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Course: Intro to AI

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Technical report for the analysis of the conference:
ACM Conference on Economics and Computation

1. Introduction: Where to get information?

The ACM Conference on Economics and Computation is the leading scientific conference on advances in theory, empirics, and applications at the interface of economics and computation. This conference is held every year since 1999. For the analysis I used resources like Web of science, Google Scholar, ACM Digital Library, Microsoft Research and Google search. I have also checked Scopus and Dimensions; but I have not found articles from my conference there. At least most of the articles were not in these two resources, so I decided to leave them out of my scope.

Mostly I relied on the ACM Digital Library data, because there is a very convenient way of filtering. As well as statistics on authors and affiliations. I can trust ACM Digital Library source, because that is an official library for this conference. In addition, in ACM Digital Library for each paper there is shown not only amount of citations but also, how many times each article was downloaded. Finally, I found ACM Digital Library as a very convenient resource to study the conference. Microsoft Research also has a substitutional amount of information about the current conference. Microsoft Research gives an opportunity to also look at the top authors and affiliations. I have used that information along with ACM Digital Library statistics to find what companies and countries provided the most contribution in the recent years.

2. Introduction: About the conference

My review started with the research on what topics are popular in the conference. Since the field is unknown for me, I started looking at the top subject areas that are highlighted in the ACM Digital Library (see Fig 1)

Figure 1 – Top subject areas in ACM conference of economics and computation.

We can observe, that most of the works are oriented towards study of algorithms in the economics field such as *Algorithmic game theory, Online algorithms* and *Algorithmic mechanism design.* These algorithms are mostly oriented towards designing an efficient and fair system auctions with many participants and parties. The studies on equilibria are also oriented towards the auctions applications, because it is important to find a balance for the price in the auctions. In addition, last year top keyword, according to the ACM Digital Library, was "market design".

To get a better view on the most recent topics, proceedings of the last 3 years were reviewed. Most popular topics observed are mechanism design (however there is a decline in the popularity over the three years), equilibrium analysis, matching, and fairness. As mentioned earlier, mostly the papers are oriented towards the auction applications. Popular example in the past ~5 years is a sharing economy revenue streams (peer to peer) – Uber/Lyft, Airbnb and etc. These are efficient revenue stream platforms that heavily rely on data analysis, matching and mechanism design.

3. Statistics by the Countries

As mentioned earlier, to see what countries and companies have the most contribution, I used statistics at ACM Digital Library and Microsoft Research. In Microsoft Research there is an interesting graphical representation, shown below

