

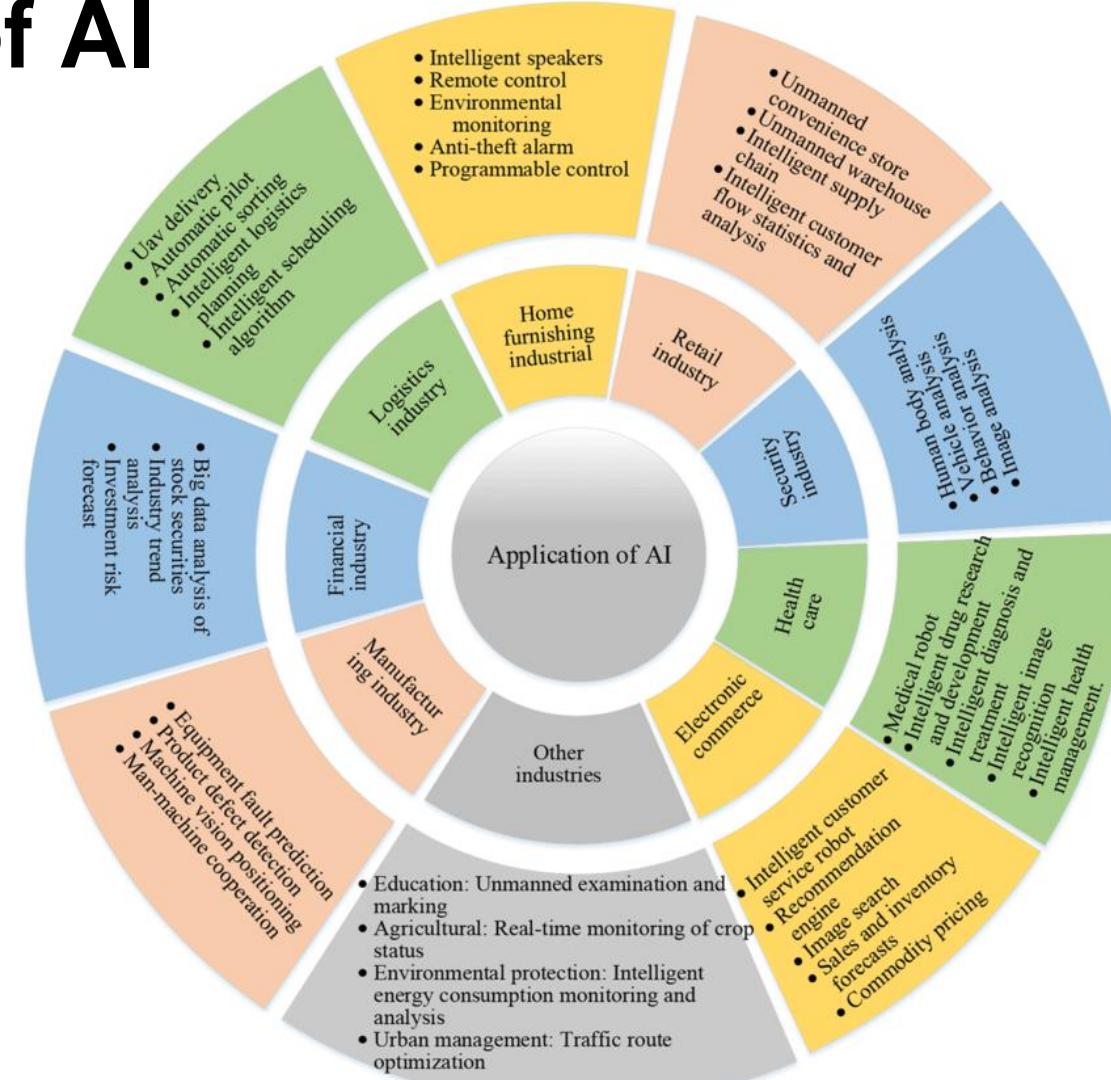
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Artificial Intelligence II (Business Aspect)

