

# Big Data, advanced analytics and personalised cancer care

Supported by:

The Princess Margaret  
Cancer Foundation  UHN



# Setting the ground

## Artificial Intelligence: Concepts, potentials and caveats

Alejandro Berlin, MD. MSc

Clinician-scientist, radiation oncologist

Princess Margaret Cancer Centre



**World Cancer**  
Leaders' Summit



# ARTIFICIAL INTELLIGENCE

→ 101: CONCEPTS, POTENTIALS AND CAVEATS

Alejandro Berlin, MD, MSc

Clinician-Scientist, Radiation Oncologist

Princess Margaret Cancer Centre



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World Cancer  
Leaders' Summit



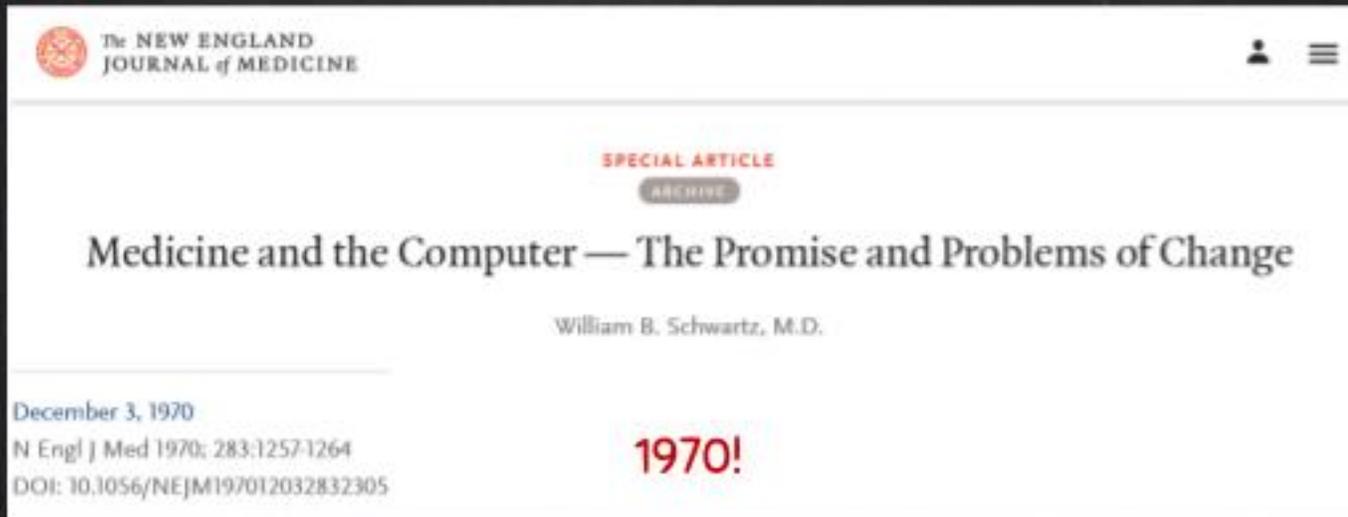
SPECIAL ARTICLE

ARCHIVE

## Medicine and the Computer — The Promise and Problems of Change

William B. Schwartz, M.D.

Rapid advances in the information sciences, coupled with the political commitment to broad extensions of health care, promise to bring about basic changes in the structure of medical practice. Computing science will probably exert its major effects by augmenting and, in some cases, largely replacing the intellectual functions of the physician. As the "intellectual" use of the computer influences in a fundamental fashion the problems of both physician manpower and quality of medical care, it will also inevitably exact important social costs — psychologic, organizational, legal, economic and technical. Only through consideration of such potential costs will it be possible to introduce the new technology in an effective and acceptable manner. To accomplish this goal will require new interactions among medicine, the information sciences and the management sciences, and the development of new skills and attitudes on the part of policy-makers in the health-care system.



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REVIEW ARTICLE

FRONTIERS IN MEDICINE

## Machine Learning in Medicine

Alvin Rajkumar, M.D., Jeffrey Dean, Ph.D., and Isaac Kohane, M.D., Ph.D.

Main take home message(s):

Still far from clinical realm, hence truly quantifying impact

nature  
biomedical engineering

REVIEW ARTICLE

<https://doi.org/10.1038/n41591-018-0205-z>

## Artificial intelligence in healthcare

Kun-Hsing Yu<sup>1</sup>, Andrew L. Beam<sup>1</sup> and Isaac S. Kohane<sup>1,2\*</sup>

Artificial intelligence (AI) is gradually changing medical practice. With recent progress in digitized data acquisition, machine learning and computing infrastructure, AI applications are expanding into areas that were previously thought to be only the province of human experts. In this Review Article, we outline recent breakthroughs in AI technologies and their biomedical applications, identify the challenges for further progress in medical AI systems, and summarize the economic, legal and social implications of AI in healthcare.

Pressing need for regulatory frameworks and incentives for VBHC (all about outcomes)

REVIEW ARTICLE | FOCUS

<https://doi.org/10.1038/n41591-018-0205-z>

nature  
medicine

## High-performance medicine: the convergence of human and artificial intelligence

Eric J. Topol<sup>1</sup>

The use of artificial intelligence, and the deep-learning subtype in particular, has been enabled by the use of labeled big data, along with markedly enhanced computing power and cloud storage, across all sectors. In medicine, this is beginning to have an impact at three levels: for clinicians, predominantly via rapid, accurate image interpretation; for health systems, by improving workflow and the potential for reducing medical errors; and for patients, by enabling them to process their own data to promote health. The current limitations, including bias, privacy and security, and lack of transparency, along with the future directions of these applications will be discussed in this article. Over time, marked improvements in accuracy, productivity, and workflow will likely be actualized, but whether that will be used to improve the patient-doctor relationship or facilitate its erosion remains to be seen.

# HC & AI



## The Dunning-Kruger effect



Hype? | Hope? | **Both?**: Let's be cautiously optimistic

TRIVIA

WHATCHAMACALLIT



## TRIVIA

### WHATCHAMACALLIT



#### Aglet

- keeps the fibers of the lace from unraveling
- firmness and narrow profile that makes easier:
  - to hold
  - to feed through eyelets

