

FYS: AI in Healthcare

Lecture 1

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September 11, 2018

^aSlides reuse material from Sontag and Makar, 2017.

Questions from last week

- More about me

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- Midterm/final project

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- Does AI = robots?

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Questions from last week

- More about me
- Midterm/final project
- Does AI = robots?
- Can AI cure cancer?
- AI in healthcare today

- Assignment 2
 - Will be announced on Piazza tomorrow.
 - Due before class next Tuesday
- First-year student resource guide

Introduction

Artificial Intelligence in Healthcare

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Artificial Intelligence

"A branch of computer science dealing with the simulation of intelligent behavior in computers."¹

"The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it."²

¹Merriam-Webster Dictionary

²Dartmouth Summer Research Project on Artificial Intelligence, 1956

AI Examples

Robotics



AI Examples

Natural Language Processing

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Welcome to
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EEEEEE	LL	IIII	ZZZZZZZ	AAAAAA
EE	LL	II	ZZ	AA AA
EEEEEE	LL	II	ZZZ	AAAAAAA
EE	LL	II	ZZ	AA AA
EEEEEE	LLLLL	IIII	ZZZZZZZ	AA AA

Eliza is a mock Rogerian psychotherapist.

The original program was described by Joseph Weizenbaum in 1966.

This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?

YOU: Men are all alike.

ELIZA: What is the connection, do you suppose ?

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ELIZA: Can you think of a specific example ?

YOU: Well, my boyfriend made me come here.

ELIZA: Is it important to you that your boyfriend made you come here ?

YOU: He says I'm depressed much of the time.

ELIZA: I am sorry to hear that you are depressed.

YOU: It's true. I am unhappy.

ELIZA: Can you explain what made you unhappy ?

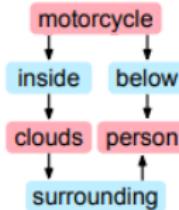
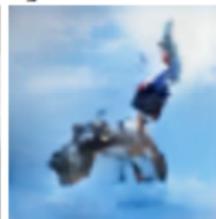
YOU: ■

AI Examples

Computer Vision³

Caption StackGAN [59] Ours **Scene Graph**

A man flying through the air while riding a bike.



Which objects are present? motorcycle, person, clouds

³Johnson J, Gupta A, Fei-Fei L. Image generation from scene graphs. CVPR 2018.

Machine Learning

“Computer algorithms for learning to do stuff”⁴

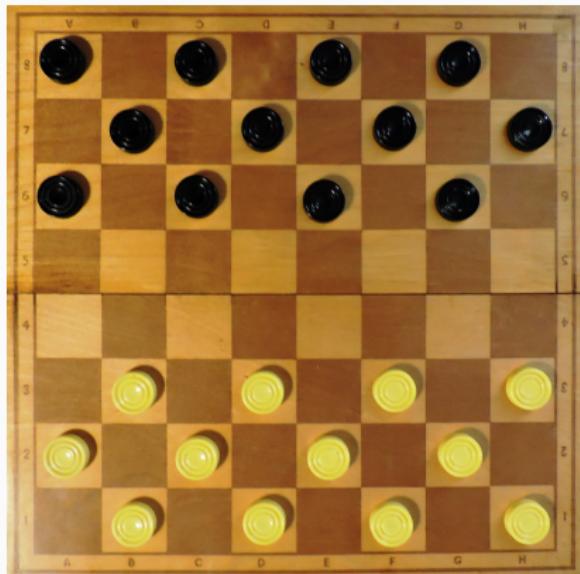
Coined by Arthur Samuel in 1959

⁴Rob Schapire, Princeton → MSR

Machine Learning

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Healthcare

“Efforts made to maintain or restore physical, mental, or emotional well-being especially by trained and licensed professionals”⁵

⁵Merriam-Webster

Goal: to design algorithms that can learn from medical data to extract information, analyze relationships, and assist in decision-making.