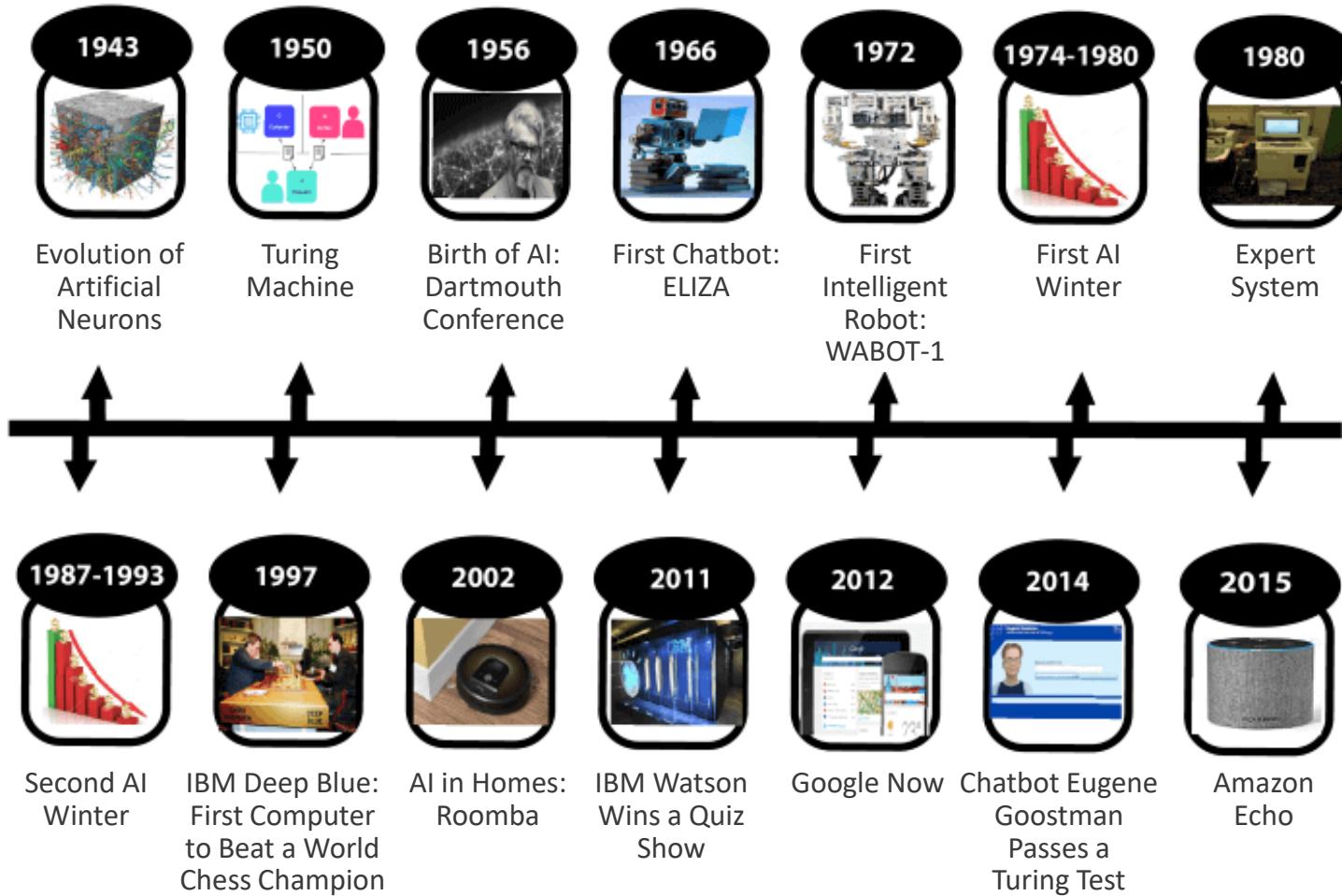
Prof Vijay Sethi, NTU



Application of AI



History of AI



Loss of Innocence



We saw computers beat humans at chess in 1997, beat humans at Jeopardy in 2011 and vanquish the world's best human players of the ancient game of GO in 2017. On Monday, a computer edged out a victory over people in a far more nuanced competition: debate.

Shankland, S. (2018, June 18). An IBM computer debates humans, and wins, in a new, nuanced competition. CNET. Retrieved August 19, 2022 from <https://www.cnet.com/science/an-ibm-computer-debates-humans-and-wins-in-a-new-nuanced-competition/>