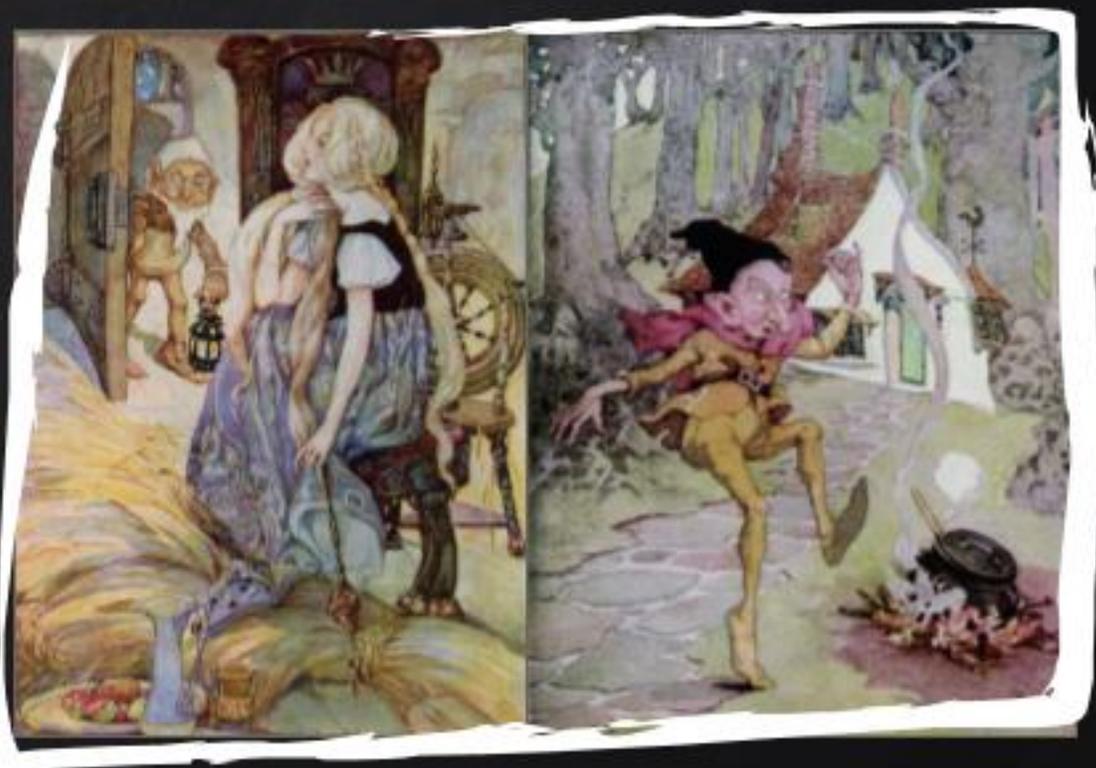
GOALS

CONCEPTS | DEFINITIONS

## Rumpelstiltskin Principle

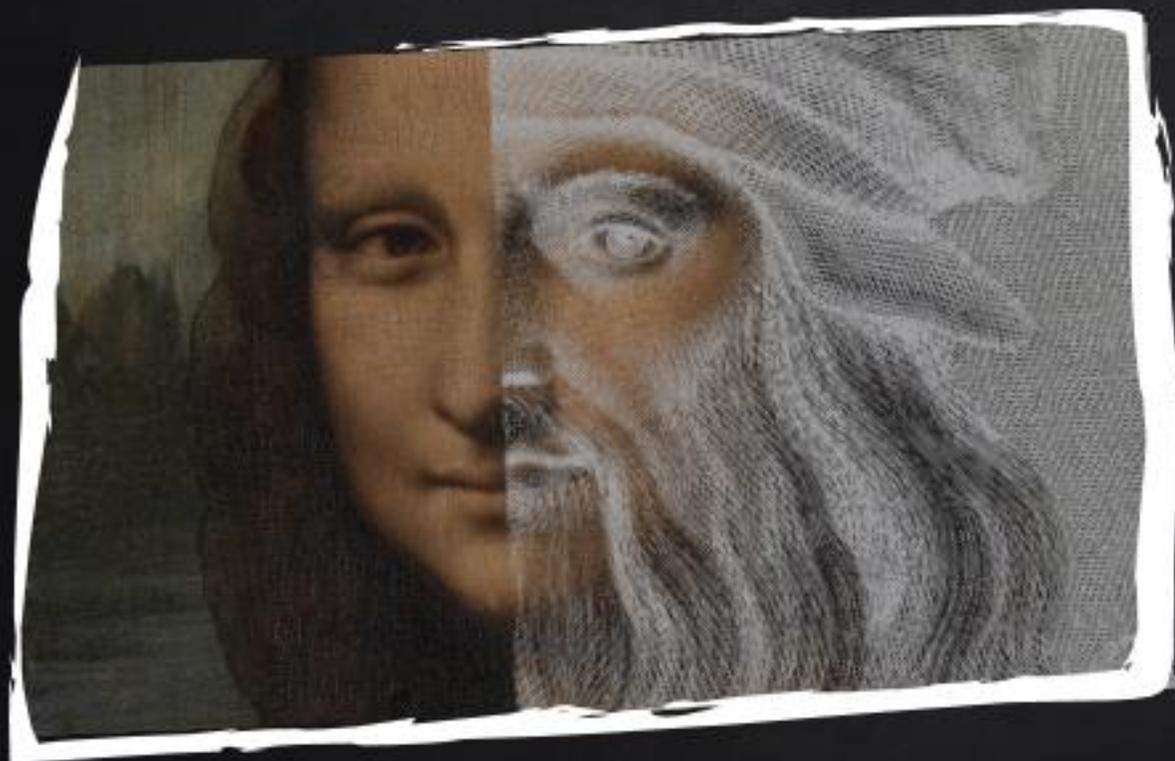
*"tonight tonight, my plans I make, tomorrow tomorrow, the baby I take. The queen will never win the game, for Rumpelstiltskin is my name"*

**Naming** something **gives you power** over it: vocabulary allows you to think/talk about it.





## WHAT THIS IS NOT (ONLY) ABOUT...



### Intelligence:

- the ability to learn or understand or to deal with new or trying situations (Merriam-Webster)
- reason | plan | solve | abstract | comprehend | learn | “catching out” | “making sense” | “figuring out”
- $F = T \nabla S_T$   
(force that acts so as to maximize future freedom of action)

AI

## COMMON DEFINITIONS

- The design, study and construction of **programs that behave intelligently** (Tom Dean)
- The enterprise of constructing a system that can reliably **pass the Turing test** (Matt Ginsberg)
- Test of a machine's ability to **exhibit intelligent behaviour** equivalent to, or **indistinguishable** from, that of a human. (Alan Turing)



# AI DEEPER DEFINITION

Thinking | Perception | Action

# AI DEEPER DEFINITION

PAST

PRESENT

FUTURE

Models Targeted at

Thinking | Perception | Action

# AI DEEPER DEFINITION



Representations that Support  
Models Targeted at  
Thinking | Perception | Action

