AI: Strategy + Marketing (MGT 853)

Economics of AI & Prediction Problems (Session 4)

Vineet Kumar

Yale School of Management
Spring 2024

Agenda for Today's Session

- Reinforcement Learning

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- Prediction & Computing Problems

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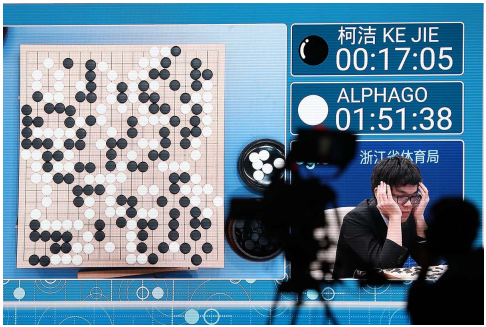
Reinforcement Learning

Power of RL in Games

- Deep Blue defeated world Chess champion in 1997



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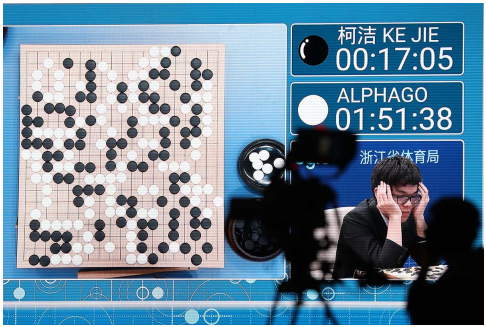

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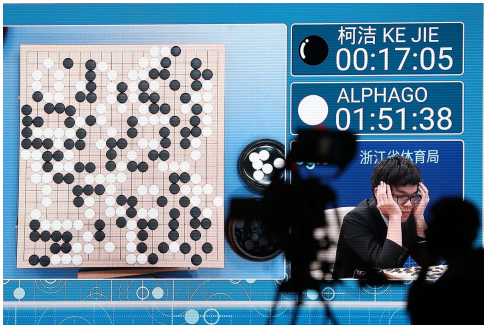

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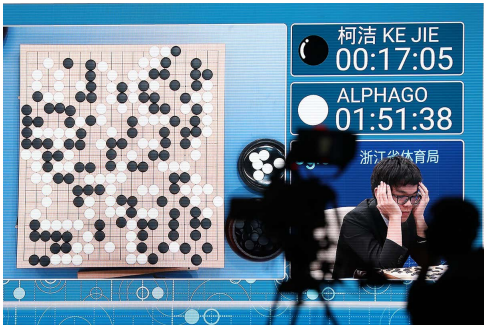

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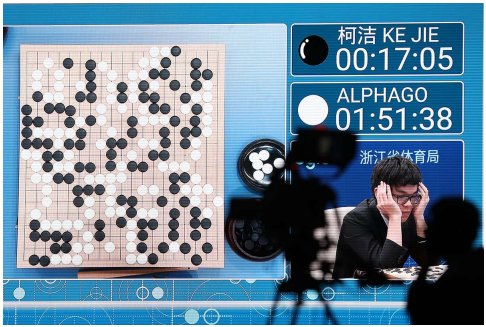

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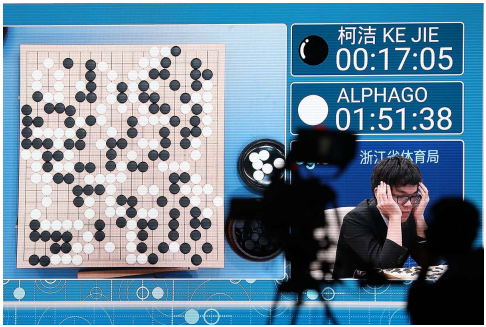

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- Critically important to specify the reward function properly

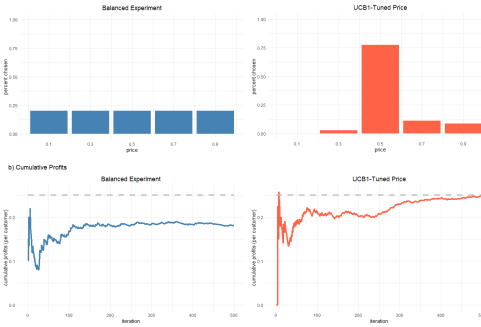
Now let's try this with Chess

Specifying the RL problem

What are the (S)tates, (A)ctions and (R)ewards?