An IBM Computer Debates Humans and Wins, in a New, Nuanced Competition

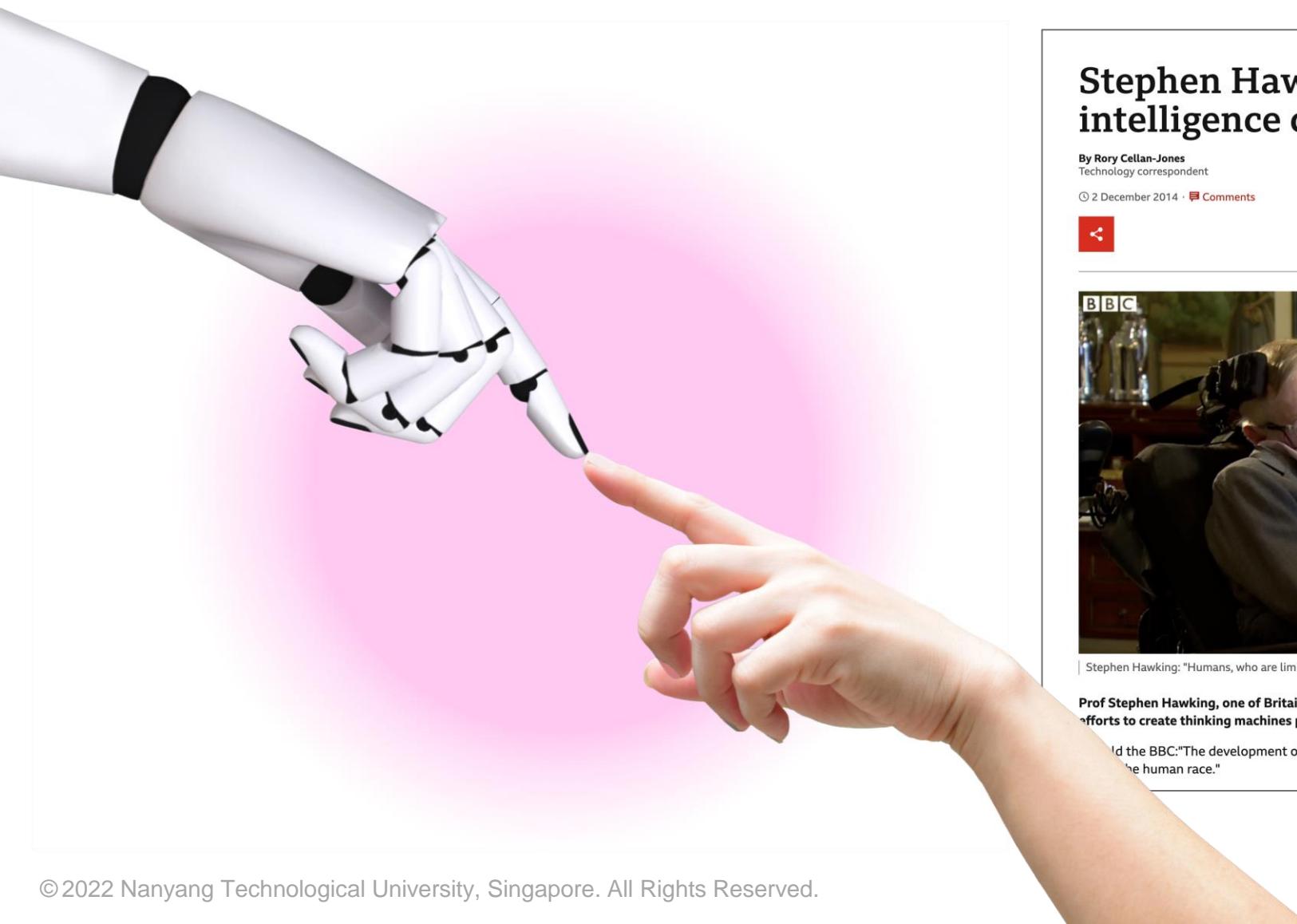
AI isn't just winning at board games. Now it's learning the art of persuasion.

IBM presents its Project Debater on stage as a black obelisk with a screen for a face. A passive blue oval shows when it's idling, but animated blue circles move around as it's processing speeches or listening to a debate opponent.



Shankland, S. (2018, June 18). An IBM computer debates humans, and wins, in a new, nuanced competition. CNET. Retrieved August 19, 2022 from <https://www.cnet.com/science/an-ibm-computer-debates-humans-and-wins-in-a-new-nuanced-competition/>

Artificial Intelligence Could End Mankind



Stephen Hawking warns artificial intelligence could end mankind

By Rory Cellan-Jones
Technology correspondent

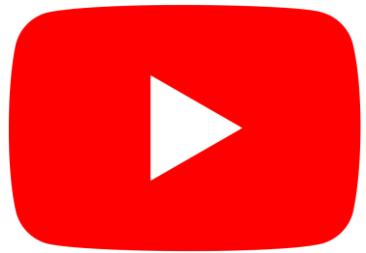
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Stephen Hawking: "Humans, who are limited by slow biological evolution, couldn't compete and would be superseded"

Prof Stephen Hawking, one of Britain's pre-eminent scientists, has said that efforts to create thinking machines pose a threat to our very existence.

