

Frontiers of Computing and Predictive Oncology

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Outline

- Computing and Oncology
- Access to Data
- Some questions

Personal & Professional Background

- PhD in Chemistry at Caltech, Postdoc in molecular genetics of RAS
- Cancer research for 20+ years - cancer informatics, data science, healthcare
- Faculty in the Feinberg School of Medicine at Northwestern for 15+ years
- Director NCI CBIIT 2013-2017; Acting NCI Deputy Director 2016-2017
- Lost three grandparents to cancer

Changes in Computing

- Converged devices
- Converged IT
- Ubiquity of devices, data, mHealth

Changes in Oncology

- Cancer is a grand challenge
- Anatomic vs molecular classification
- Health vs Disease

Cancer is a grand challenge

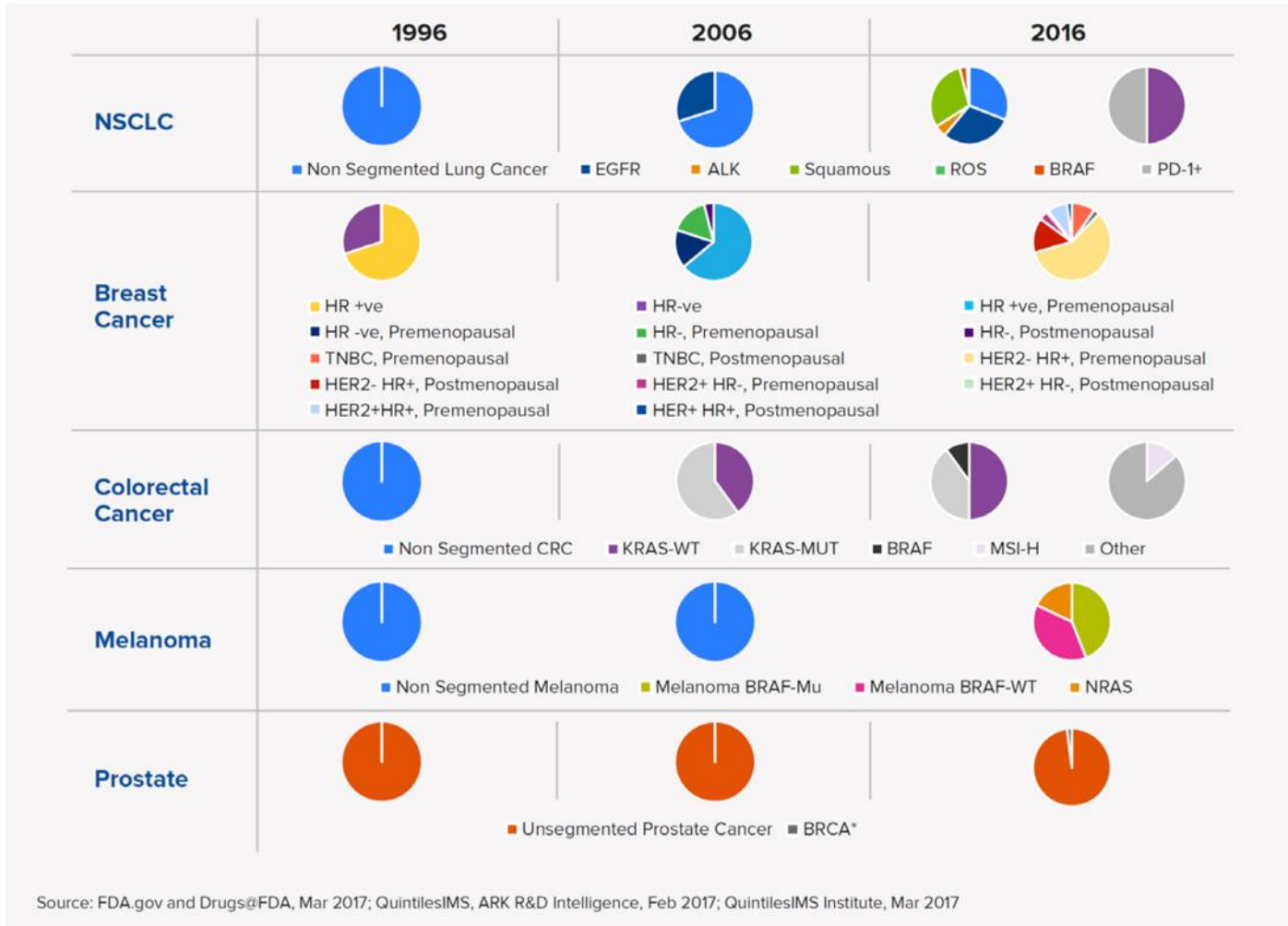


Requires:

- Deep biological understanding
- Advances in scientific methods
- Advances in instrumentation
- Advances in technology
- Data and computation
- Mathematical models

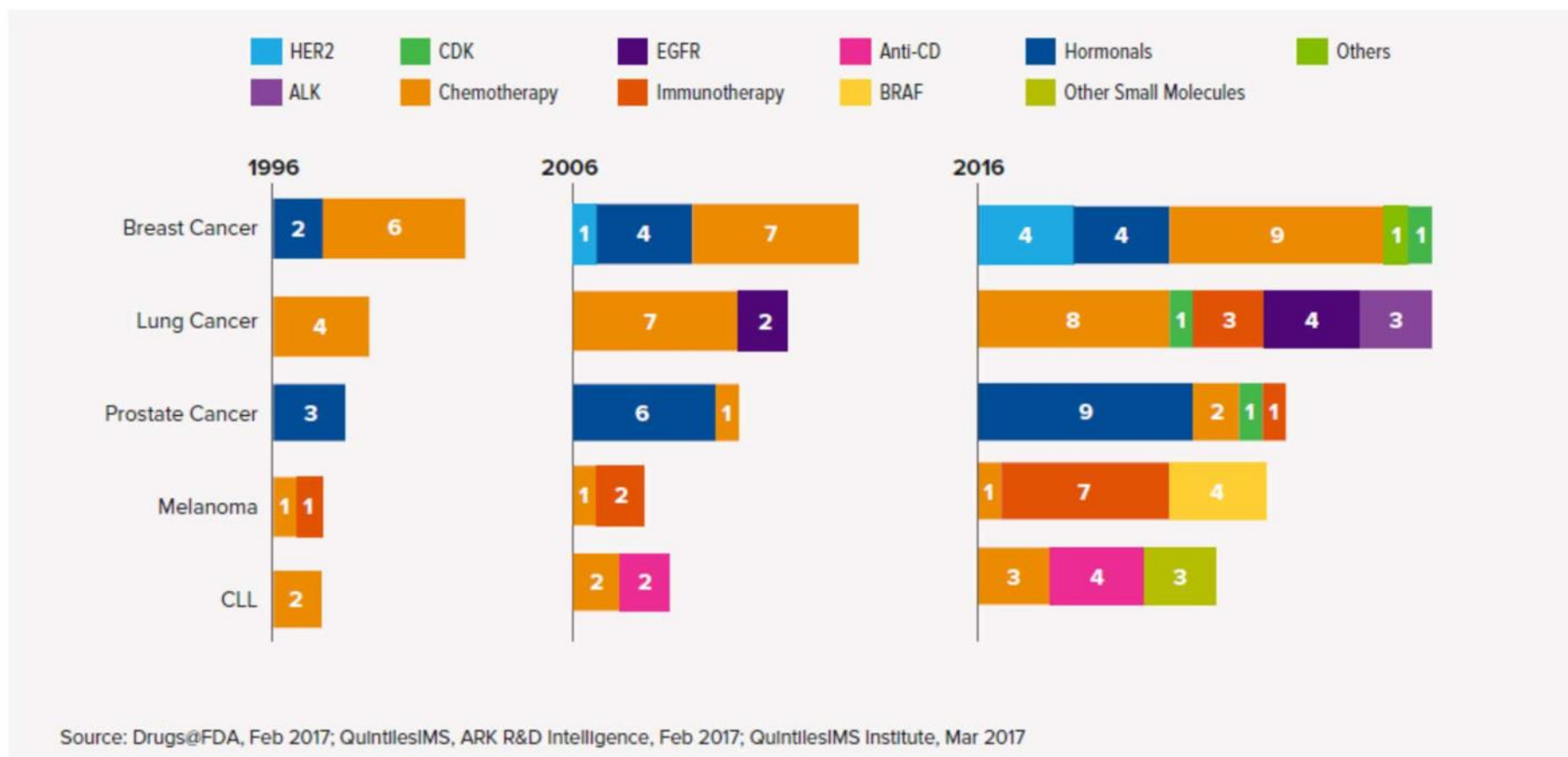
*Cancer Research and Care generate detailed **data** that is critical to create a learning health system for cancer*