# AI DEEPER DEFINITION

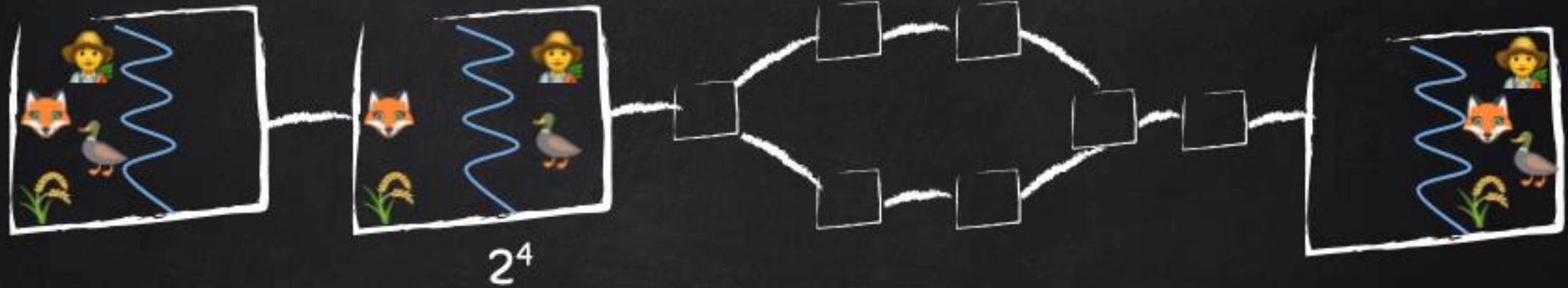


Representations that Support

Models Targeted at

Thinking | Perception | Action

# AI DEEPER DEFINITION

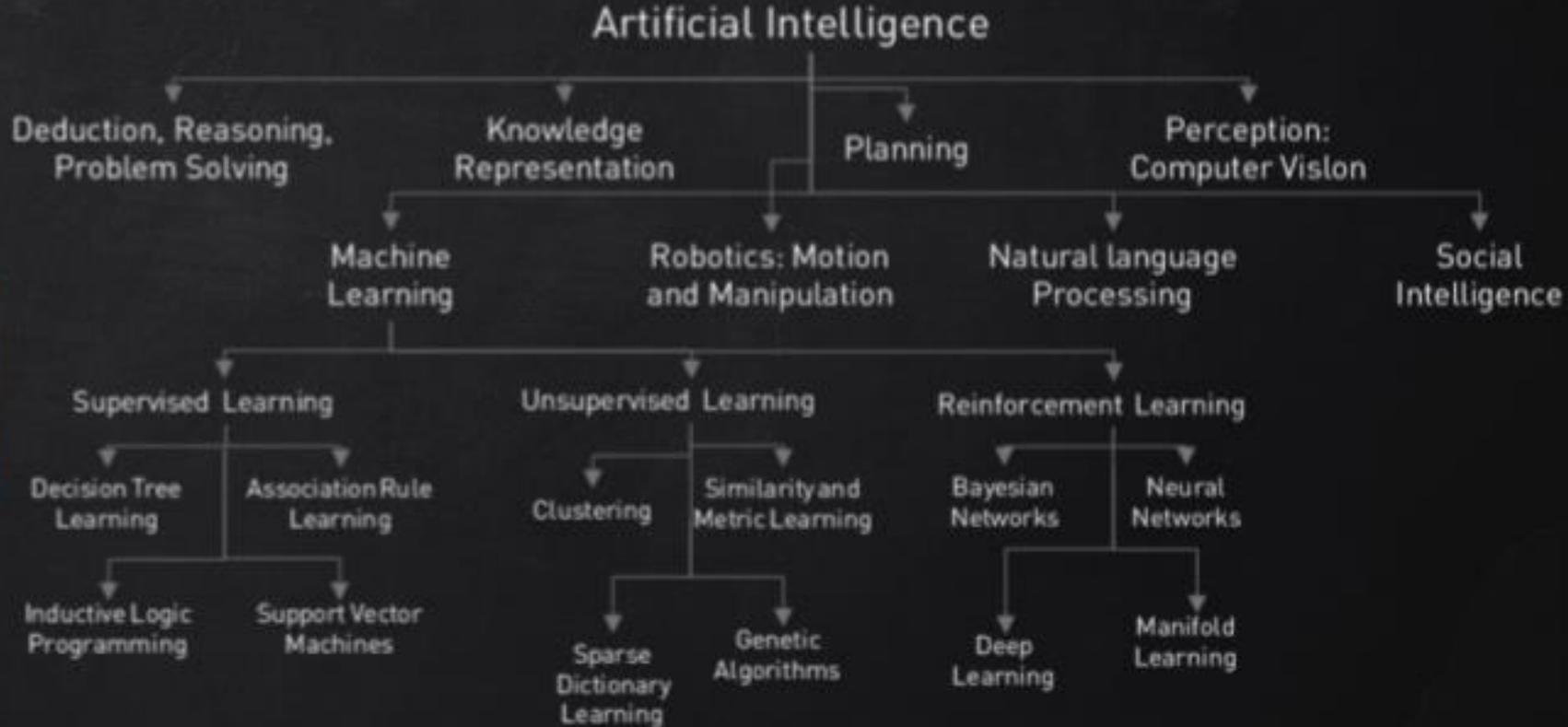
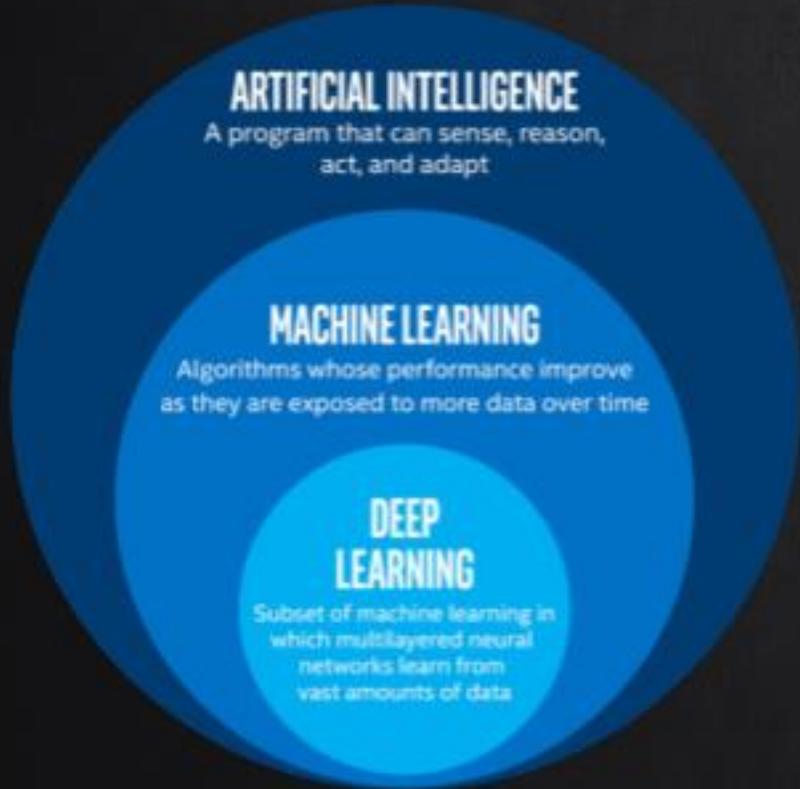


Representations that Support  
Models Targeted at  
Thinking | Perception | Action

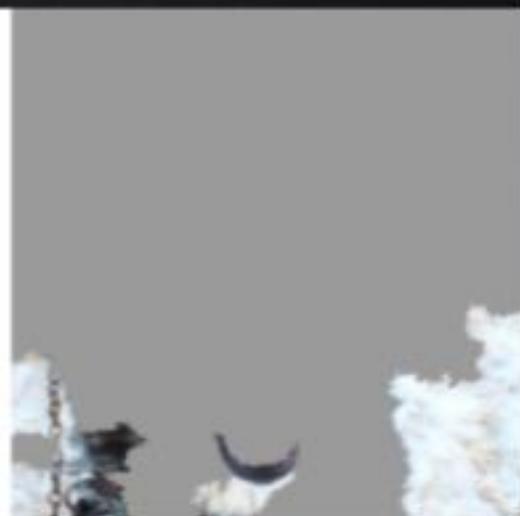
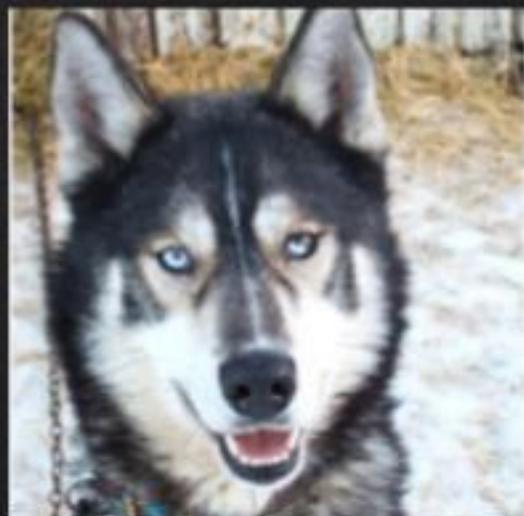
# AI DEEPER DEFINITION

Algorithms | Procedures | Methods Enabled by  
Representations that Support  
Models Targeted at  
Thinking | Perception | Action

