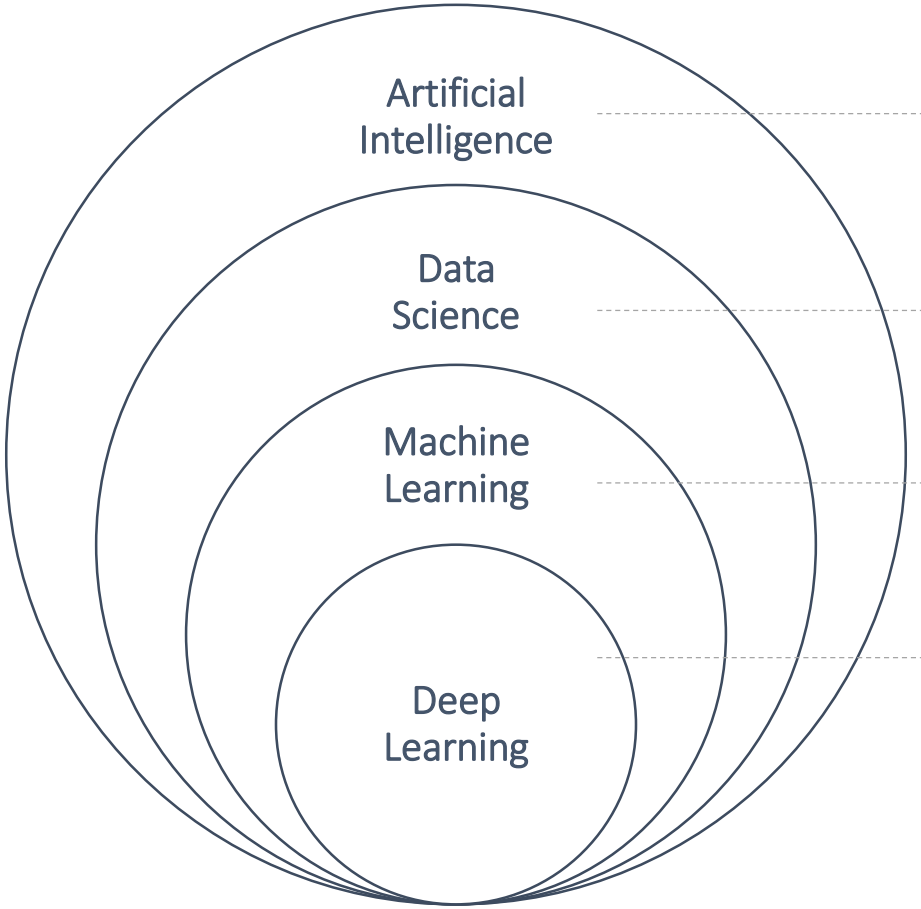
Artificial Intelligence in Infection Control and Antimicrobial Resistance

Lisbon Antimicrobial Resistance and Healthcare Associated Infections Congress, 2019

Today we are talking about…

1. What is AI and why do we need it?
2. What does AI mean for the medical practice?
3. How do we use it?
4. How do we get started?
5. What are the best practices for organizations?

What is AI?



When a computer can mimic human cognitive functions (umbrella term)

Extracting knowledge or insights from data (field of study)

Ability to learn without being explicitly programmed (subfield of computer science)

Multi-layered neural networks that can learn from large amounts and multiple types of data

The scope of AI is not consensual and changes over time

AI = f(models(data))

Model question: what is the probability of this episode/patient being classified with an event of “hospital acquired infection (HAI)”?

- Clinical Variables
- Demographic variables

Predict **HAI** at 4h/8h/24h/72h before onset

“Is this patient likely to satisfy the definition of HAI within the next 24 hours?”