Cancer has been progressively redefined over the past 20 years



This redefinition has been driven by improved biological understanding

Number of Treatment Options over Time for Selected Tumors (1996–2016)

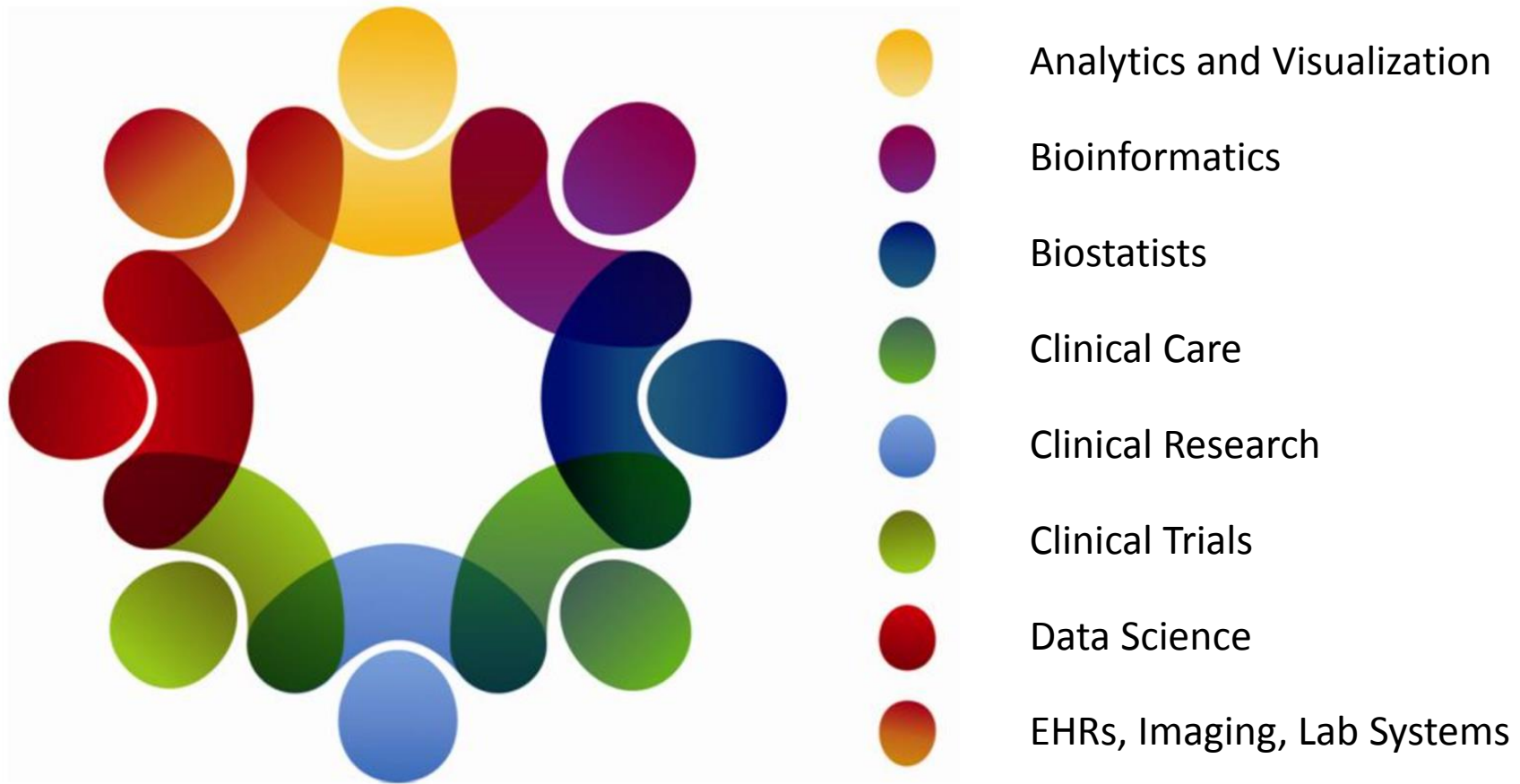


This change has been driven by improved technology - sequencing, imaging, nanotech, drug developing, computing and the availability of data about patient response to therapy

Health vs Disease

- What is 'normal'?
- Systematic and measurement error
- Biological heterogeneity

Team Science is critical



Open Data enhances collaboration and team science!