# AI LANDSCAPE



## SOME CONSIDERATIONS



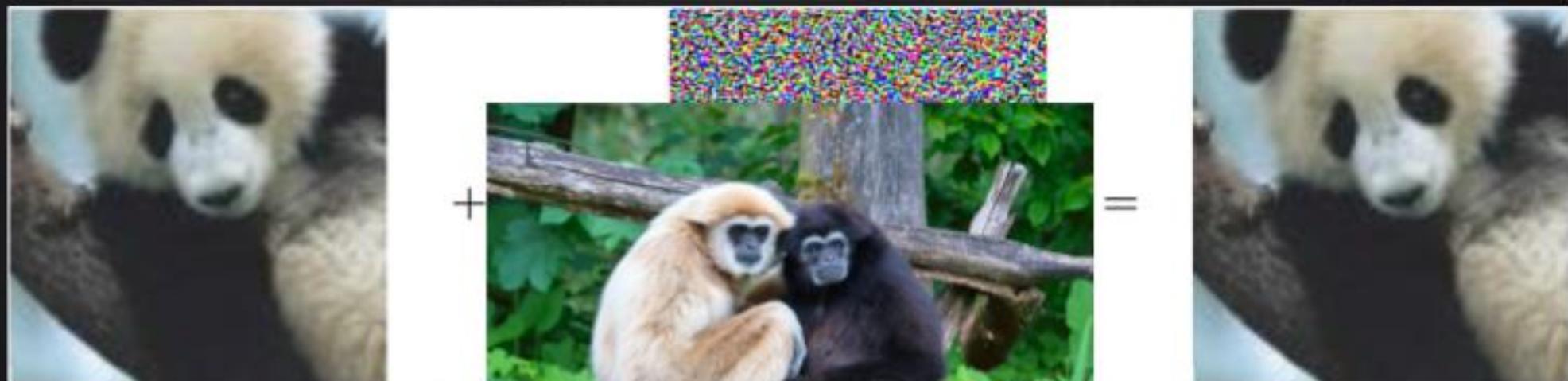
*Value in understanding method? Or OK with black box?*

# SOME CONSIDERATIONS



Panda  
57.7% confidence

## SOME CONSIDERATIONS

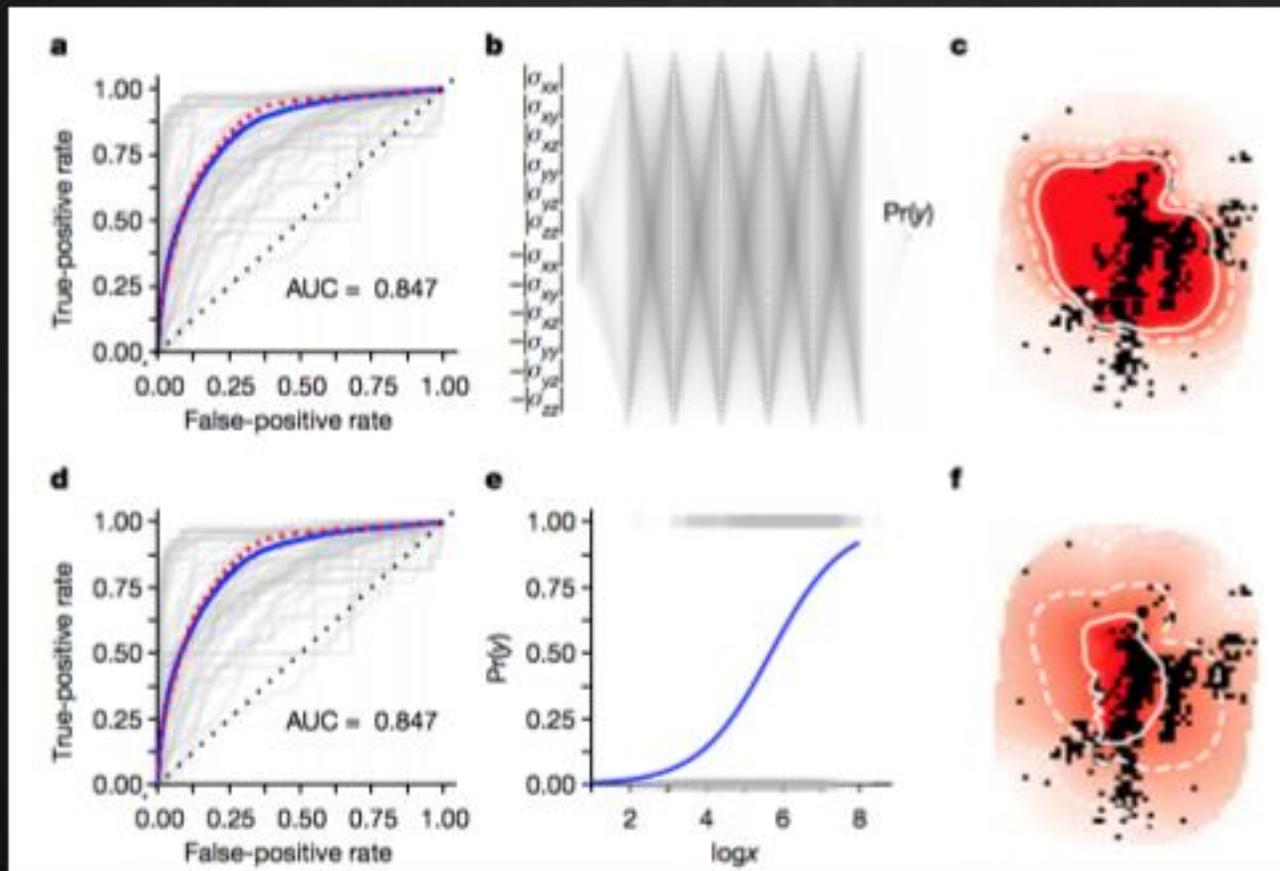


Panda  
57.7% confidence

Gibbon  
99.3% confidence

*Artificial things are susceptible to artificial problems*

# SOME CONSIDERATIONS

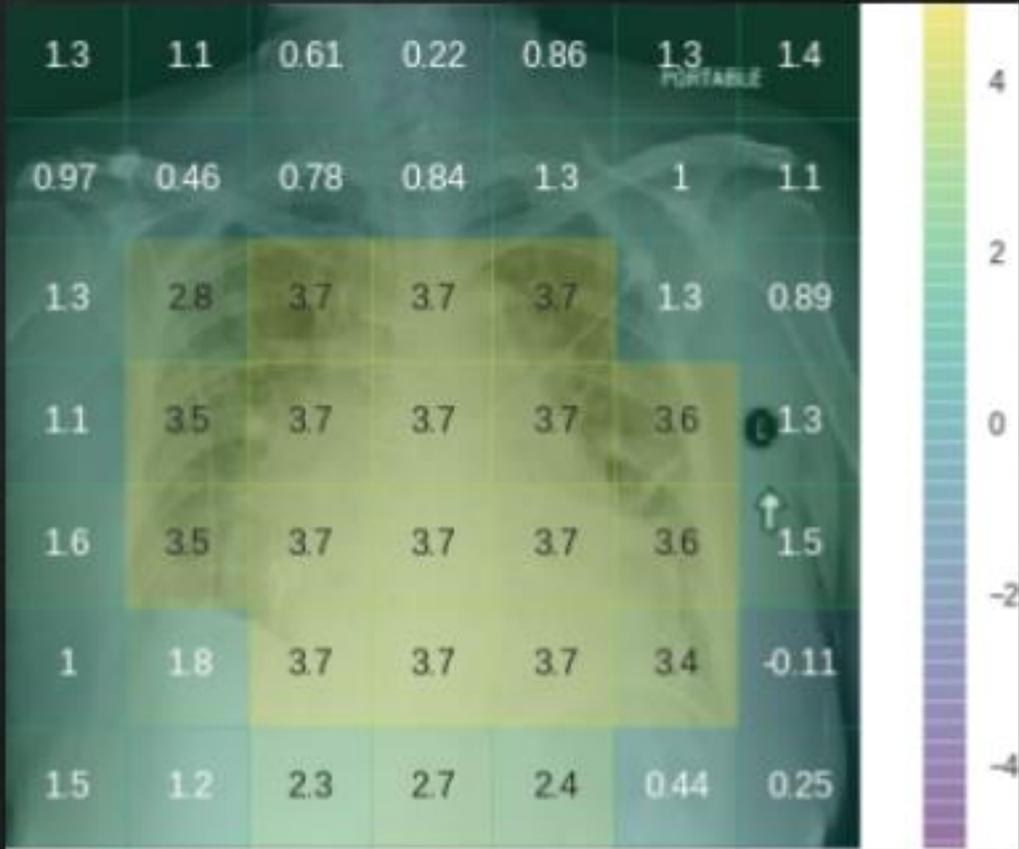


Aftershock prediction  
13,451 DNN vs 1 neuron logistic  
regression  
(distance and slip)

Same performance

*Novel does not necessarily mean better insights or accuracy*

# HC & AI



*Intelligent or Deceitful?*

HC & AI



GE Healthcare

UCSF

cdhi

Center for  
Digital Health  
Innovation  
at UCSF



**GE Healthcare Receives FDA  
Clearance of First Artificial  
Intelligence Algorithms  
Embedded On-Device to  
Prioritize Critical Chest X-ray  
Review**

Sep 12, 2019

*Maybe less ambitious... but more supportive*

1995...