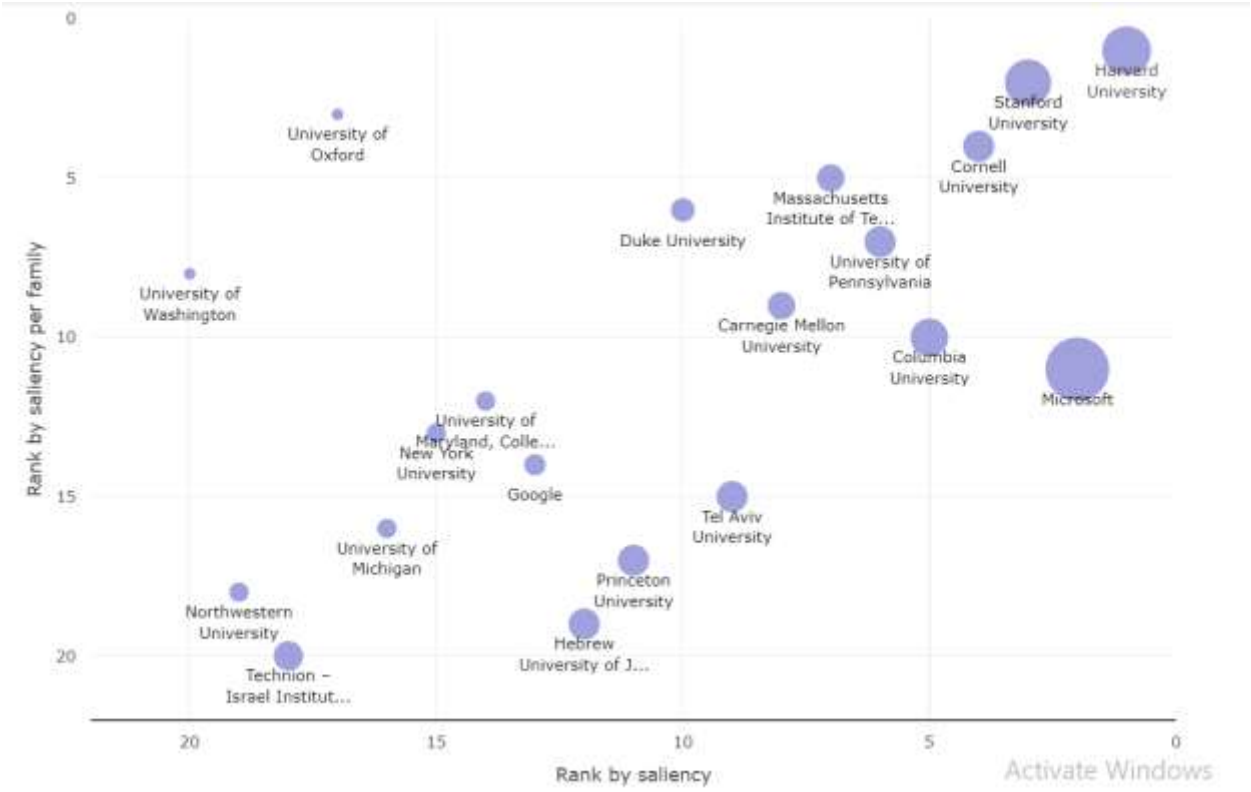

Figure 2 - Institutions that presented the most impactful work in the years 2017-2020

From this chart we can observe that Ivy League schools along with Microsoft are the main contributors to this conference. Therefore USA has the most contribution. On the chart we can also find University of Oxford (England) and Tel Aviv University (Israel). Looking at the top institutions list (as shown in Fig 3) for each year, we observed that a few more Israel institutions such as Technion - Israel Institute of Technology and Hebrew University of Jerusalem. Therefore, one can conclude that Israel is has the second most contribution to this conference in the recent years (2017-2020). While researching papers, as well as looking at the rank in ACM Digital Library, it was noticed that countries like England, Greece, Switzerland, Singapore, China, Poland and Chile have also made publications. I want to point Greece, because I have met authors from Greek institutions in top cited/downloaded papers.

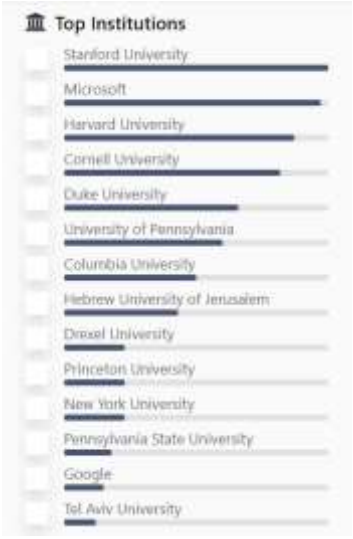

Figure 3 – Top institutions rating for the year of 2017 from Microsoft Research

4. Statistics by the companies

Once should have noticed that most of the contribution comes from universities. However, in the chart and top lists there are few companies. The most contributing company to this conference is Microsoft. There are multiple affiliations connected to Microsoft: Microsoft Research (23 papers), Microsoft Corporation (6 papers), and Microsoft Research Cambridge (18 papers). Few other big contributors over the last few years are Facebook (7 papers) and Google (14 papers). In addition, huge sharing economy companies such as Uber (3 papers) and Lyft (2 papers) also have participated and presented their work at the conference. The number of papers is taken over the 2017-2020 years from the ACM Digital Library statistics. To evaluate companies' distribution, I have also looked at who sponsored the conferences. I believe that this is important, because companies would sponsor the conference if the novelty findings in the published work would help to increase the company's revenue. Most companies interested in the conference, would not only sponsor but also take part in the research because research based on these companies' user cases, with the involvement of the company research would give the best result for the company. Indeed Facebook, Lyft, Uber, Microsoft are among most popular sponsors in the recent years. Yahoo is also presented as a sponsor, however, in the past years Yahoo have not presented their work in the last 4 years of the conference, while being active in the beginning of the 2000's.