What we need

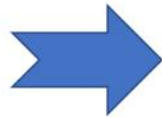
- Ability to build, analyze, validate predictive models
- Well annotated and appropriate data sets to use for building, analyzing, and validating predictive models
- Ability to present information in a human relevant, human informative way

Late analysis results do not result in changes in treatment

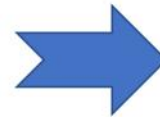
Scale is changing!



2001



2010



1 million healthy genomes

2015



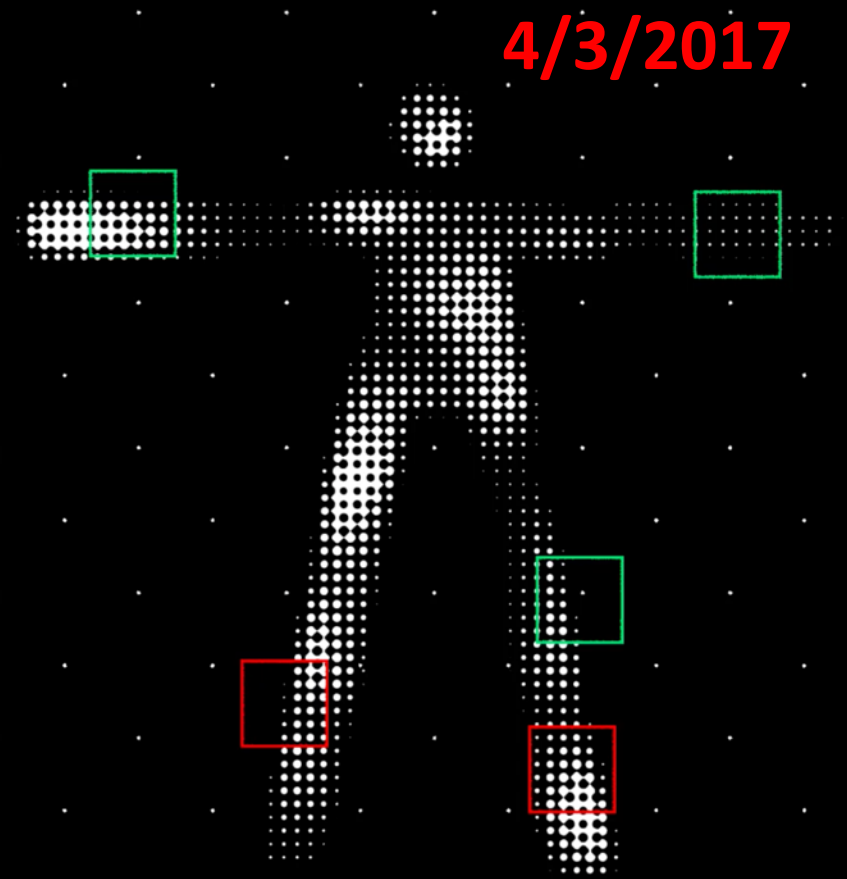
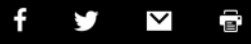
4/3/2017

ANNALS OF MEDICINE APRIL 3, 2017 ISSUE

A.I. VERSUS M.D.

What happens when diagnosis is automated?

By Siddhartha Mukherjee



Expert Systems vs Machine Learning

- In 1945, the British philosopher Gilbert Ryle identified two kinds of knowledge—factual, propositional knowledge that can be ordered into rules—“**knowing that.**” versus implicit, experiential, skill-based—“**knowing how.**”
- **Machine Learning** is based on ‘**learning how**’. **Expert systems**, or rule based machines, are based on ‘**knowing that**’.