RL in Dynamic Pricing

- When you have a new product we don't know demand



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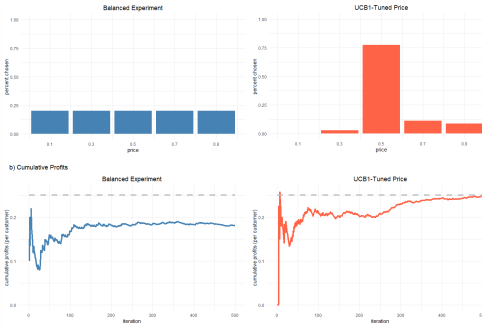

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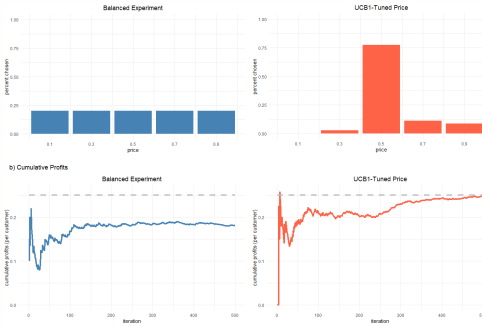

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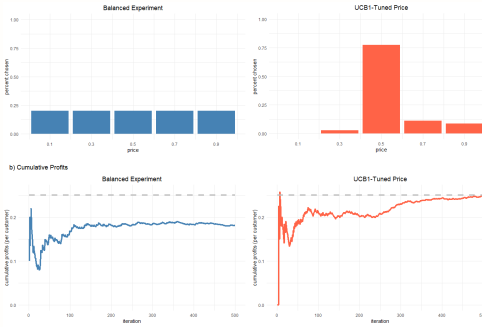

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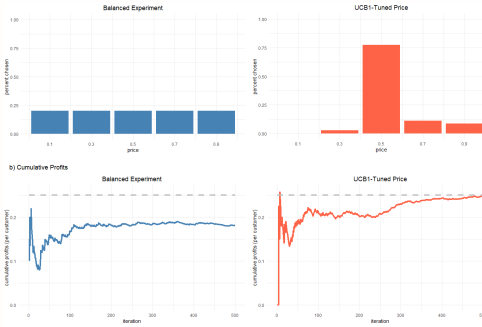

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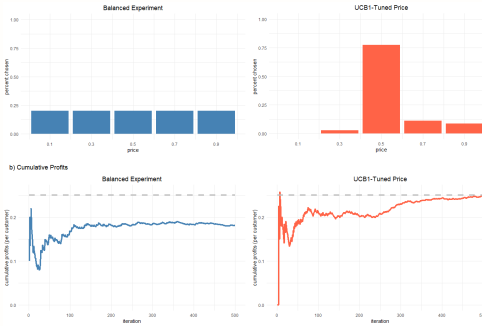

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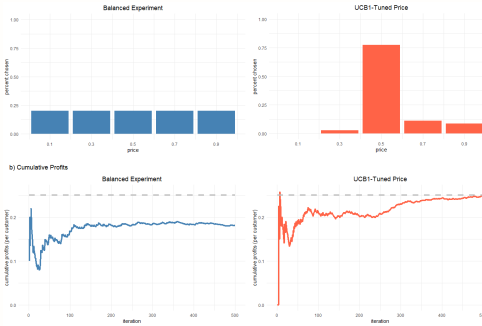

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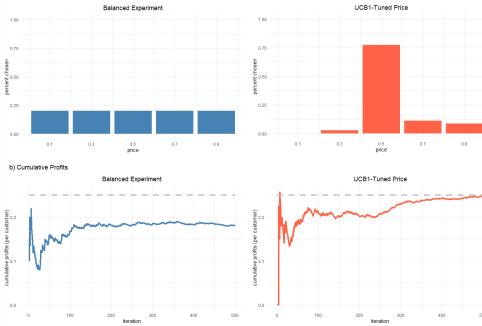
- **State:** Sequence of prices tested and quantities sold