I'd the BBC: "The development of full artificial intelligence could spell the end of the human race."



NETFLIX

amazon

Making Our Lives Easier?

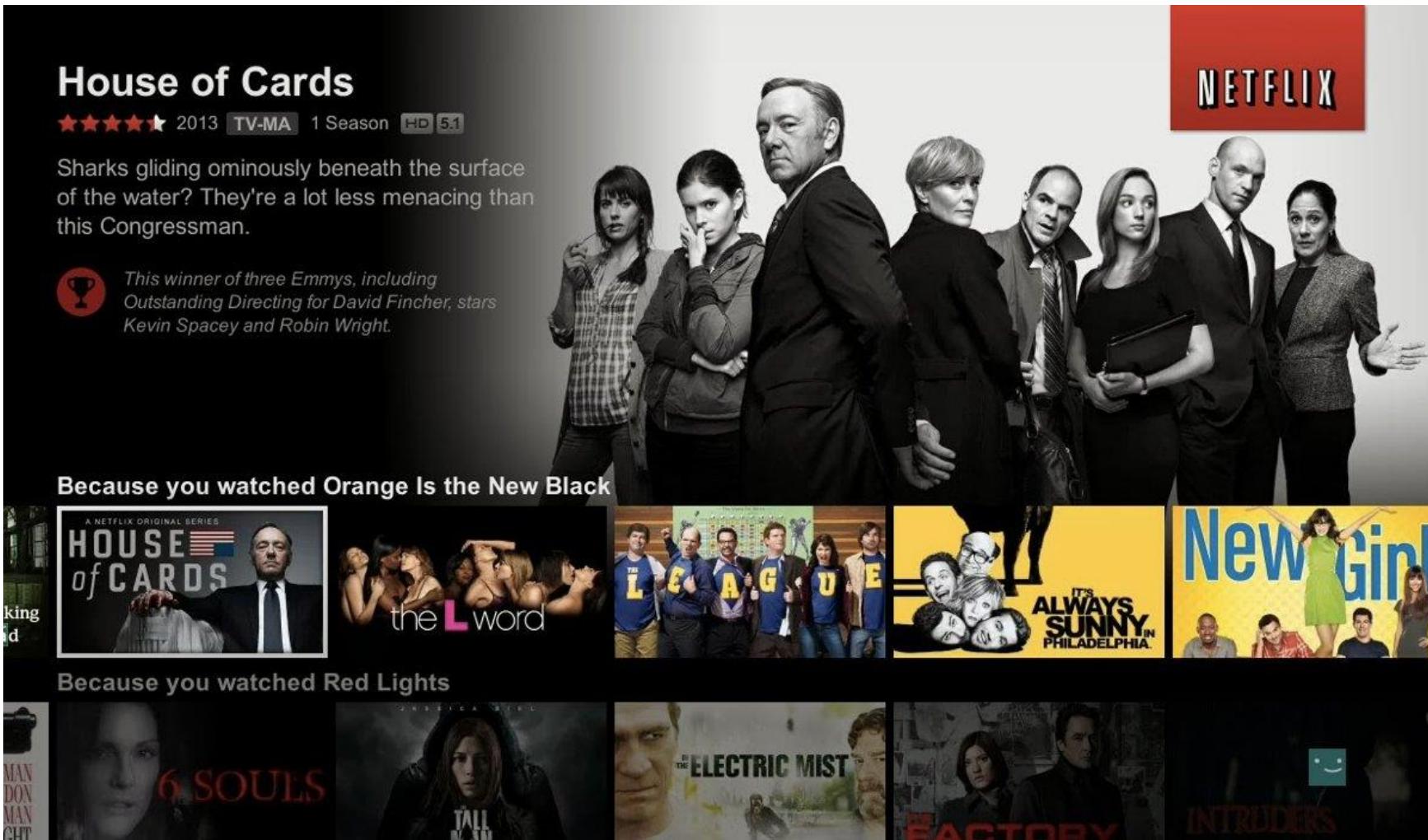
- **Amazon**: Do you know how many products it sells?
 - More than 350 million (12 million owned, remaining from Amazon Marketplace sellers)!
- **Netflix**: How many titles does it carry?
 - 17k titles (April 2022)
 - Netflix users spend 18 minutes browsing (twice as much as cable TV viewers), before selecting their shows (April 2016)
- **Google**: How many search queries are there per day?
 - An astronomical 8.5 billion Google searches are made *daily*!



NETFLIX



Recommendation Systems



Collaborative Filtering (Netflix, Amazon)

- An algorithm that leverages on historical data of various users.
- Users who share similar profiles would share similar preferences/recommendations.