Based on a group of pre-selected variables, the model will predict the probability of the patient/episode being classified as “HAI”

We need to define a probabilistic threshold

Probability > threshold	Probability < threshold
HAI	**NO HAI**

AI = f(models(data))

The machine learning model as prediction system:

1. Take a data set and train a system
2. Learn patterns from the data
3. Classify previously unseen data

Features are key

(features = variables used by the system)

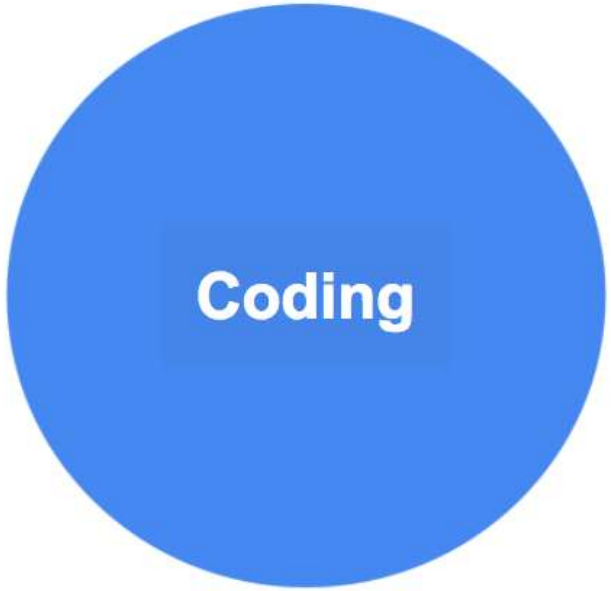
Rule of thumb: quality features represent 80-90% of the performance of a model

AI = f(models(data))

Year	Breakthroughs in AI	Datasets (First Available)	Algorithms (First Proposed)
1994	Human-level spontaneous speech recognition	Spoken Wall Street Journal articles and other texts (1991)	Hidden Markov Model (1984)
1997	IBM Deep Blue defeated Garry Kasparov	700,000 Grandmaster chess games, aka "The Extended Book" (1991)	Negascout planning algorithm (1983)
2005	Google's Arabic- and Chinese-to-English translation	1.8 trillion tokens from Google Web and News pages (collected in 2005)	Statistical machine translation algorithm (1988)
2011	IBM Watson became the world Jeopardy! champion	8.6 million documents from Wikipedia, Wiktionary, Wikiquote, and Project Gutenberg (updated in 2010)	Mixture-of-Experts algorithm (1991)
2014	Google's GoogLeNet object classification at near-human performance	ImageNet corpus of 1.5 million labeled images and 1,000 object categories (2010)	Convolution neural network algorithm (1989)
2015	Google's Deepmind achieved human parity in playing 29 Atari games by learning general control from video	Arcade Learning Environment dataset of over 50 Atari games (2013)	Q-learning algorithm (1992)
Average No. of Years to Breakthrough:		**3 years**	**18 years**

Data sets, not algorithms, are the key limiting factor for AI

AI = f(models(data))