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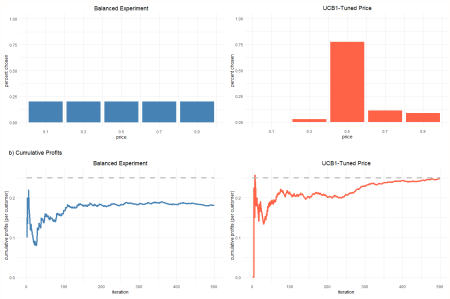

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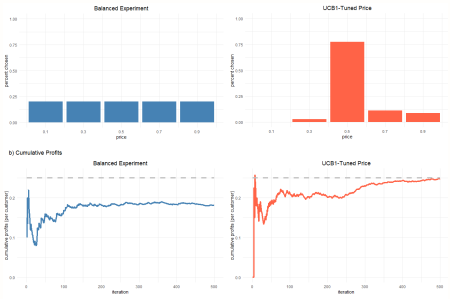

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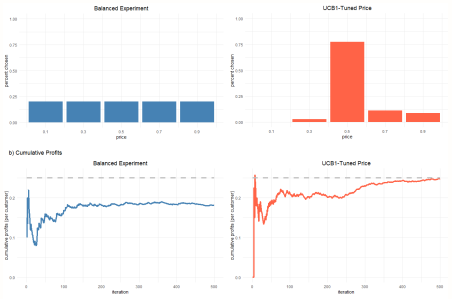
- Learning *while* experimenting (RL) versus Learning *after* experimenting (A/B)



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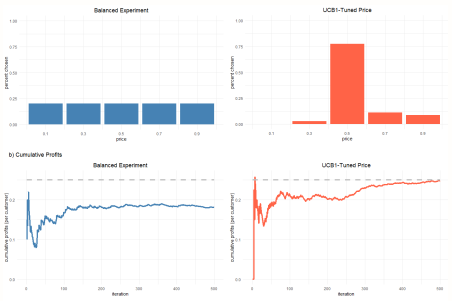
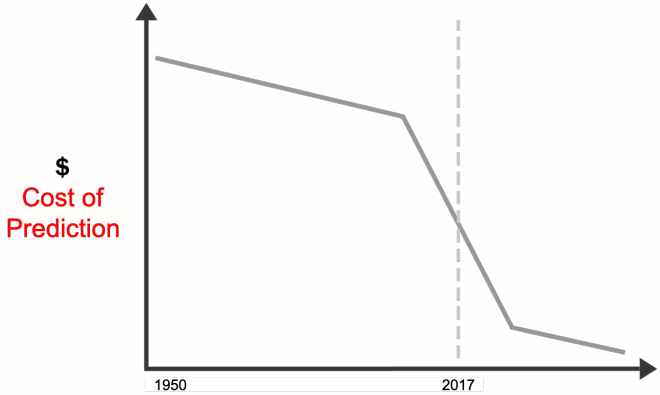
- RL obtains higher profit levels quicker



RL in Robotics

Economic Impact of AI

Prediction Costs Over Time



Cost of high-quality prediction (accurate, robust) has decreased significantly

Economics of AI

Impact of Cheap Prediction

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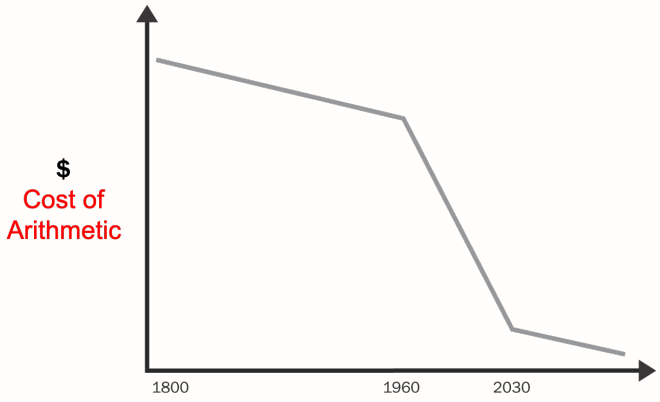
Biggest Impact

Convert non-prediction problems to prediction problems

Computing Costs Over Time



Converting to a Computing Problem

How has writing become a computing problem?

- Computing has become much cheaper over past few decades.