Data Collected

Primary Data: Asking users to:

- Search for items.
- Rank a collection of items.
- Rate items.
- Select one out of two items as being favoured.
- Create a list of items that are favoured.

Secondary Data:

- Analysing users' social network.
- Analysing users' viewing items.
- Keeping records of purchased items.
- Tracking users' browsing history.
- Tracking users' social networks' browsing history.

Cinematch

- A trivial algorithm that predicts for each movie its average grade from the training data produces an RMSE of 1.0540.
- Cinematch uses “straightforward statistical linear models with a lot of data conditioning” and scores an RMSE of 0.9514.

NETFLIX

- A Netflix viewer usually loses interest after 60–90 seconds of scrolling through 10–20 titles.
- Either they find something useful, or there is a risk that they eventually abandon the service.
- A 2015 paper reported that personalised recommendation for users has helped Netflix save about *\$1 billion annually*.



Netflix Prize



- Netflix sponsored a competition from 2006–2009, with a grand prize of \$1M for a team that could take a dataset of 100 million movie ratings and significantly beat its existing Cinematch's recommendation system.
- Sparked intense research in building recommendation systems.
- Won by BellKor's Pragmatic Chaos on 21st September 2009.



Challenges of Collaborative Filtering

- **Cold start**: New users are **unmapped** to existing database. Several tries to gather data about new users are necessary before more effectively producing relevant recommendation.
- **Sparsity and scalability**: With increasingly huge number of items, many of them have **few ratings**.





Amazon's Recommendation System

Amazon.com uses “*item-to-item*” collaborative filtering as targeted recommendation for products on its website.

The screenshot shows a product page for a book titled "Deep Learning" by Ian Goodfellow. Below the main product image, there are three additional book covers: "Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow" by Aurélien Géron, and "The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman. A yellow button labeled "Add all three to Cart" is visible on the right.

Total Price: S\$149.58

Add all three to Cart

Some of these items ship sooner than the others. Show details

- This item: Deep Learning by Ian Goodfellow Hardcover \$43.20
- Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems by Aurélien Géron
- The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition by Trevor Hastie, Robert Tibshirani, Jerome Friedman

Customers who bought this item also bought

Hands-on Machine Learning with Scikit-Learn, Keras, and... Aurélien Géron 4.5 stars, 2,765 reviews Paperback	The Elements of Statistical Learning: Data Mining, Inference, and... Trevor Hastie 4.5 stars, 907 reviews Hardcover	Pattern Recognition and Machine Learning Christopher M. Bishop 4.5 stars, 584 reviews Hardcover S\$114.00
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Why Item-to-Item?



- The algorithm's online component looks up similar items that a user has purchased, and **scales independently** of the number of customers or number of items in the catalogue.
- Plus, item-to-item collaborative filtering works remarkably well even with **limited users and items** (like 2–3 items).





- Larry Page and Sergey Brin founded Google in 1998.
- This search algorithm is called ***PageRank***.
 - It is named after Larry Page.
 - ***PageRank*** is trademarked by Google, and the algorithm is patented.
 - However, the patent is owned by Stanford University, and Google paid 1.8 million of its shares to Stanford University for use of the patent.