Human Cognition

Three kinds of learning:

- Learning that – rule-based knowledge
- Learning how – experiential knowledge
- Learning why – integrative, explanatory knowledge

Questions

- How do we make data machine readable?

Questions

- How do we improve interoperability between instruments, data types, locations, organizations?

Questions

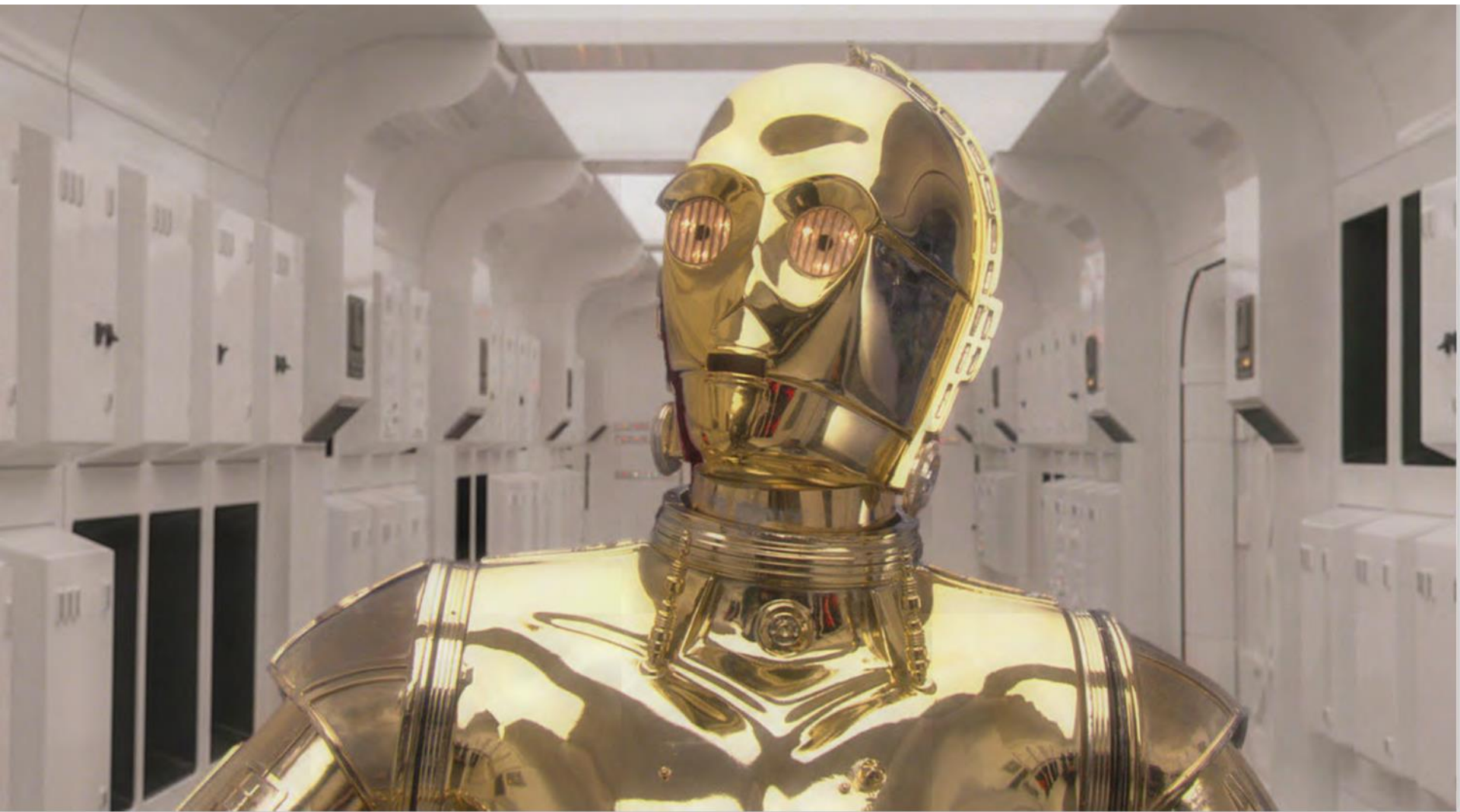
- How do we build, improve, validate algorithms, tools, pipelines?