The screenshot shows the Netscape browser window titled "Netscape: Welcome to Netscape". The address bar contains "http://home.netscape.com/". The navigation toolbar includes buttons for Back, Forward, Home, Reload, Images, Open, Print, Find, and Stop. Below the toolbar are links for "What's New?", "What's Cool?", "Handbook", "Net Search", "Net Directory", and "Newsgroups". The main content area features a large banner with the text "WELCOME TO NETSCAPE" and a "NETSCAPE SERVER GALLERIA" at the bottom. The gallery consists of six panels: "EXPLORING THE NET" (space shuttle), "COMPANY & PRODUCTS" (factory), "NETSCAPE STORE" (storefront), "NEWS & REFERENCE" (news anchor), "ASSISTANCE" (lighthouse), and "COMMUNITY" (iceberg). Below the gallery are two news items: "SECURE COURIER" and "WINDOWS 95 NAVIGATOR BETA".

**SECURE COURIER**  
Netscape announces [the first open, cross-platform "digital envelope" protocol](#), to be supported by Intuit, MasterCard, and others.

**WINDOWS 95 NAVIGATOR BETA**  
[Download](#) the latest beta release of Netscape Navigator, specially tuned to take advantage of [Win 95 interface enhancements and features](#).



# Arithmetics

\$



Q



DATE	DEBIT	CREDIT	BALANCE	DATE	DEBIT	CREDIT	BALANCE
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1/2				1/2			
1/3				1/3			
1/4				1/4			
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1/28				1/28			
1/29				1/29			
1/30				1/30			
1/31				1/31			
TOTAL				TOTAL			



XYZ Company Accounts Payable							
Suppliers							
Invoice Date	Invoice Number	Supplier Name	Payment Terms	Total Amount	Due Date	Balance Due	Days Overdue
11/10/19	5444	ABC Company	30	\$ 1,000.00	12/10/19	\$ 500.00	30
11/15/19	5555	DEF Company	30	\$ 500.00	12/15/19	\$ -	0
11/20/19	5656	GHI Company	30	\$ 445.75	12/20/19	\$ 345.75	30
12/10/19	5757	JKL Company	30	\$ 1,000.00	01/10/20	\$ 1,000.00	0
TOTAL DUE						\$ 1,445.75	



AI



AI

## PREDICTION



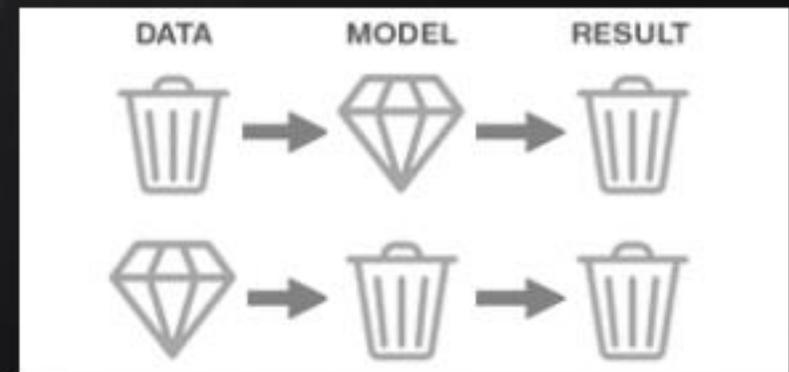
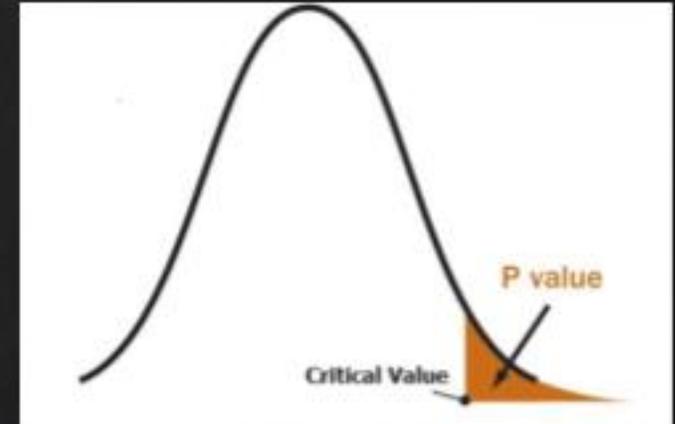
Use  
information  
you **do** have,  
to generate  
information  
you **don't** have

# ANATOMY OF DECISIONS AND TASKS



# BIG DATA

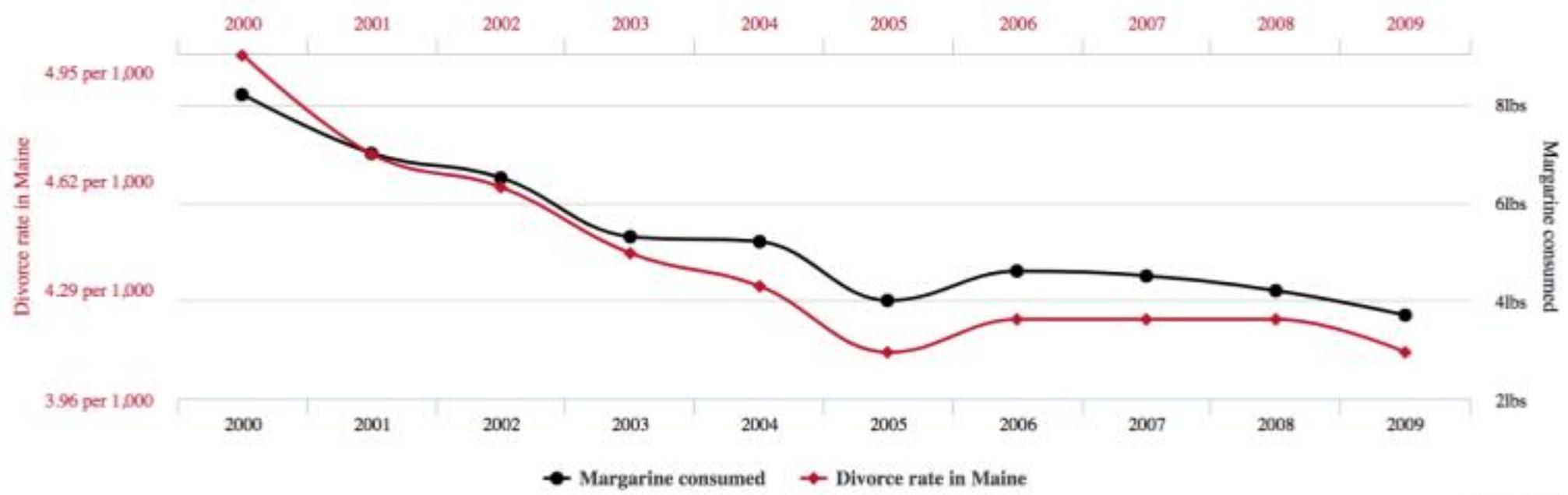
- Field that treats ways to deal with, analyze, systematically extract information from data sets:
  - Too large or complex (usually unstructured)
  - Exceed capacity of usual software to process (within acceptable time and value)
  - **Challenges:** capturing, storage, analysis, search, sharing, transfer, visualization, querying, updating, privacy, sources.... FDR
- **4Vs:** Volume | Variety | Velocity | Veracity
- Dilemma: **Utility or Futility ?**