PageRank: Ranking of Node Importance

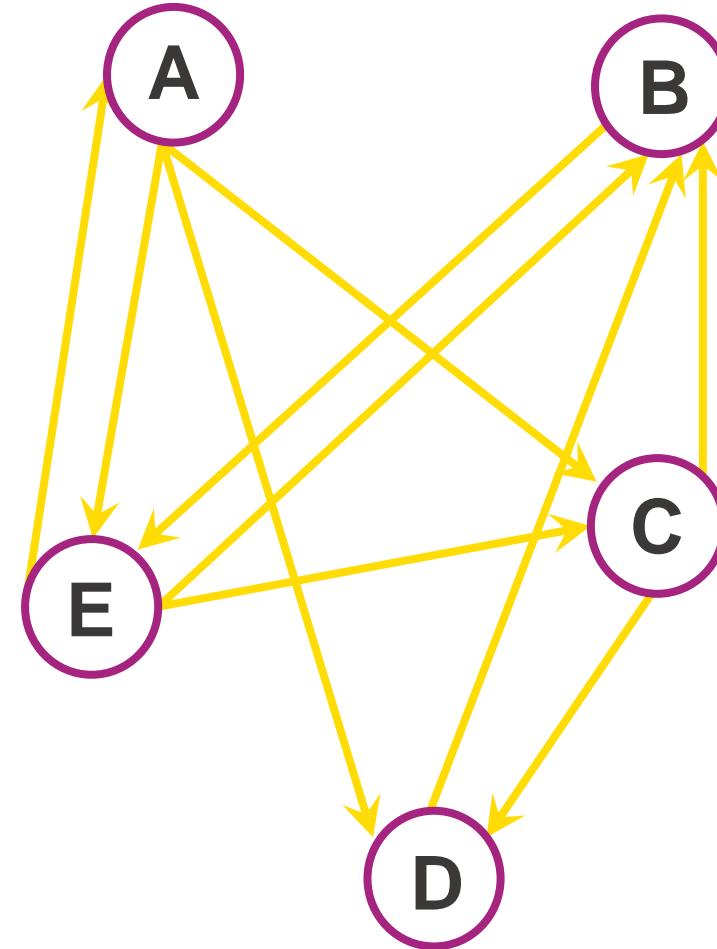


- Webpages are a network with directed links connecting them (each page is a node).
- An important node is one that has many links pointing towards it.
- Naïve ranking would simply count the number of links pointing to the nodes, and rank them by these numbers.
- But simply counting links pointing to a node as a measure of importance is not always an accurate reflection of node importance. — *One can create many dummy nodes to point to your desired node.*
- Some links are more important than others, leading to the notion of weighted links.



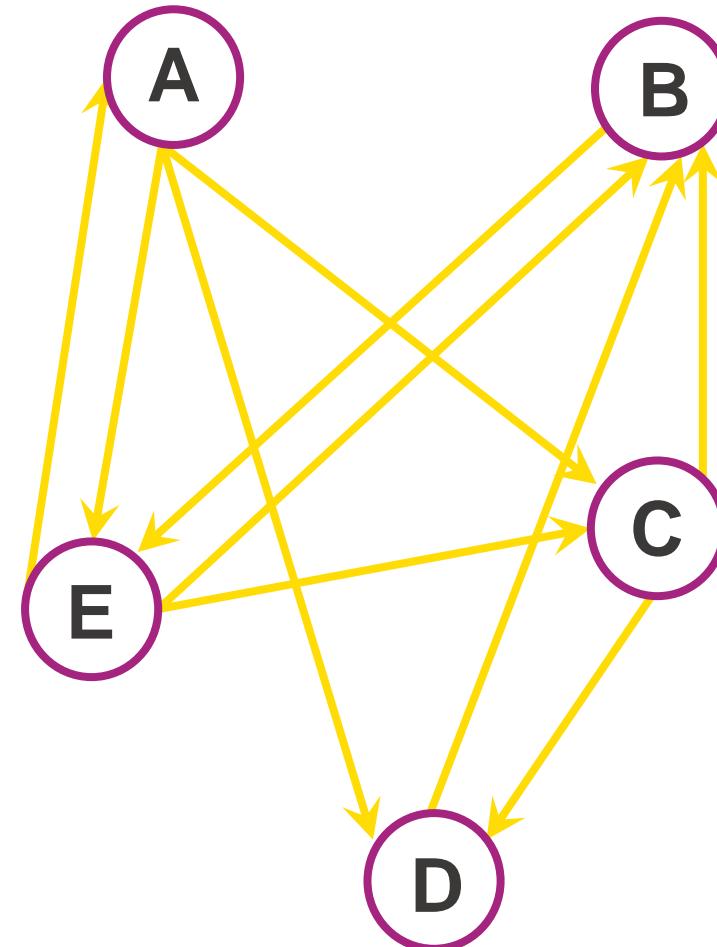
Weighted Links

- A way to decide on the weights of a link is to proportion out with respect to the **total number of links arising from a node**.
- On top of that, the *importance of a node is used as weights on the importance of other nodes it points to.*
- Doing this for all nodes leads to a system of linear equations. One can solve them to determine the importance of each node.



Large Networks: Simple Algebraic Methods Breakdown

- Here, we have just five nodes.
- But real-world problems have billions, trillions, etc. of webpages and things to sort.
- The simple Gaussian elimination algorithm or any standard textbook linear algebra method would take too long to solve.



Machine Learning (AI) Replaces PageRank

01

With data, machine learning methods can be used to *learn and estimate* PageRank algorithm. An example is a graph neural network (GNN).

02

This GNN can also successfully *learn* other types of search algorithms like TrustRank, HITS and OPIC.

03

A machine learning approach would become *superior* to traditional hand-crafted algorithmic search engines, because with *vast data* available today, GNN can *learn any kind of appropriate ranking* without the bias of human judgement.