5. Top 5 works on AI in the conference

To find top works in the conference I used multiple criteria. In ACM Digital Library there is statistics about the citations and downloads. Citations are a good metric, but not ideal, so we cannot rely only on citations. I believe that downloads are also an important metric, because topics and papers that have an application in the real word might have a lot of downloads but not as many citations. Articles are not made just for the sake of citations, articles are made to share the latest findings in the field that lead to the development of the specific sector. This conference is dedicated

towards the economics, therefore the important metric is the profit that companies earn. Findings in the works presented in the current conference have a direct application in the real world. Researchers and managers of the companies might download the articles and implement the suggested work in their business models. That way some articles might get a lot of downloads but not as many citations. Articles that have many citations are fundamentals to the more research in their area that potentially lead to the real world applications presented in the later works. I choose articles that are more application important and fundamental research important.

I have also introduced a few more metrics from the data I took from ACM DL library. I am looking at the downloads /citation ratio. A paper might not have many downloads or many citations, because it is has a very narrow topic or too complicated for the general audience. However, if it is cited a lot comparing to how many times it was downloaded – I consider that this paper is important.

I introduce another metric, to take a year into account. It is obvious, that younger articles have less downloads and citations. Therefore, I divided downloads / citation ration by a year of publication and scaled the result by a 100 to get a "pretty" number that is easier to read.

Finally, I have also looked at the citations metric at other resources like Microsoft Research, Web of Science and Google scholar. Since Google Scholar aggregates information from multiple databases I put the database in the parentheses.

Besides the metrics I have also looked at the content of the papers, which is described later. Below one can find a table with the information on the top 5 chosen articles from the conference.

Year	Name	ACM DL Downloads	ACM DL Citations	Downloads / Citations Ratio	((Downloads / Citation)/ Year)*100	Microsoft Research Citations	WoS Citations	Google scholar Citations	Affiliation
2016	The Unreasonable Fairness of Maximum Nash Welfare	463	75	6.17	0.31	218	48	218(acm)	University of Patras (greece); Carnegie Mellon; Glasgow University
2017	Surge Pricing Solves the Wild Goose Chase	766	35	21.89	1.09	126	Not Found	128 (acm)	Stanford University; Uber; Microsoft Research
2018	Fair Allocation of Indivisible Goods: Improvements and Generalizations	409	16	25.56	1.27	62	6	62 (acm)	Indian Institute of Science; Chennai Mathematical Institute (India)
2019	A Marketplace for Data: An Algorithmic Solution	345	6	57.50	2.85	18	1	36 (acm)	MIT
2019	Spatio-Temporal Pricing for Ridesharing Platforms	158	10	15.80	0.78	15	0	31 (arhiv.org)	Harvard University; Carnegie Mellon

- **The Unreasonable Fairness of Maximum Nash Welfare (2016)**

Generally, I did not want to include the articles that are older than 2017. However, this article is article is very important in terms of foundations for the research in the fairness of price setting. This article has the best ratio of downloads / citations in the past 20 years. Also this article has the highest number of citation since 2013. The content of the article is rather complicated for the reader without background knowledge in this field. Authors proposed the maximum welfare Nash

solution can provide outstanding fairness guarantees not only when allocating divisible goods but also dealing with indivisible goods. One of the important fairness metric – envy free allocation. It is crucial to understand that equal is not the same as fair. Not all the people would be happy with the equal sharing, based on the circumstances. In addition, the seller wants to allocate goods in the way that it brings the maximum profit. Therefore finding a market design that satisfies all the participants of the so called "auction" is a challenging and important task, especially in the era of the sharing economy. Authors of the current paper not only theoretically proved their idea, but also made a validation on the real market data. In addition, their idea was deployed in the popular fair division website. Finally, this paper is cited by other papers that have high citations and downloads. Some papers even from my top 5 have taken the ideas from this paper and moved on to a new level of research.

- **Surge Pricing Solves the Wild Goose Chase (WGC) (2017)**

This paper has a very high number of downloads – 766, which is the 3rd highest since 2016. However, this article does not have as many citation and its downloads/citations ration relatively high. This can be explained by the fact that current article is not only written in the way that even for a non-researcher (business people) it is easy to understand the topic, what was done and why it is important. In addition, the idea proposed in the current article has a real life application. As we are in 2020, we can observe that proposed surge pricing is actually used in some of its form in day to day life of many people living in the city.