# BIG DATA | BIG RISKS

## Divorce rate in Maine correlates with Per capita consumption of margarine

Correlation: 99.26% (r=0.992558)



Data sources: National Vital Statistics Reports and U.S. Department of Agriculture

DATA

- “Intelligent”: able to understand meaning of information
- Information is acquired/delivered/conveyed in a selected **representation language**.
  - Source → Receiver
  - Same “language” (**meaningful** exchange)
  - Interpret as intended by source’s **semantics**
- Data → Information → Knowledge





## SUMMARY

- ✘ **Definitions** of AI from Pragmatic, Scientific and Economic angles.
- ✘ AI is not a panacea: **data & judgement** (still) define value.
- ✘ Importance of **semantically-rich data** underscored.
- ✘ Discovery  $\neq$  **change**

### Overarching Goal:

convey **concepts** that enhance thoughts on the subject,  
in order to (try) enrich the roadmaps **towards action**.



**THANKS!**

**Any questions?**

You can find me at:

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The dinner later today :-)

# Transforming healthcare through a new era of data and analytics

Pakinam ElSaadani

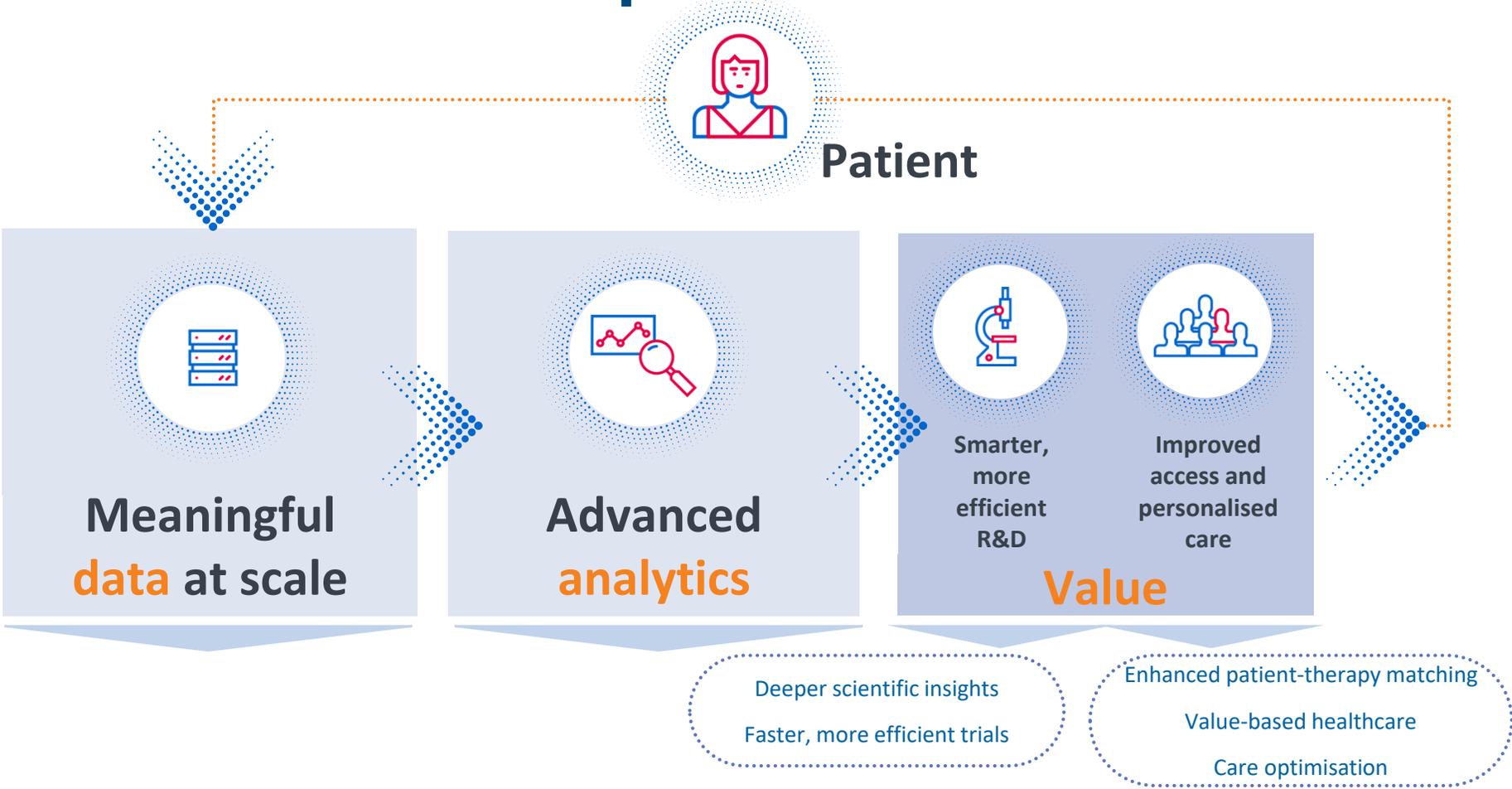
Medical Scientific Liaison and Personalized Healthcare strategy.  
Roche Pharmaceuticals, United Arab Emirates