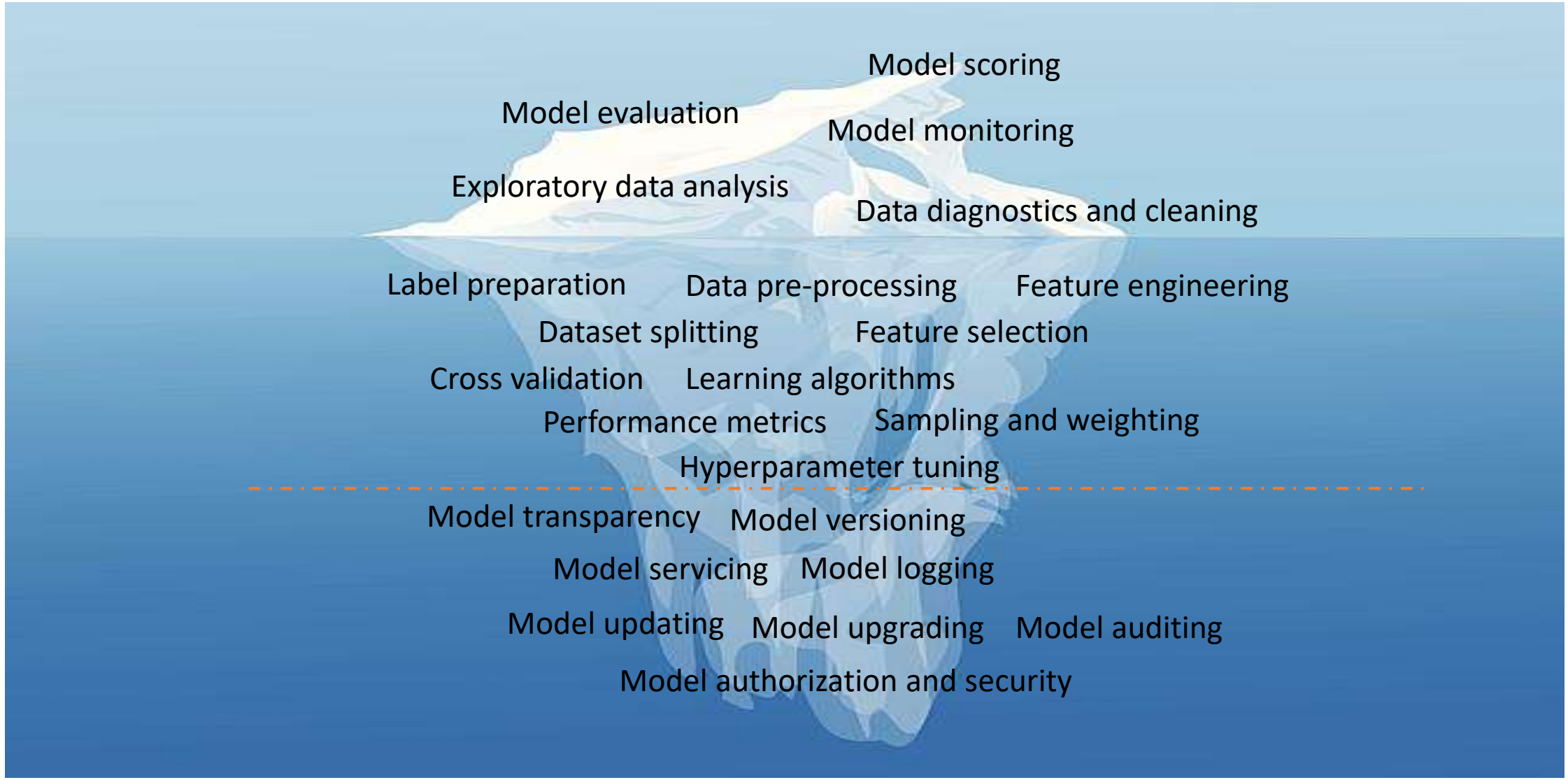


What people think AI is about

The reality

Rule #1: get training data. Rule #2: follow rule #1

AI = f(models(data))



"All I want to know is where I'm going to die so I will never go there" – Charlie Munger

Why is AI becoming pervasive?