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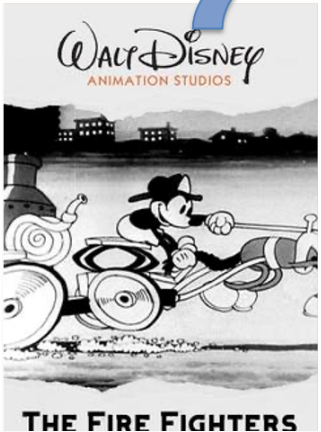


Computing problem

Converting to a Computing Problem

How has photography become a computing problem?

Converting to a Prediction Problem

What is a Prediction Problem?

What is a Prediction Problem?

Using information that you *do have*
to
generate information that you *don't have*

Converting to a Prediction Problem?

With Smartphones, can we think of a prediction problem here?

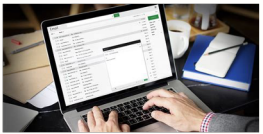
Converting to a Prediction Problem?

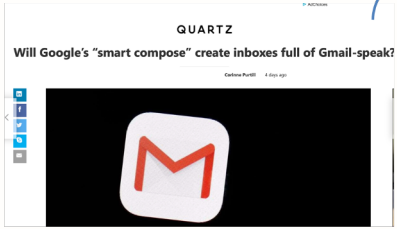
How Apple Uses AI To Produce Better Photos

By Paul Mah on November 03, 2021

Converting to a Prediction Problem?

Generative AI





From Prediction Performance to Business Impact

AI Drives Change in Firm Strategy

Google Products and Services · Artificial Intelligence · Companies · Google (company)

What does it mean for Google to become an "AI-first" (quoting Sundar) company? How will this affect prioritization and product development?

https://googleblog.blogspot.com/2016/04/this-years-founders-letter.html

Google sees huge value in moving from 80% accuracy in search to 99.x% accuracy

Willing to de-prioritize everything else (before this, Google was "Mobile First")

Peter Norvig, Research Director at Google

Answered May 16 2016 · Upvoted by Pål Bergerskogen, M.Sc Artificial Intelligence, Norwegian University of Science and Technology (2018) and Ken Fishkin, former Software Engineering Manager at Google (2013-2018)

"Classic" Google was an information retrieval company: you give a query, we quickly respond with ten suggestions of relevant pages, and it is your job to make sense of the suggestions. "Modern" Google, as Sundar has set out the vision, is based not just on suggestions of relevant information, but on informing and assisting. Informing, meaning that we give you the information you need, when you need it. For example, Google Now telling you it is time to leave for an appointment, or that you are now at the grocery store and previously you asked to be reminded to buy milk. And assisting means helping you to actually carry out actions—planning a trip, booking reservations; anything you can do on the internet, Google should be able to assist you in doing.

With information retrieval, anything over 80% recall and precision is pretty good—not every suggestion has to be perfect, since the user can ignore the bad suggestions. With assistance, there is a much higher barrier. You wouldn't use a service that booked the wrong reservation 20% of the time, or even 2% of the time. So an assistant needs to be much more accurate, and thus more intelligent, more aware of the situation. That's what we call "AI-first."

Preparing for the Future

Science Fictioning?

- What if we can turn the dial to 100% on prediction accuracy?

Would you consider this an incremental change or disruptive change?

Preparing for the Future

Science Fictioning?

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- How will business activities or models change?

Would you consider this an incremental change or disruptive change?

Preparing for the Future

- Suppose Amazon could predict with close to 100% accuracy what you would buy.

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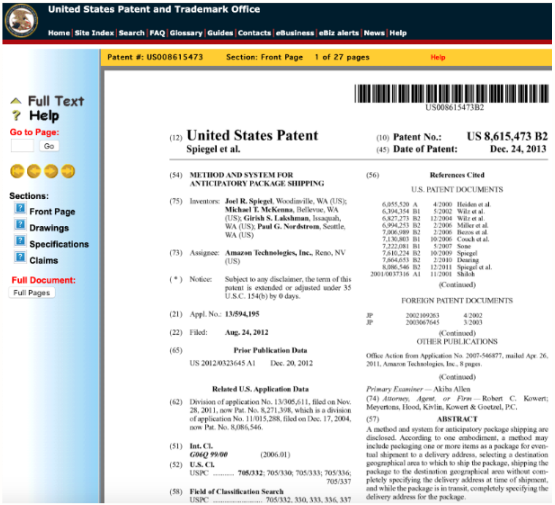

Is Prediction Sufficient?