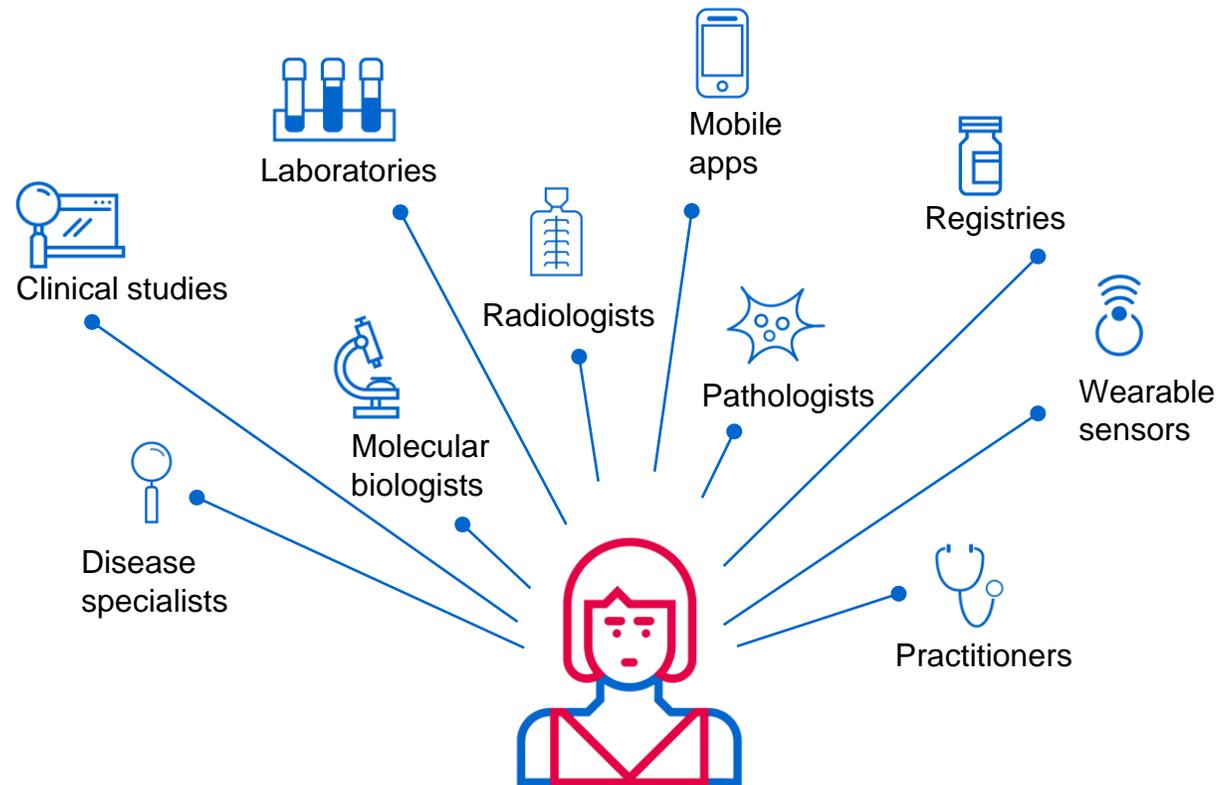
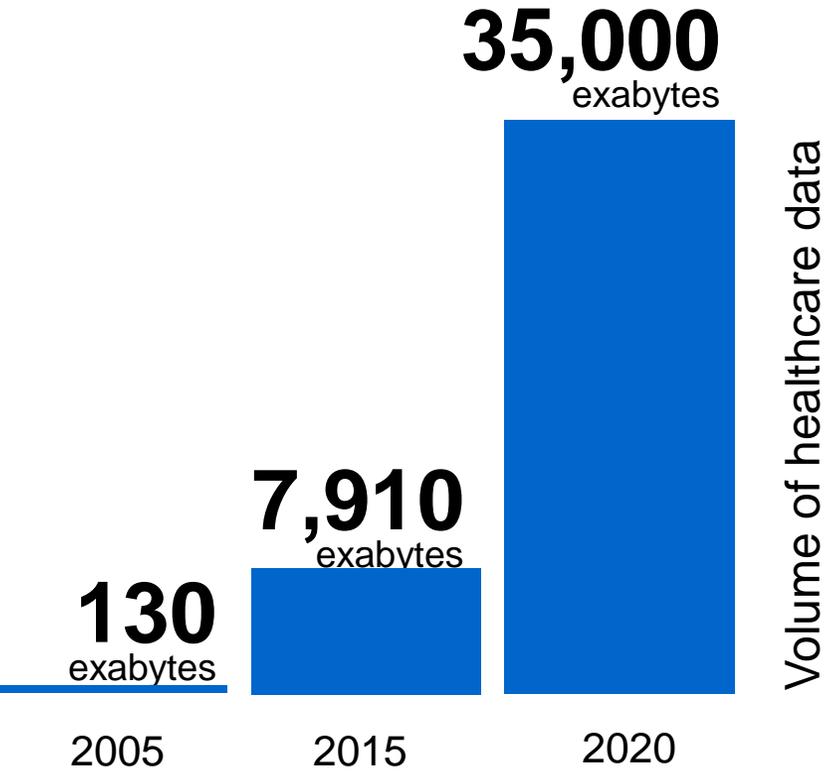




# Combining data with advanced analytics delivers value in personalised care for patients

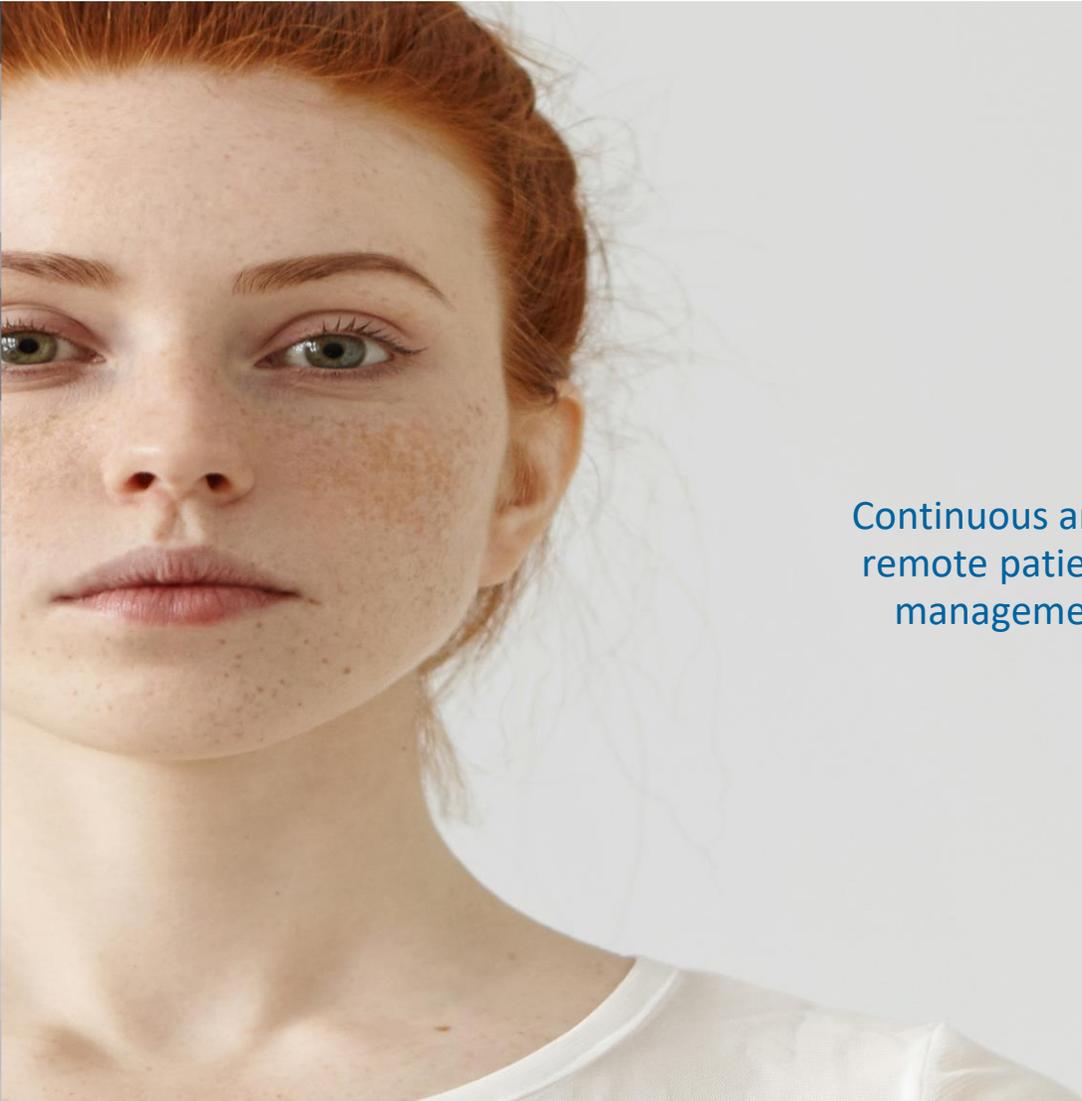


# Technological advances are increasing the volume and the variety of healthcare data



1. Feldman B *et al.* 2012. Big data in healthcare hype and hope [Internet; cited 2019 October 10] <https://drbonnie360.com/white-papers>  
2. Raghupathi W, Raghupathi V. Big data analytics in healthcare: promise and potential. *Health Inf Sci Syst* 2014;2:3

# Generation and application of data and insights throughout the patient journey for improved patient experience and outcomes