Larger and better data sets

More efficient computing

Wide access to algorithms

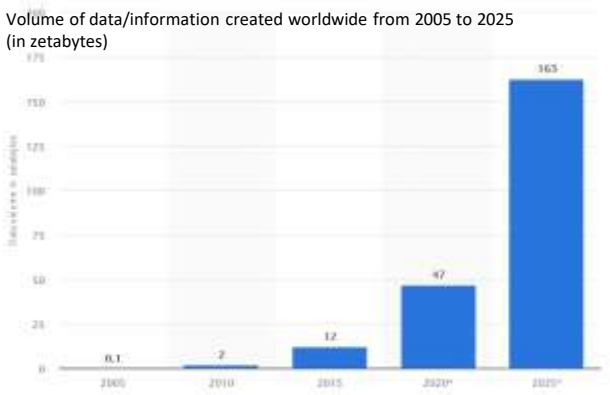


Image: https://www.statista.com/statistics/871513/worldwide-data-created/

Image: Artificial Intelligence Index 2018 Annual Report

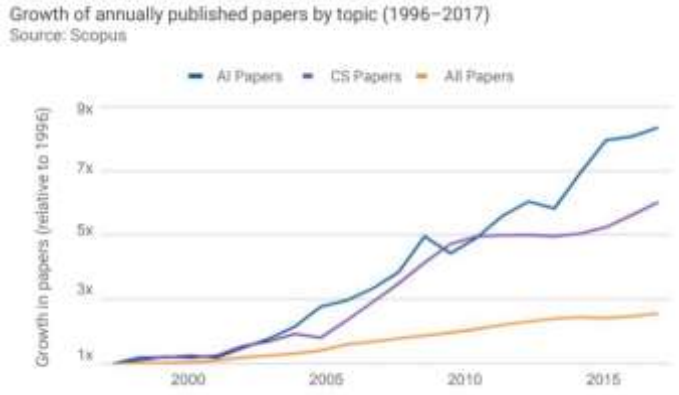
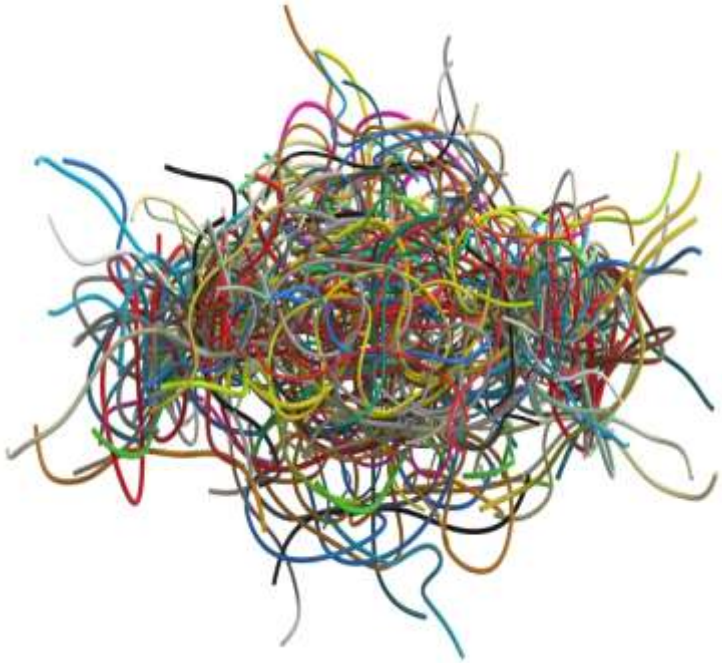


Image: Artificial Intelligence Index 2018 Annual Report

AI adoption is growing due to lower barriers to access data, computing and algorithms

Why do we need AI?

Complexity



Decision Making

Faster

Better

Cheaper

AI is all about simplifying complexity and lowering the “cost” of inference

AI in infection control and antibiotherapy

Monitor handwashing compliance	Predict infection risk per patient	Detect anomalies in records or procedures	Perform condition diagnosis
Detect outbreaks	Identify changing trends in an organism population	Predict outcomes from treatments	Predict future resistance of specific organisms
Assist in drug discovery and repurposing	Recommend appropriate antibiothic therapy	Detect therapies at risk of failure	Predict antibiothic resistance genes
Predict the usage of specific antibiotics	Identify unknown patterns and relationships in infection control	Guide prescription before culture results are available	Screen for inconsistencies between therapies and test results

Plenty of opportunities to use AI in infection control and antibiotherapy

Can we do more with AI? A framework

Automate

Automate manual/cognitive and routine/non-routine tasks

Assist

Help people perform tasks more efficiently (faster, better, cheaper)

Augment

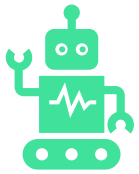
Help people make more and better decisions as a group

