledge," he said. "But this research is an example of how even a fairly simple AI, given a fairly plain dataset that the research community has had lying around for years, can provide insights that have eluded experts for decades."

He added, "Even more exciting is the fact that an undergraduate student, with no background in forensics whatsoever, can use AI to challenge a widely held belief of an entire field successfully. We are about to experience an explosion of AI-led scientific discovery by non-experts, and the expert community, including academia, needs to get ready."

modified from source: JANUARY 10, 2024, Tech Xplore
/techxplore.com/news/2024-01-ai-fingerprint-unique.html

(*) "Law and Order", "CSI": titles of popular crime TV-dramas in the US.
(**) cold case: a case (= a series of events investigated by the police) that has not been solved

(1) What was the conventional understanding and what was newly achieved by using AI?
(2) What was the conventional method to do so and how was it enhanced by AI?
(3) How could the new method affect 'cold cases' in the future?
(4) What are the expectations of the 'AI-led sciences'?

2 Answer all questions following a passage on the basis of what is stated or implied in that passage, either in Japanese or English.

(*) NOTE: all figures referred in the text below were purposely omitted

Our lives are becoming increasingly data-driven. Our phones monitor our time and internet usage, and online surveys discern our opinions and likes. These data harvests are used for telling us how well we've slept or what we might like to buy.

Numbers are becoming more important for everyday life, yet people's numerical skills are falling behind.

For example, the percentage of Year 12 schoolchildren in Australia taking higher and intermediate mathematics has been declining for decades.

To help the average person understand big data and numbers, we often use visual summaries, such as pie charts. But while non-numerate folk will avoid numbers, most numerate folk will avoid pie charts. Here's why.

A pie chart is a circular diagram that represents numerical percentages. The circle is divided into slices, with the size of each slice proportional to the category it represents. It is named because it resembles a sliced pie and can be "served" in many different ways.

An example pie chart(1) below(*) shows Australia's two-party preferred vote before the last election, with Labor on 55 percent and the Coalition on 45 percent. The two near semi-circles show the relatively tight race – this is a useful example of a pie chart.

Once we have more than two categories, pie charts can easily misrepresent percentages and become hard to read.

The three charts below(*) are a good example – it is very hard to work out which of the five areas is the largest. The pie chart's circularity means the areas lack a common reference point.

Pie charts also do badly when there are lots of categories. For example, this chart(*) from a study on data sources used for COVID data visualization shows hundreds of categories in one pie.

The tiny slices, lack of clear labeling and the kaleidoscope of colors make interpretation difficult for anyone.

It's even harder for a color-blind person. For example, this is a simulation of what the above chart would look like to a person with deuteranomaly or reduced sensitivity to green light. This(*) is the most common type of color blindness, affecting roughly 4.6 percent of the population.

It can get even worse if we take pie charts and make them three-dimensional. This can lead to egregious misrepresentations of data.

Below(*), the yellow, red, and green areas are all the same size (one-third), but appear to be different based on the angle and which slice is placed at the bottom of the pie.

Despite the well known problems with pie charts, they are everywhere. They are in journal articles, PhD theses, political polling, books, newspapers and government reports. They've even been used by the Australian Bureau of Statistics.

While statisticians have criticized them for decades, it's hard to argue with this logic: "if pie charts are so bad, why are there so many of them?"

Possibly they are popular because they are popular, which is a circular argument that suits a pie chart.

There's a simple fix that can effectively summarise big data in a small space and still allow creative color schemes.

It's the humble bar chart. Remember the brain-aching pie chart example above with the five categories? Here's the same example(*) using bars – we can now instantly see which category is the largest.

Linear bars are easier on the eye than the non-linear segments of a pie chart. But beware the temptation to make a humble bar chart look more interesting by adding a 3D effect. As you already saw, 3D charts distort perception and make it harder to find a reference point.

Below(*) is a standard bar chart and a 3D alternative of the number of voters in the 1992 US presidential election split by family income (from under US$15K to over $75k). Using the 3D version, can you tell the number of voters for each candidate in the highest income category? Not easily.

We've shown some of the worst examples of pie charts to make a point. Pie charts can be okay when there are just a few categories and the percentages are dissimilar, for example with one large and one small category.

Overall, it is best to use pie charts sparingly, especially when there is a more "digestible" alternative – the bar chart.

Whenever we see pie charts, we think one of two things: their creators don't know what they're doing, or they know what they are doing and are deliberately trying to mislead.