Other Machine Learning Enhancements for Search Engines



Sometimes a user may not fully know what the intended search keyword is. But with **text predictor and autocomplete**, this can greatly complement and provide suggestions for the users.



Also, Google's **image search or reverse image search** is implemented by image recognition algorithms that can infer images and tag description to them.



Google introduced **RankBrain**, so that user query is “interpreted” and the search engine can evaluate even if it has never encountered that specific search query.

AI Applications

- Recommendation systems



Infrastructure Challenges

today

Signal-related fault causes delays, large morning peak crowds at Circle Line MRT stations

BY BRYAN NG

Published May 10, 2022
Updated May 11, 2022



The scene captured by a social media user of Bishan MRT Station along the Circle Line, which intersects with the North-South Line, on the morning of May 10, 2022.

THE STRAITS TIMES

Train fault delays travel between Kranji and Jurong East stations



Commuters waiting at Jurong East MRT Station at 7pm after a train fault on the North South Line. ST PHOTO: ADITI BHARADE

SMRT Maintenance Cost

- Maintenance and repairs spent by SMRT totalled \$425 million, which accounted for 71% of revenue from fares, up from just 45% in 2016!
- With mature and ageing rail systems, maintenance costs inevitably pile up.





Maintenance Cost: Airline Industry

- According to IATA (International Air Transport Association, 2020), global maintenance, repair and overhaul costs were valued at \$50 billion, which is 10.5% of airline operating costs.
- Singapore Airlines Engineering Company (SIAEC) recently signed a 10-year maintenance deal with Rolls-Royce, which is the aircraft service provider for maintenance, repair and overhaul.



Infrastructure Challenges

- Infrastructure requires regular maintenance work.
- This involves repairs, parts replacements, functionality testing.
- In the past, experienced engineers and technicians monitor and record when parts tend to wear off, and when critical upkeep needs to be carried out.
- For such critical functionalities, businesses and governments cannot afford to only act **after** breakdown occurs.
- Thus, for such critical functionalities, they are inspected and serviced well in advance.
- **However, costs are involved; unnecessarily frequent replacements of hardware may become wasteful. Therefore, a balance is needed.**

Types of Maintenance

- **Reactive**
 - Fix the problem after breakdown occurs.
- **Preventive**
 - Carry out maintenance well in advance.
- **Predictive**
 - Carry out maintenance optimally, based on data.