19070s - MYCIN

- 1970's (Stanford): MYCIN expert system for identifying bacteria causing severe infections
- Proposed a good therapy in ~69% of cases. Better than infectious disease experts

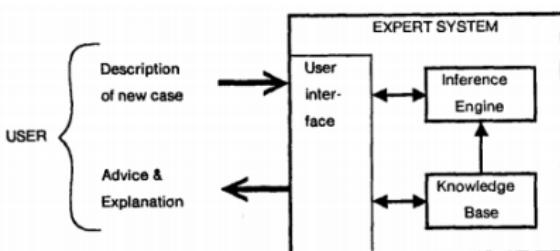


FIGURE 1-1 Major parts of an expert system. Arrows indicate information flow.

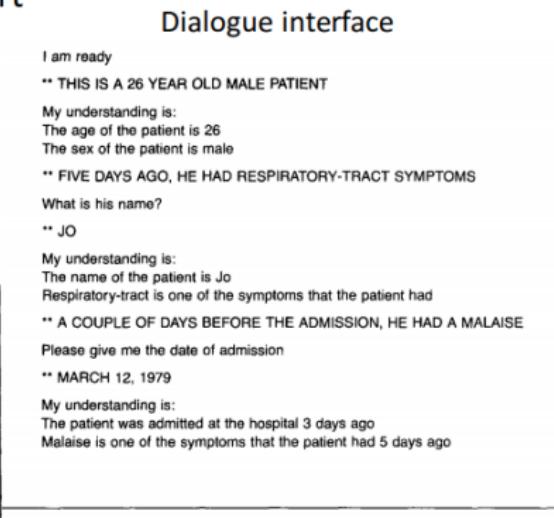
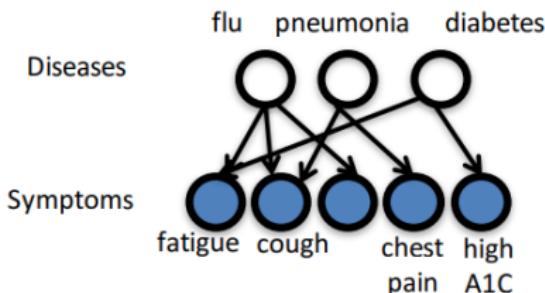


FIGURE 33-1 Short sample dialogue. The physician's inputs appear in capital letters after the double asterisks.

1980s - INTERNIST1/QMR

- 1980's (Univ. of Pittsburgh): INTERNIST-1/Quick Medical Reference
- Diagnosis for internal medicine



Probabilistic model relating:

570 binary disease variables
4,075 binary symptom variables
45,470 directed edges

Elicited from doctors:
15 person-years of work

Led to advances in ML & AI
(Bayesian networks, approximate inference)

- Problems:**
1. Clinicians entered symptoms *manually*
 2. Difficult to maintain, difficult to generalize

[Miller et al., '86, Shwe et al., '91]

1990s - Neural Nets!!

- Neural networks with clinical data took off in 1990, with 88 new studies that year
- Small number of features (inputs)
- Data often collected by chart review

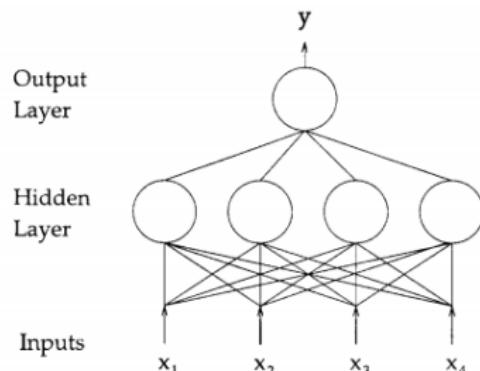


FIGURE 2. A multilayer perceptron. This is a two-layer perceptron with four inputs, four hidden units, and one output unit.