Authors propose that dynamic pricing (Surge pricing) which means setting a price based in the demand or other factors. Main reason, why authors suggest Surge Pricing is that it help so overcome the problem of the Wild Goose Chase (when a driver spends too much time while going to the customer, which leads to the decrease in the revenue). "Surge pricing is thus a fundamental component of ride hailing apps, which allows them to serve markets efficiently and reliably while having lower prices than older technologies when demand is low". In 2020 we observe how Surge Pricing is actively used by ride-hailing platforms like Uber, Lyft, Yandex and etc. In addition, it is also used in car sharing platforms such as Yandex Drive. Many people think that Surge Pricing means setting a price higher that it should be, while it is actually like a discount. Surge Pricing lets the platforms to set lower prices when there is a chance. In this paper, authors made a great research based on the real life data to prove the efficiency of the Surge Pricing. Bellow the trand of the "Surge Pricing" term is provided. We can observe that it became popular in 2013-2018. Now it goes towards the decline because most of the research has been already conducted and Surge Pricing is actively used without much of additional research on it.

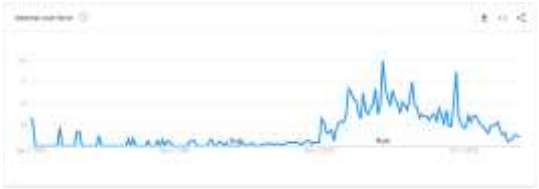

Figure 4 – Google Trends for the "Surge Pricing" term

- **Fair Allocation of Indivisible Goods: Improvements and Generalization**

The title of this paper speaks up by itself. Authors of this article took several notions of fairness – "proportionality" and "envy-free". The goal of the article is similar to the goal of the *"The Unreasonable Fairness of Maximum Nash Welfare (2016)".* Researchers keep searching for the most efficient market design. This work is based on the maxmin share paradigm. One can consider this work as a next step after the "*The Unreasonable Fairness of Maximum Nash Welfare (2016)"*, at least one of the next steps. Authors have done a great research of the past works and worked on the improvement based on the ideas introduced in the earlier works. For the researchers and students that are working in the area of fairness and market equilibrium, this paper provides a great overview and a fresh step forwards. Therefore, I find this paper important. In addition, this paper has good metrics, which shows that this work became popular and crucial.

- **A Marketplace for Data: an Algorithmic Solution (2019)**

In 2017-2020 the term "Data is a new oil" became very popular. Indeed, in the modern world with the evolution of machine learning and neural networks the data becomes more and more valuable product on the market. Modern data analysis techniques provide an opportunity to get the most out of data. If there is a demand for the data, people and enterprises are ready to pay for it. Data market is evolving. In the data market the question of market design is also important same as with ride-healing platforms. Authors' goal in this work was to design and data marketplace: "a robust real-time matching mechanism to efficiently buy and sell training data for Machine Learning tasks". This paper does not have great metric results, however still high for the year of 2019. I consider this paper is very important, because it cover a very important topic of data market.

In the paper, authors described a wide range of challenges that they had to solve while working on their goal. One can read about it in their 26 page long paper. As an outcome, authors have a great contribution to a mathematical model and architecture, as well as two technical contributions. First technical contribution is "a new notion of "fairness" required for cooperative games with freely replicable goods". Second, "a truthful, zero regret mechanism for auctioning a particular class of combinatorial goods, which utilizes Myerson's payment function and the Multiplicative Weights algorithm". I believe that in future years this paper will get many citations and its metrics will go up.

- **Spatio-Temporal Pricing for Ridesharing Platforms (2019)**

Authors of this paper introduce and study a very simple though hard to implement Spation-Temporal mechanism. The goal of the paper is similar to the *Surge Pricing Solves the Wild Goose* Chase (WGC), however, I would consider this as a next step in the ridesharing platforms market design. Spatio-Temporal pricing mechanism is based on "a complete information, discrete time, multiperiod, multi-location model". This mechanism is also "welfare-optimal, envy-free, individually rational, budget balanced and core-selecting from any history onward". Authors have done a substantial work on the mathematical algorithms and their empirical study suggests that the

STP mechanism achieves substantially high social welfare. The metrics for this article are also high for 2019.

I consider this work important, not only due to the deep market design algorithms analysis, but also because I see the real application of this in nowadays world. Companies like Uber and Yandex are looking for a ways to maximize their profit and keep a high retention of their customers. Complex but efficient market design are crucial for such enterprises. I have a friend, working as a Yandex taxi driver. He said, that prices for Yandex taxi are indeed very dynamic and depend on various factors besides the demand.

6. Future Trends of the Conference

My decision on the future trends is based on the articles that are published and that are popular in the recent year. Along with the Google trends analysis.