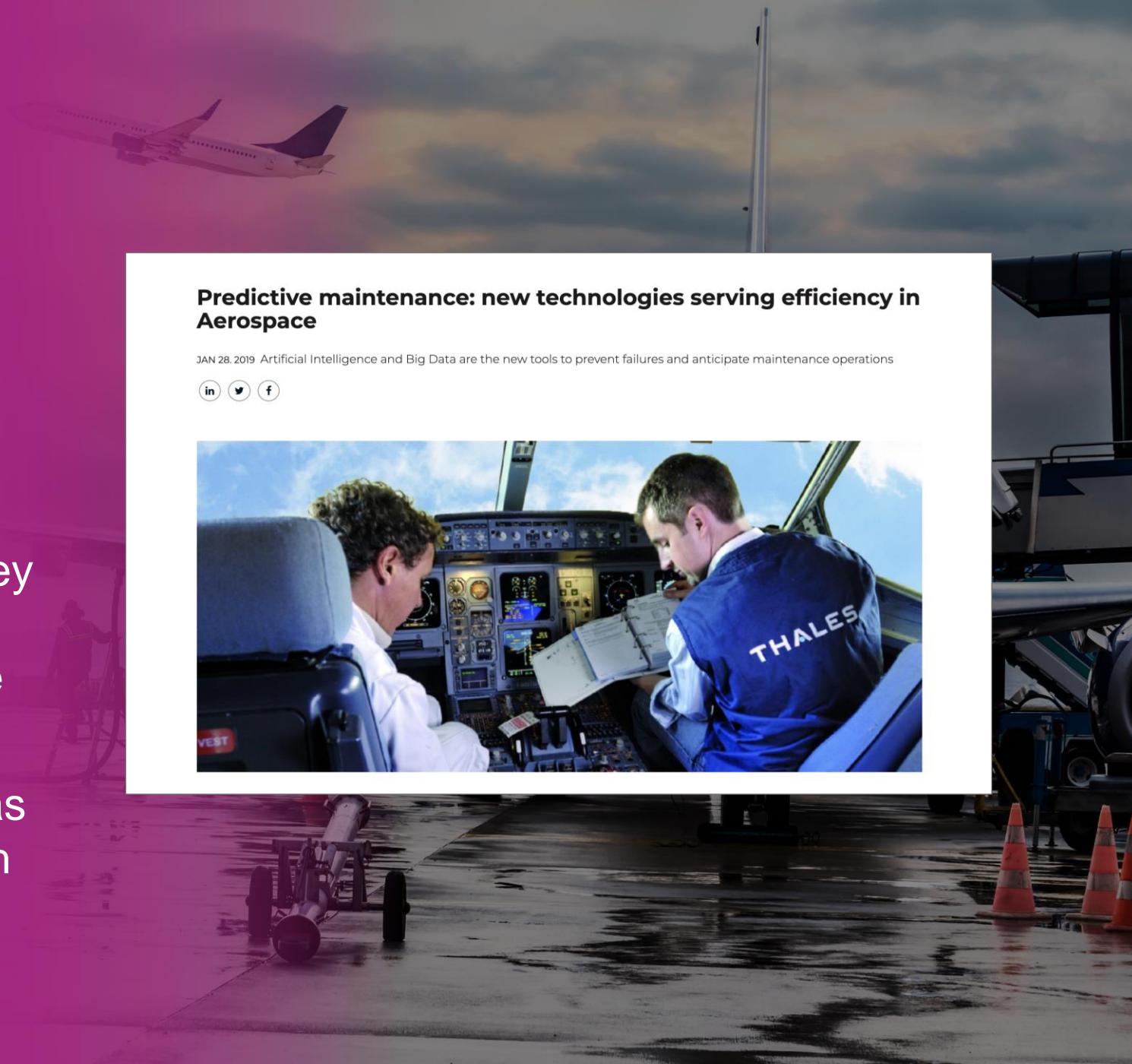
Predictive Maintenance With AI

- With abundance of data, several AI methods have been implemented to better predict when critical parts of an infrastructure or industrial machinery require replacements or repair.



Air Travel Industry

- 3 billion people travel annually by planes, with this figure projected to triple by 2030.
- A grounded aircraft can cost approximately **\$10k per hour!**
- Predictive maintenance is thus a key area which airlines and associated companies invest heavily to ensure such wastage is minimised.
- For example, Singapore Airlines has recently formed a collaboration with A*STAR in this area.



A*STAR, SIA, SIAEC Collaborate on Enhanced AI Tech for Airlines

- This collaboration aims to develop AI solutions to enhance engineering productivity, customer experience, cost-effectiveness of airline operations, using predictive analytics.
- This is a 3-year project, presently at the development phase.
- With vast data available to them, state-of-the-art deep learning can predict and therefore **reduce flight delays**.
- A key cause of delays is **component failures of the aircraft**. This is where predictive maintenance can help.
- The SAAVIS (Smart Automated Aircraft Visual Inspection System) programme by A*STAR organises and synergises expertise from computer vision, AI and robotics, to develop new algorithms.



More...

The screenshot shows a news article from CNA (Channel NewsAsia) titled "AI eyed to help bring lift maintenance to a higher level". The article discusses a project by Surbana Jurong to develop an AI prediction model for lift faults. It includes a photograph of two engineers working in an elevator pit. The CNA logo and "mediacorp" watermark are visible at the bottom right.

AI eyed to help bring lift maintenance to a higher level

Surbana Jurong, which monitors about 25,000 lifts in Singapore, says it is months in a year-long project with apprentices from AI Singapore's training programme to develop a prediction model for lift faults.

File photo of engineers checking the buffers in a lift pit. (Photo: TODAY)

Kevin Kwang
03 Sep 2018 06:00AM | (Updated: 31 Aug 2021 03:50PM)

The screenshot shows a news article from readwrite titled "New Technologies Will Make Elevator Breakdowns a Thing of the Past". The article is by Augustin Celler and was published on 01 Aug 2022. It features a photograph of a couple in an elevator. The sidebar on the left lists various technology categories: AI, Blockchain, Connected Devices, Fintech, Industrial, Startups, Smart Cities, Product Reviews, Lifestyle, Guest Post, and More. Social media sharing icons for Facebook, Twitter, LinkedIn, and Mail are also present.

New Technologies Will Make Elevator Breakdowns a Thing of the Past

Augustin Celler / 01 Aug 2022 / ReadWrite

We often forget that elevators are the most used transportation and, statistically, one of the safest. Therefore, the global elevator market is a lucrative niche worth more than \$90 billion and yields massive cash flows. Yet, the end customers still experience an average of five failures a year despite frequent service visits. So let's explore how and why a technological shift in the elevator industry could eventually prevent breakdowns.

AI Applications

- Recommendation systems
- Predictive maintenance



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