AI is about human-centric problem solving

How do we get started? AI enablers

Models / cognitive functions

Chatbots / conversational interfaces

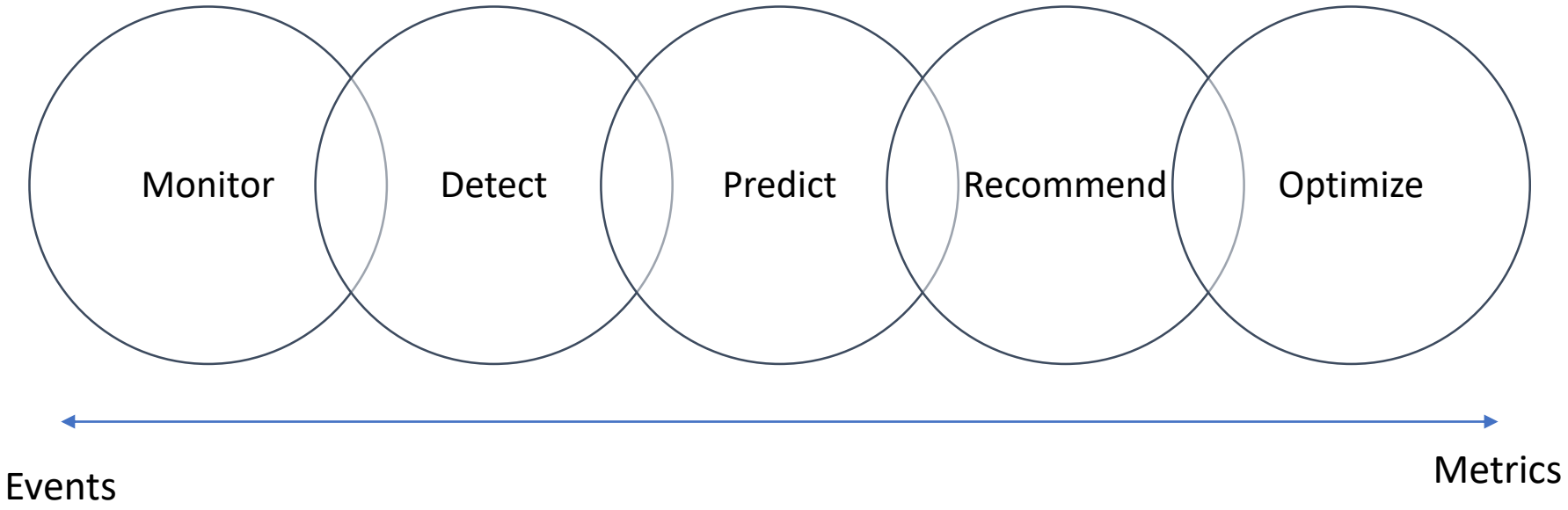


Robotic process automation

Active learning / dataset building

The future is now.