The Impact of Prediction

A Wartime example from WWII

- We have the images from 100s of planes showing bullet holes

The Impact of Prediction

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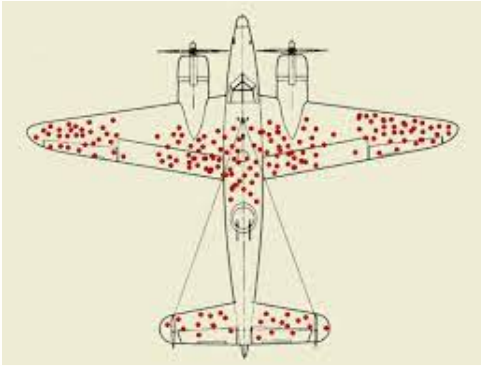

Source: An Except from How not to be Wrong

AI Decision Making Framework (Prediction $\neq$ Decision)

The Role of Judgment

What is Judgment?

"The ability to make considered decisions or come to sensible conclusions" – Oxford

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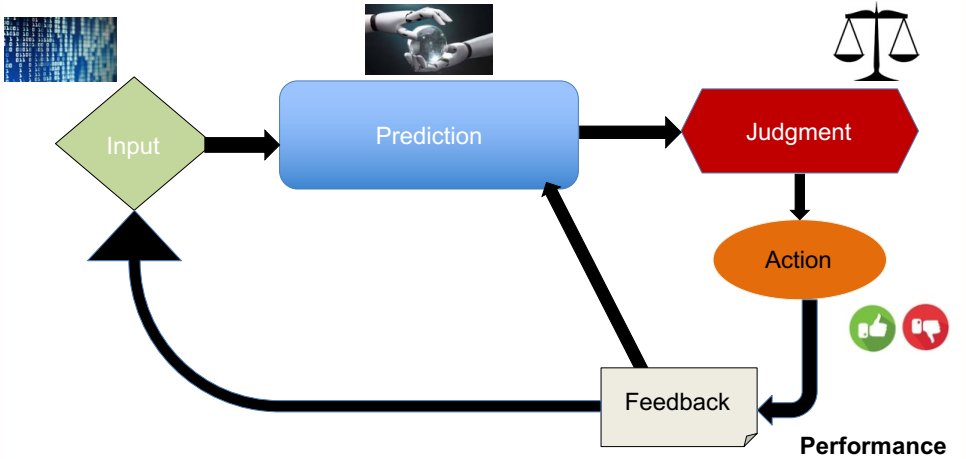
The Confusion Matrix

Understanding Performance and Consequences

- Two class problem: $y = \text{Y}\ (1)$ or N (0)

Judgment: Now we need to assign values (utilities) to each cell

AI Decision-Making Framework



Does Feedback also inform Judgment?

Autonomous Vehicles


HYSTER
80
24
XL2
HYSTER

Autonomous Vehicles

Three Waves

First-wave used mechanical control (1970s)

Mechanical Control

- Works in very limited way
- No flexibility if environment is changed even a bit

Autonomous Vehicles

Three Waves

First-wave used mechanical control (1970s)

Expert Systems
Second-wave used computer programming (1980s to early 2000s)

Mechanical Control

- Works in very limited way
- No flexibility if environment is changed even a bit

If condition X, Then do Y

- Could go to 1000s or 100K lines of code
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Autonomous Vehicles

Three Waves

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Predictive Model

- AI system learns and builds the model and delivers better (more accurate prediction) as more data is generated

Converting to Prediction Problem (In class exercise)

Autonomous Vehicles

- Consider the role of prediction in autonomous driving
- Let's walk through the AI Decision Framework

Questions to Ponder

0) What sources of data should the system use?
1) What are the possible predictive problems one might encounter?
2) How should we measure performance?
3) What are appropriate ML algorithms in our toolbox to solve them?
4) What role does judgment play in this problem?

Converting to Prediction Problems (In class exercise)

Let's try this in Groups

- Choose one of (1), (2) or (3). Tell the class what you have chosen before you get started.
  $\geq$ 2 groups for each.

3 Cases – Chose ONE

1) Social media (Instagram) – increase engagement
2) Content firm (Spotify) – recommend new content to its users
3) Apparel retailer – improve its product assortment

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- What metric would you use to measure improvement?

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- Try and develop skills that serve as a complement to prediction