Problems:

1. Did not fit well into clinical workflow
2. Poor generalization to new places

[Penny & Frost, Neural Networks in Clinical Medicine. Med Decis Making, 1996]

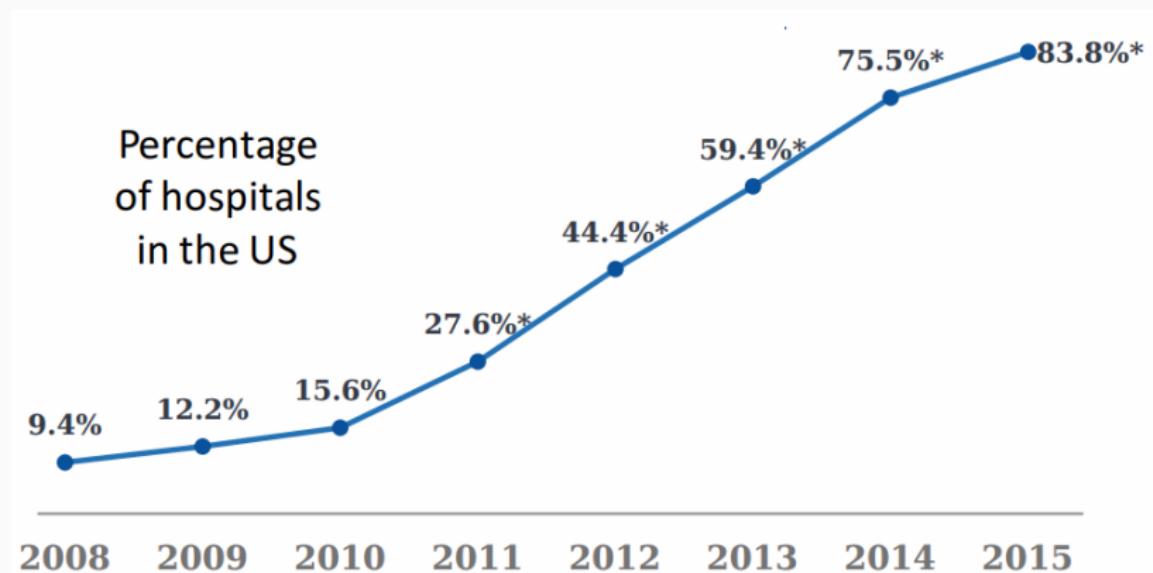
Why now?

Why now?

Data, Algorithms, and Industry

Data

Electronic Health Records (EHRs)



[Henry et al., ONC Data Brief, May 2016]

Data

Datasets



If you use MIMIC data or code in your work, please cite the following publication:

MIMIC-III, a freely accessible critical care database. Johnson AEW, Pollard TJ, Shen L, Lehman L, Feng M, Ghassemi M, Moody B, Szabolts P, Celi LA, and Mark RG. *Scientific Data* (2016). DOI: 10.1038/sdata.2016.35. Available from: <http://www.nature.com/articles/sdata201635>



De-identified
health data from
~40K critical care
patients

Demographics,
vital signs,
laboratory tests,
medications,
notes, ...

Data

Datasets

The screenshot shows a web browser window with the URL truvnhealth.com/markets/life-sciences/products/data-tools/marketscan-databases. The page header includes the Truven Health Analytics logo, a navigation bar with links for MEDIA ROOM, SUPPORT, and CAREER, and a main menu with SOLUTIONS, EVENTS, KNOWLEDGE, and AB. The main content area has a purple header "Life Sciences" and a breadcrumb trail: Home » Life Sciences » Data & Tools » MarketScan Databases. Below this is a large image of a hand holding a smartphone displaying a grid of numbers. To the left is a sidebar with links: Market Knowledge, Real World Evidence, Stakeholder Management, Data & Tools (which is highlighted in light gray), MarketScan Databases, Treatment Pathways, Inpatient/Outpatient View, PULSE, and Heartbeat Profiler. The main article title is "Putting Research Data Into Your Hands with the MarketScan Databases". A summary below states: "The Family of MarketScan® Research Databases is the largest of its kind in the industry, with data on nearly 230 million unique patients since 1995." To the right of the article are three large, semi-transparent blue boxes containing the letters "PU", "\$\$\$" (with a small icon above it), and "W".