- **Data Market**

As mentioned, I believe that data market will be evolving and there is still lots of room for the research. Data market is way more complicated than ridesharing because data has much higher value that a 10$ ride, as well as data is much more diverse that a simple ride. Therefore, pricing for the data must include many more metrics that a taxi ride or car sharing or house rent. Since data has a very high value, the fairness question getting even more important. I believe, that studies on the data market design will become more and more popular. In addition, in the picture below the Google Trends for “data market” term is shown. We can observe that is it actually growing. Along with the “machine learning” trend, where data is used.

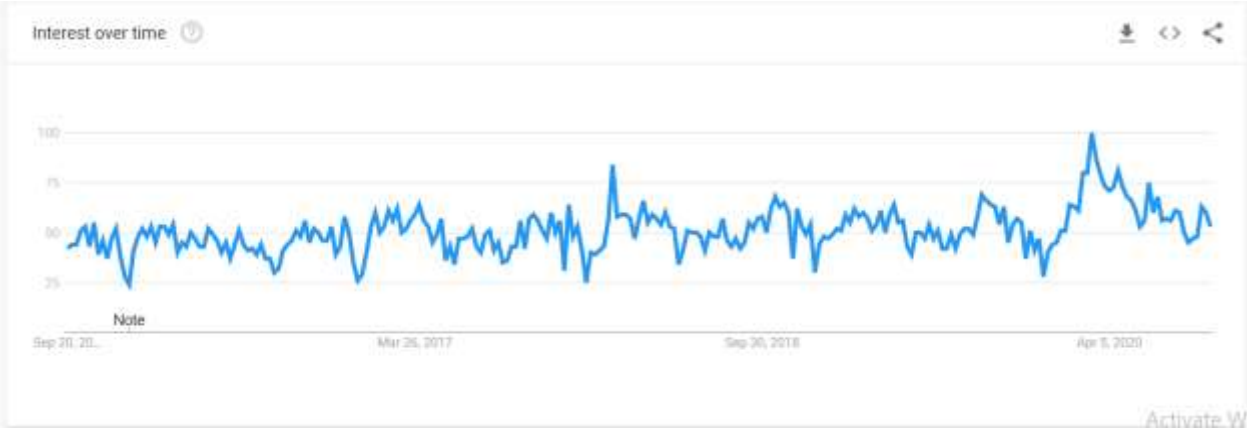

Figure 5 – Google Trends for the “data market” term

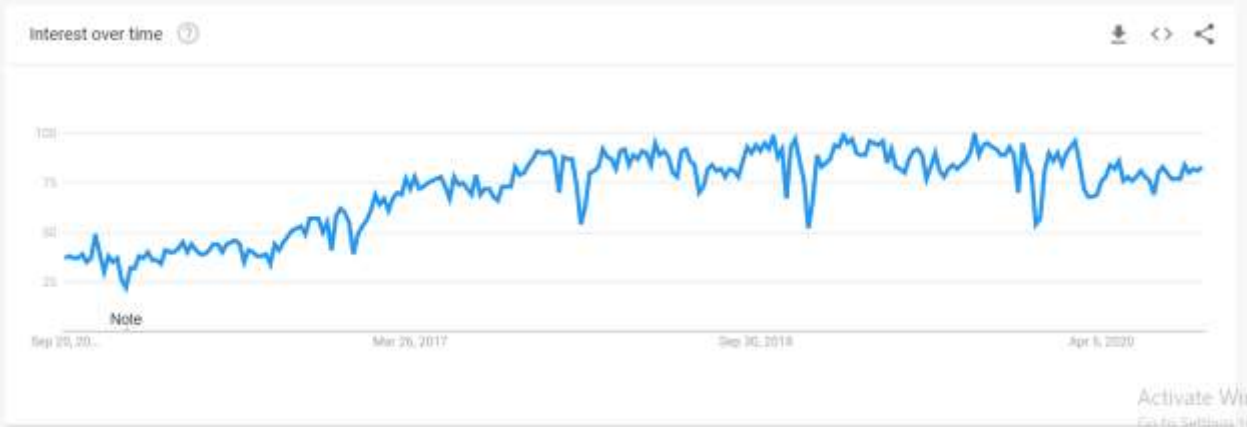

Figure 6 – Google Trends for the "machine learning" term

- **Sharing Economy Market**

Recently I have read a book "Enlighment Now" (which was written in 2016) where the author proposed that in the future the economy will be mostly based on sharing. We observe how popular car, scooter and bike sharing is. Clothes, books and other goods sharing is also becoming popular. However, the auction for this type of economy is rather complicated and might depends on the type of good that is set on the auction. As such an economy is evolving more studies on the marked design will be conducted. Fairness, matching, price setting and market equilibrium are all the topics that will be popular in the next decade. Below, the trend for few terms is shown, which shows the