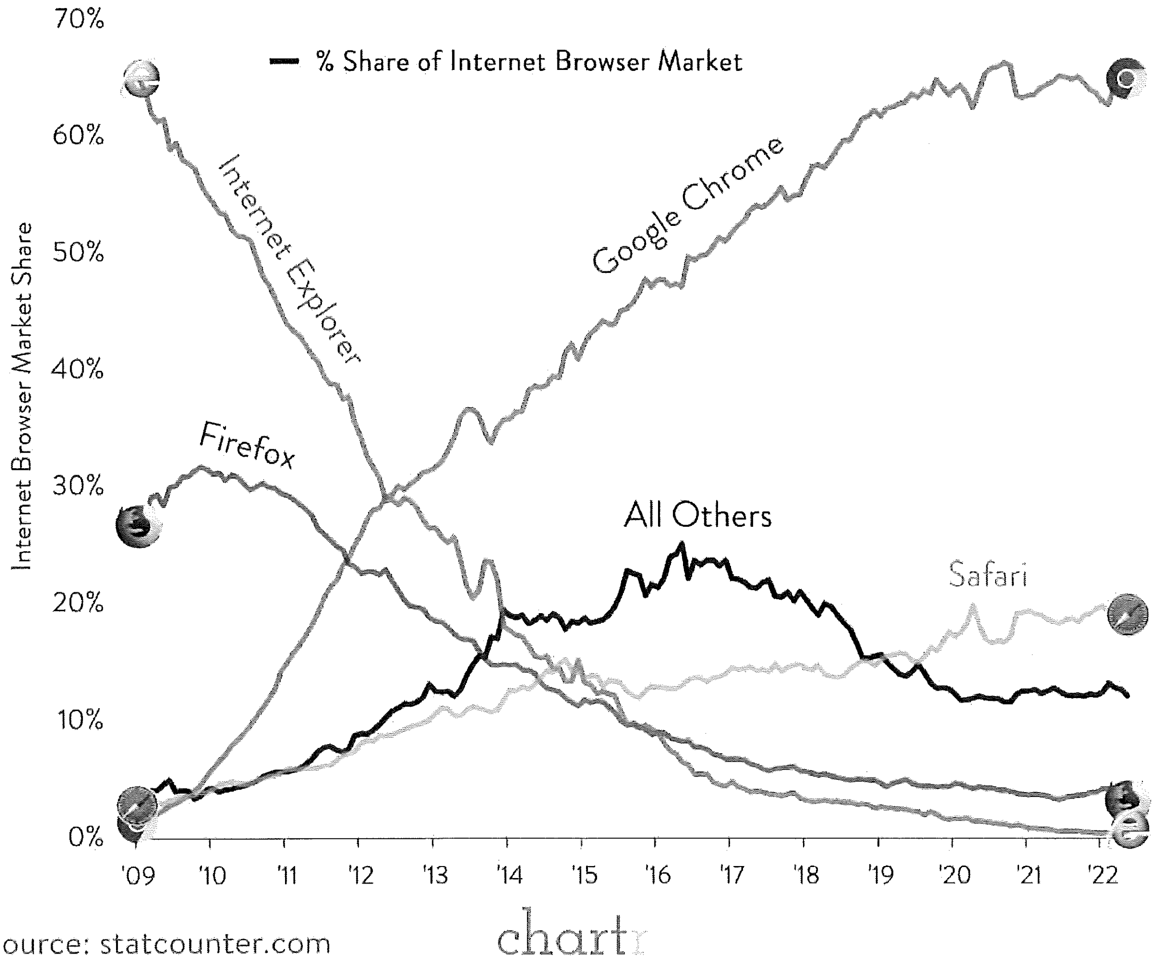
A graphical summary aims to easily and quickly communicate the data. If you feel the need to spruce it up, you're likely reducing understanding without meaning to do so.

modified from source: A.Barnett, V. Oguomao, 9th January, 2024, IFLScience / www.iflscience.com/heres-why-you-should-almost-never-use-a-pie-chart-for-your-data-72357

(1) Under lined part (1): Draw the pie chart which is explained in the text.
(2) What is the purpose to use 'charts' in general?
(3) Why shouldn't we use pie charts? OR, "What are some of the problems with using pie charts?"
(4) What is the potential alternative to using a pie chart?

3 Answer the questions below in English.

1. Describe what facts are displayed in the figure, in detail.
2. Explore (free) discussion points based on the information in the figure.



background information: Microsoft stopped the support to Internet Explorer, as an internet browser in the end of 2022.

source: /www.chartr.co/stories/2022-06-15-1-internet-explorer