“Data on nearly 230 million unique patients since 1995”

Market Knowledge
Real World Evidence
Stakeholder Management
Data & Tools
MarketScan Databases
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Inpatient/Outpatient View
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Datasets

President Obama's initiative to create a 1 million person research cohort



Core data set:

- Baseline health exam
- Clinical data derived from electronic health records (EHRs)
- Healthcare claims
- Laboratory data

[Precision Medicine Initiative (PMI) working Group Report, Sept. 17 2015]

Data

Digital health data



Algorithms

- Advances in AI (especially ML)
 - Deep learning
 - Semi-supervised/unsupervised learning
 - Learning with high-dimensional features
- High-quality open-source software
 - scikit-learn
 - Pytorch
 - TensorFlow

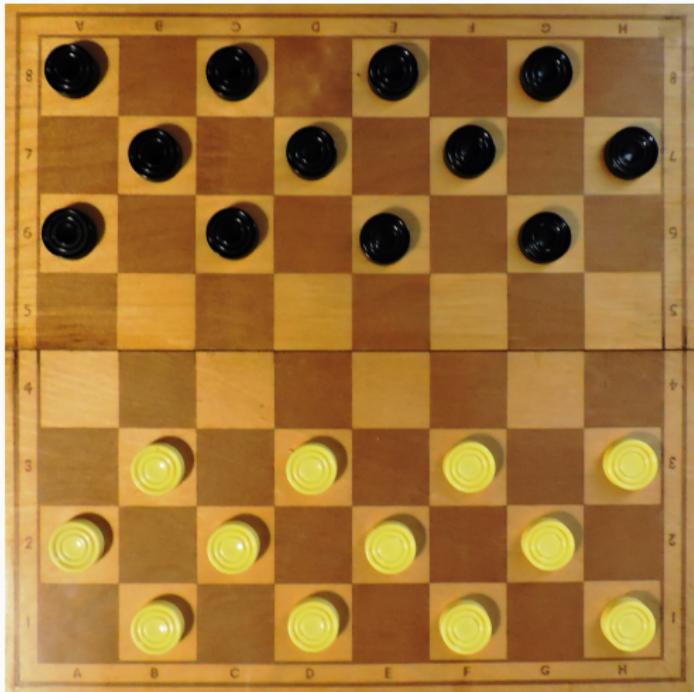
Industry Interest

The image displays four separate screenshots of websites for different healthcare AI companies, arranged side-by-side:

- Google DeepMind Health:** The top-left screenshot shows the DeepMind Health logo with a blue heart icon. Below it, the text "DeepMind Health" and "CLINICIAN-LED TECHNOLOGY" is visible. The background features a dark blue gradient with a faint image of a medical professional.
- enlitic:** The top-right screenshot features the enlitic logo with a blue circular icon. The main text reads: "Deep learning technology can save lives by helping detect curable diseases early". The background is a blurred image of a medical professional in a white coat.
- IBM Watson for Oncology:** The bottom-left screenshot shows the IBM Watson for Oncology logo. The main text is "IBM Watson for Oncology". Below it, a descriptive paragraph states: "Get oncologists the assistance they need to make more informed treatment decisions. Watson for Oncology analyzes a patient's medical information against a vast array of data and expertise to provide evidence-based treatment options." The background is a dark image of a medical professional.
- lumia:** The bottom-right screenshot shows the lumia logo. The main text is "Enabling healthcare to be predictive-first where health + care is proactive, hyper-personalized, and real-time". The background is a blurred image of a group of people in a professional setting.

Activity: AI or not AI?

Activity: AI or not AI?



Activity: AI or not AI?