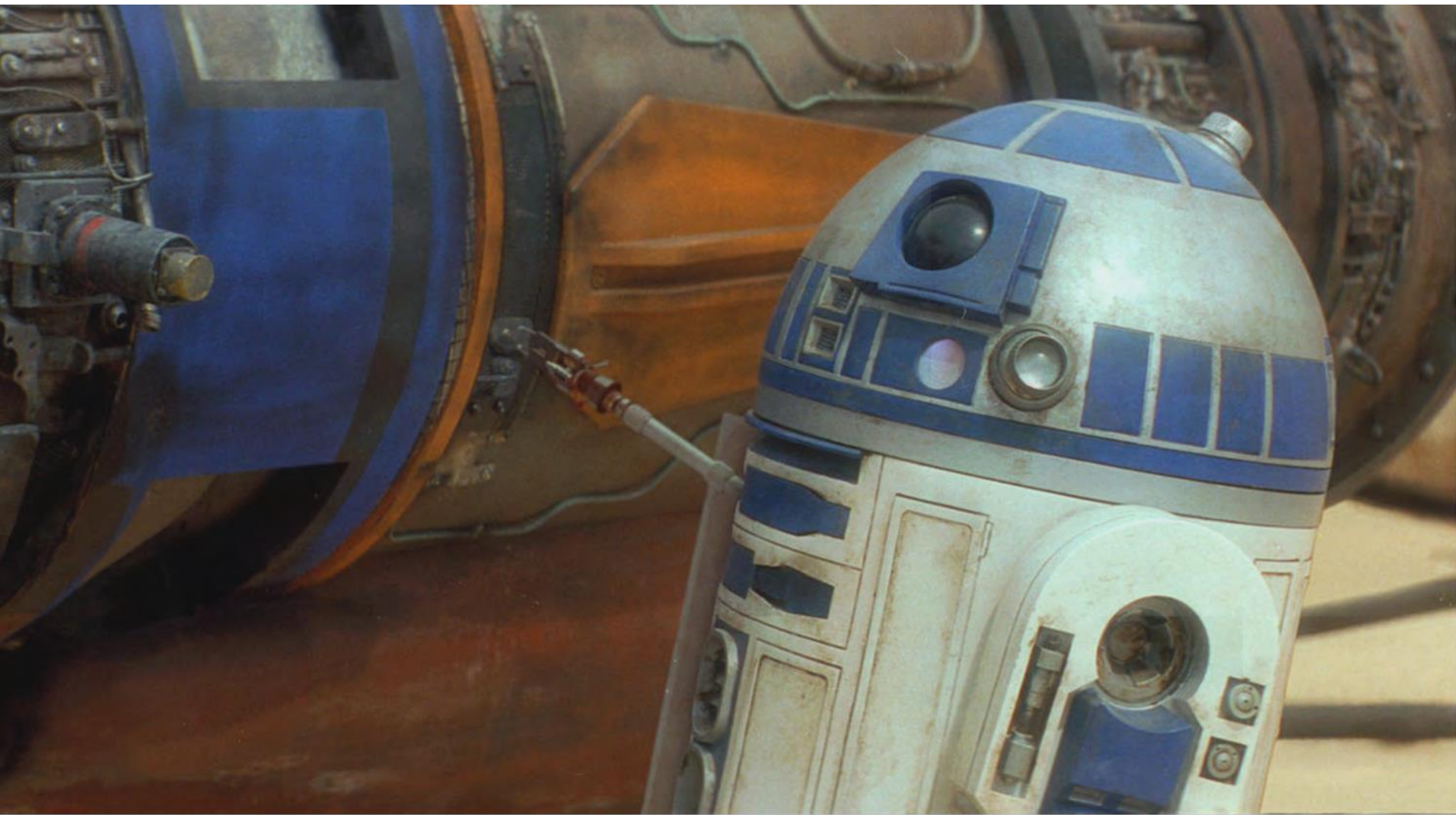
Questions

- How do we scale our infrastructure, processing, analytics to provide timely data?

Questions

- How do provide data in a cognitively friendly way that helps humans make decisions?
- We need to:
 - Reduce cognitive load
 - Improve data access & 'show your work'
 - Enable timely decision support





Questions?



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