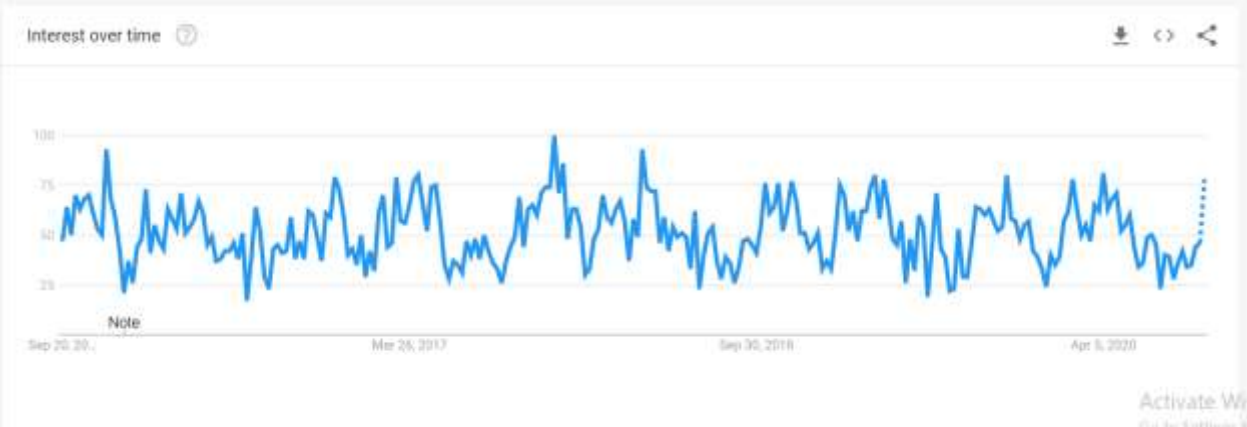

Figure 7 – Google Trends for the "Price setting" term

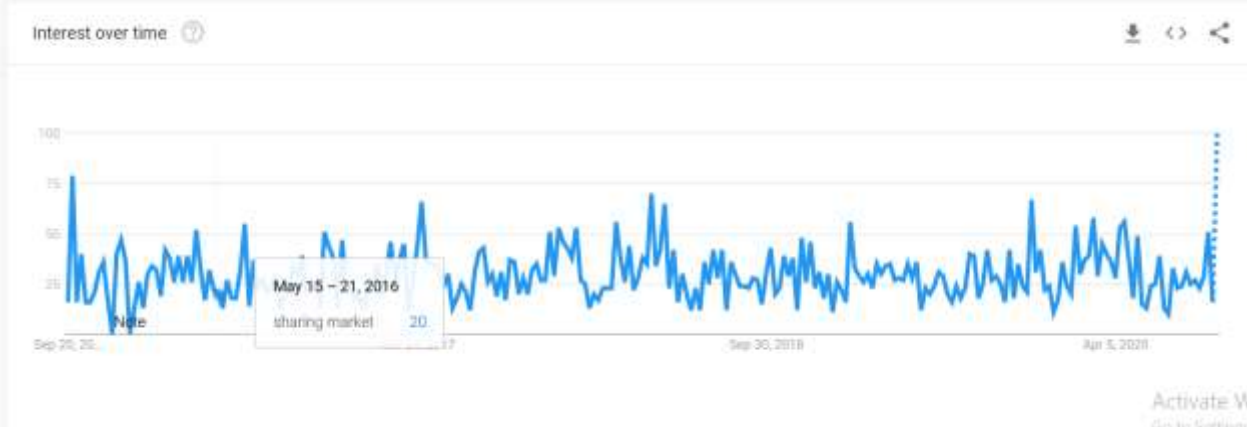

Figure 8 – Google Trends for the “sharing market” term

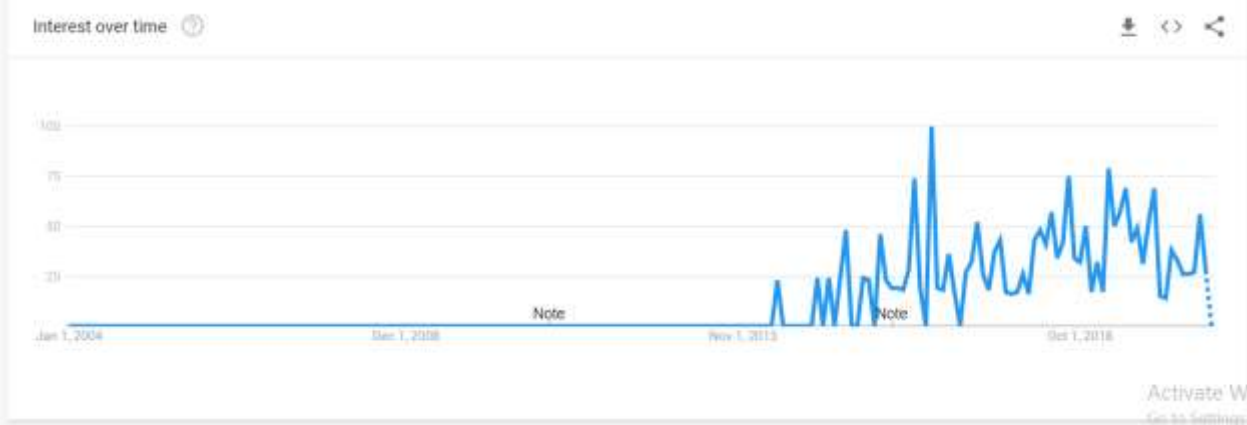

Figure 9 – Google Trends for the “ride-hailing” term

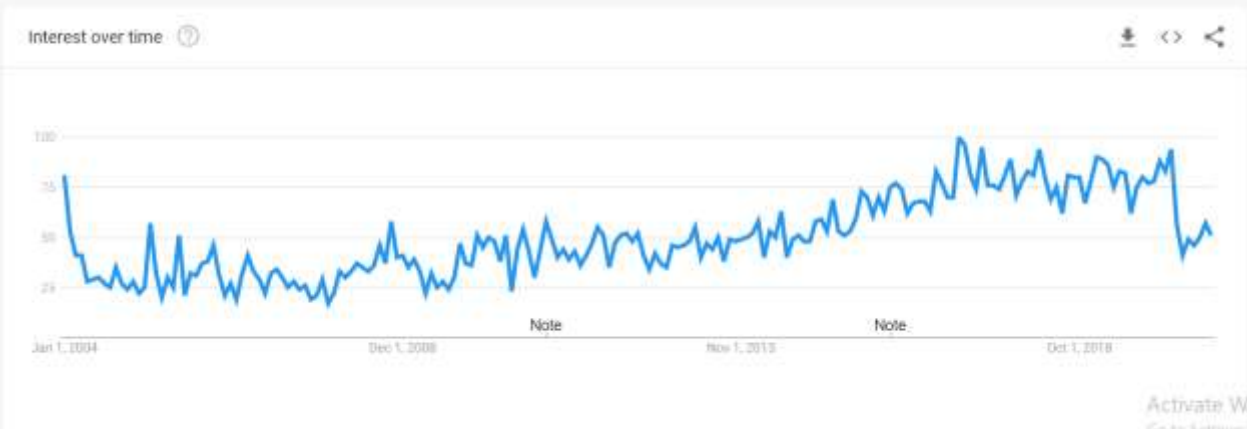

Figure 10 – Google Trends for the “Clothes rent” term. Drop in 2020 due to COVID.

We can observe the topics are still popular and some are rising.

- **Conclusion**

The performed study showed that market design is a very important and essential tool. AI takes an important role, even though it is not said specifically. All the market design is based on complicated mathematical models and AI algorithms. The computational power, data and customer demand will move the research of the market design in the positive direction. The economy will utilize the computational power and resources to boost the profit and increase the efficiency. Top enterprises like Facebook, Microsoft, Google, Amazon, Uber and etc. perform and utilize the research from this conference to keep being the top level company and keep growing their capitals. I believe, that Amazon, who just started to be involved in the conference from 2020 will stay engaged as the data market demand is growing. In addition, we observe that USA has most of the contribution, while China is almost unnoticeable in that conference. It will be interesting to look on the trends in the next year and compare to my predictions.