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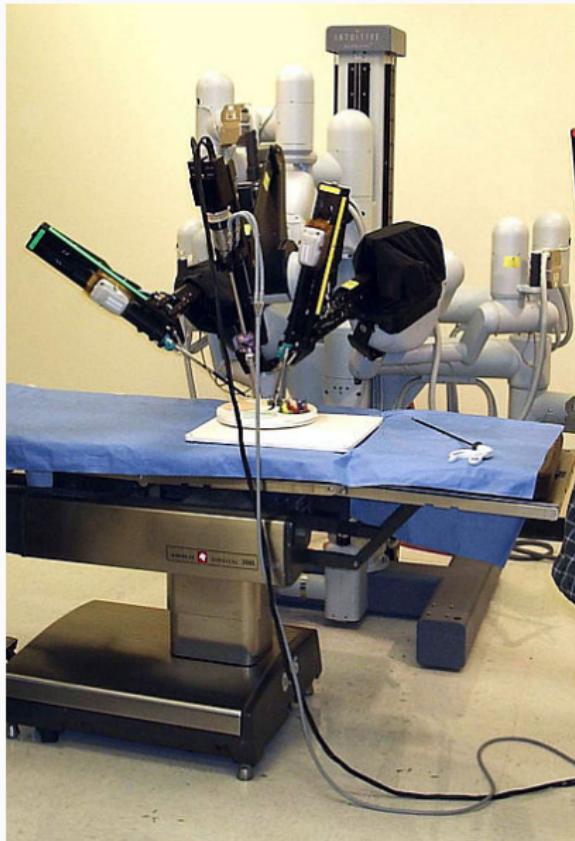
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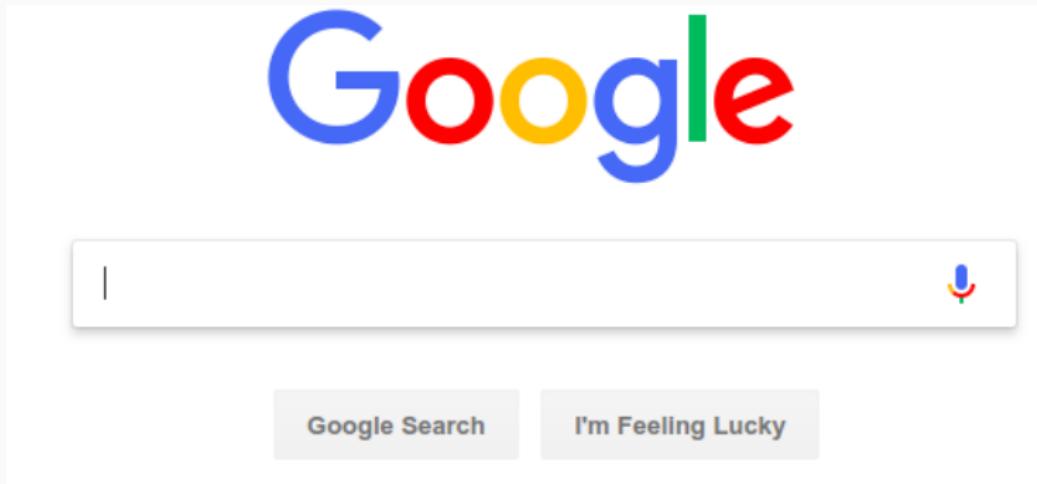
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Activity: AI or not AI?

The screenshot shows the Netflix homepage with a red header. In the top left, there are 'Browse' and 'Kids' buttons. The center features the 'NETFLIX' logo. On the right is a search bar with a magnifying glass icon and the word 'Search'. Below the header, there's a section titled 'Continue Watching' with three movie thumbnails: 'House of Cards: Season 2: Chapter 1', 'Orange Is the New Black: Season 1: Ep. 5', and 'Lilyhammer: Season 2: Ep. 2'. Each thumbnail has a play button icon. Below this is a section titled 'Top 10 for You' featuring six show thumbnails: 'ORANGE IS THE NEW BLACK', 'CHUCK', 'HOUSE OF CARDS', 'SAFE HAVEN', 'DEXTER', and 'BREAKING BAD'. At the bottom is a section titled 'Popular on Netflix' with five show thumbnails: 'SCANDAL', 'FAMILY GUY', 'MITT', 'OLYMPUS HAS FALLEN', and 'SONS OF ANARCHY'. Each thumbnail includes the show's title.

Activity: AI or not AI?



Activity: AI or not AI?

Google Assistant



amazon alexa