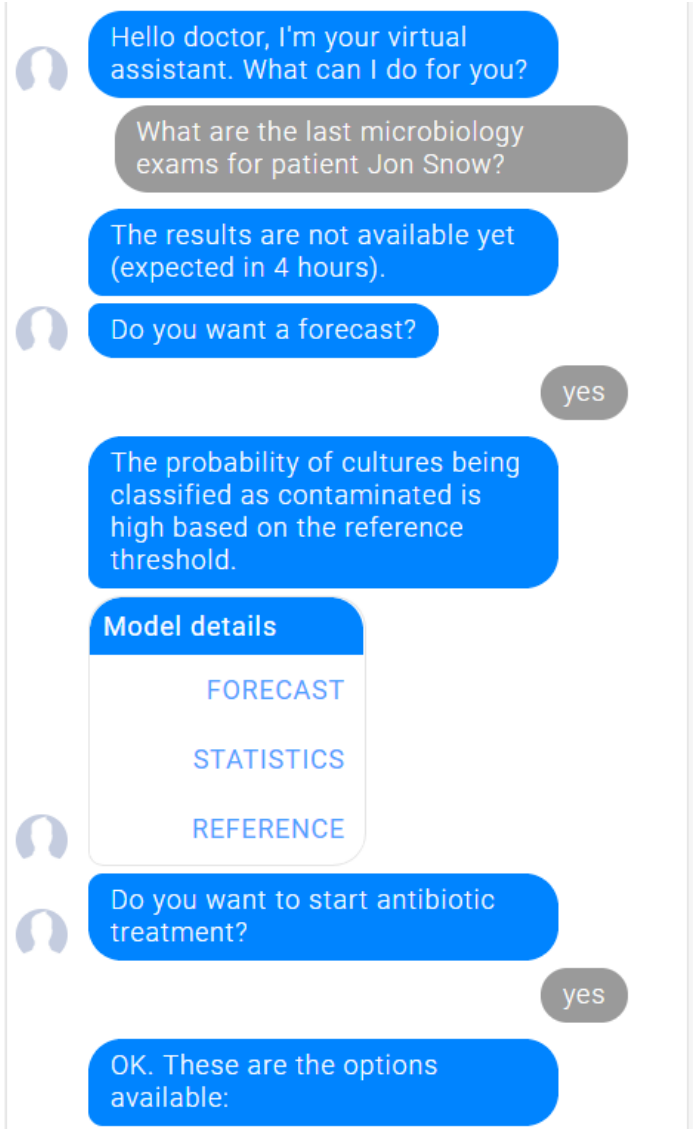
AI enablers: models



Think in systems and metrics. We know who is sick. We want to know who is actionable

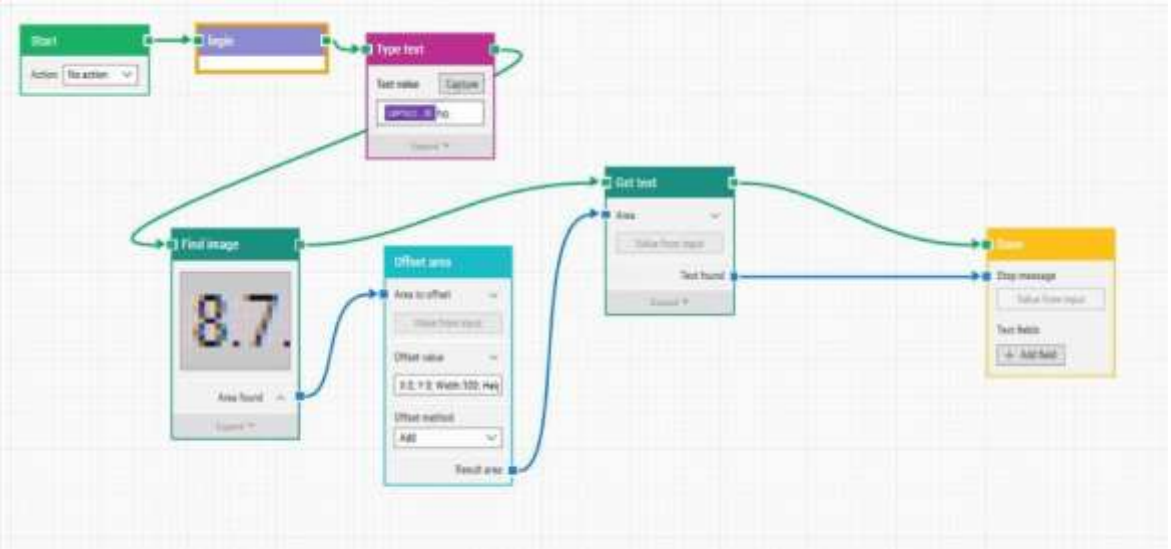
AI enablers: chatbots

Information retrieval	•"Show me the treatments for this patient" •"Get me all the past episodes for this patient"
Knowledge provisioning	•"'What is the maximum time allowed for this prescription''?" •"How do I stop the treatment?"
Transactional dialog	•"I need to start a treatment for this patient" •"I need to schedule an appointment with cardiology"
Call to action	•"Based on this patient records we suggest to schedule an appointment in 30 days" •"Your clinical notes need additional information"



Use virtual assistants to help professionals during clinical practice

AI enablers: robotic process automation



https://dojo.ministryoftesting.com/

Take over repetitive tasks done multiple times a day	Periodic reporting, data entry and data analysis
Mass mail generation, archiving, extracting	Conversion of data formats and graphics
Input/output EHR transactions and records	Process lists and file storage

Automate low value, repetitive tasks

AI enablers: data building & active learning

GIGO

Garbage in, garbage out

DRIP

Data rich, information poor

AI solution that works across datasets and systems, growing faster and smarter over time

https://news.greylock.com/the-new-moats-53f61aeac2d9

Build processes and tools to improve data richness, utility and quality

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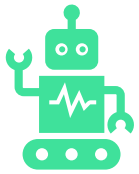

Robotic process automation

Active learning / dataset building

The future is now.

Lessons learned

- Data stewardship
- Analytics at scale
- Change management