Continuous and remote patient management



data & insights



Early and accurate diagnosis

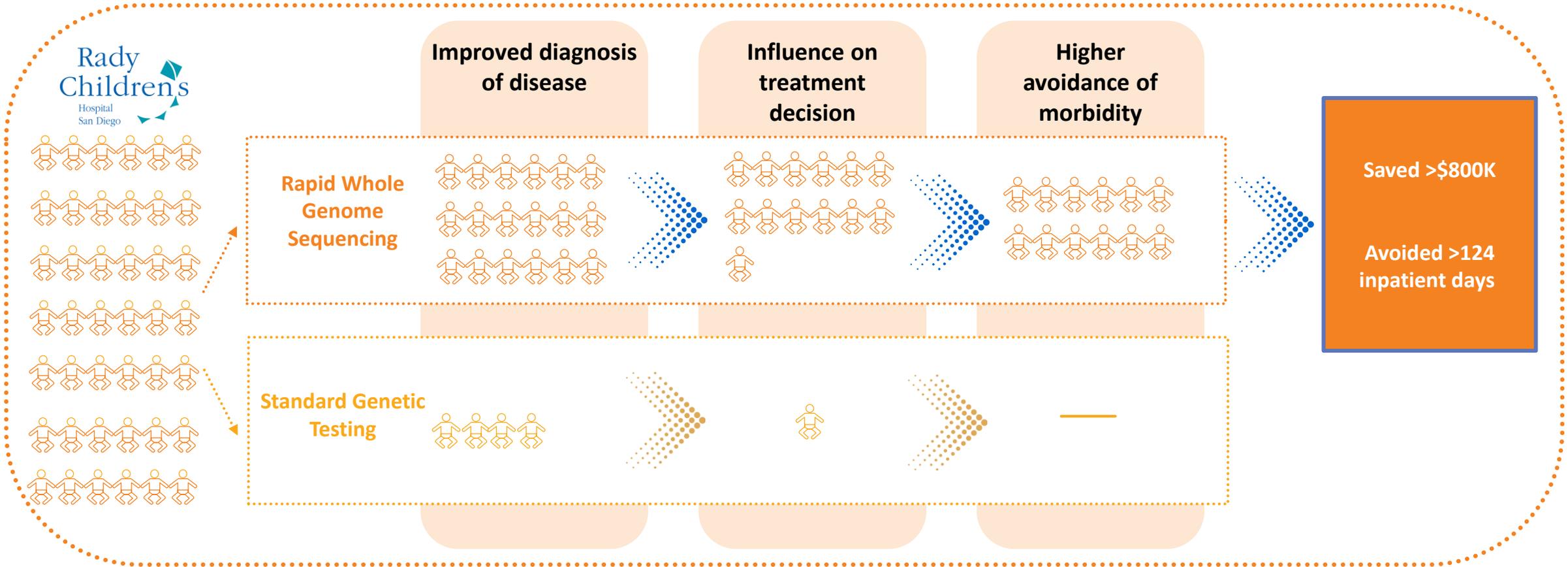


Tailored care plan



Full access to optimal care intervention

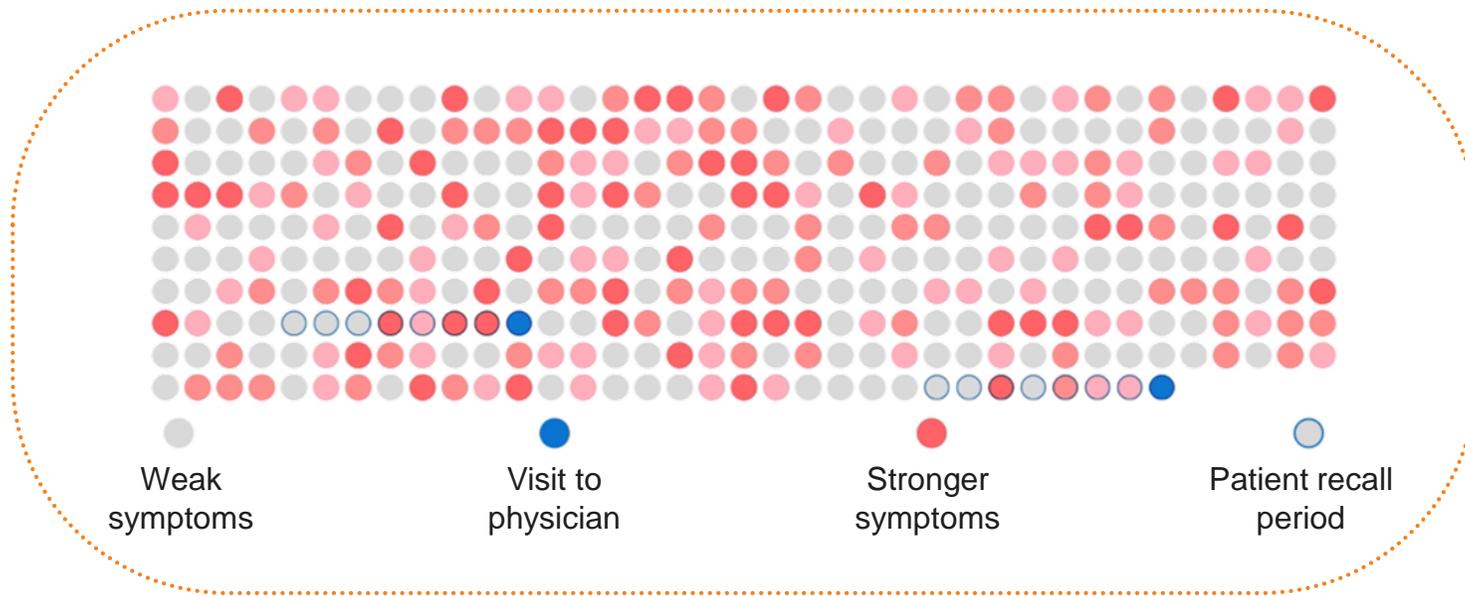
# Genomic sequencing improves diagnosis rates and reduces healthcare costs



# Digital tools provide reliable and timely data for patients' day-to-day experience with disease

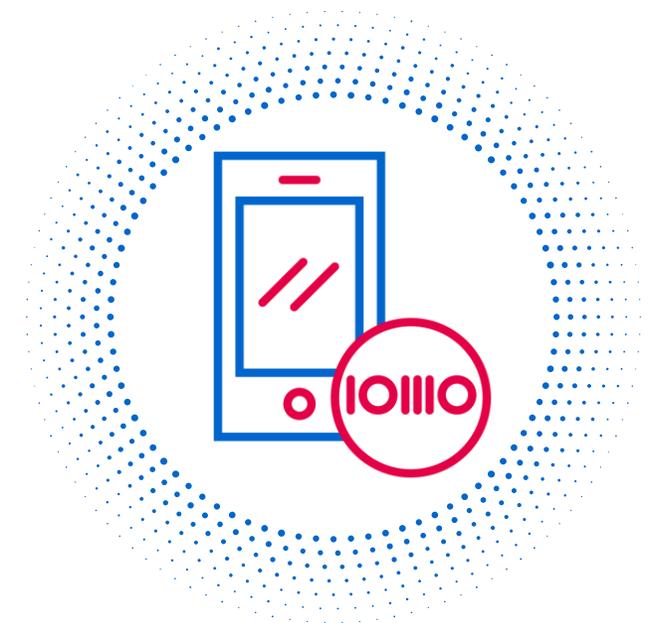
## 365 days living with a disease

The patient recall period is generally limited to a few days, limiting the insight he/she can transmit to a physician



## Monitoring symptoms daily

Apps, sensors and wearables



# A successful learning healthcare system integrates all insights to deliver better care, more cost-effectively and sustainably

## Principles of a learning healthcare system:

- Culture of learning and data sharing (both clinical and Real World Data) between healthcare practitioners, institutions and across healthcare systems and geographies



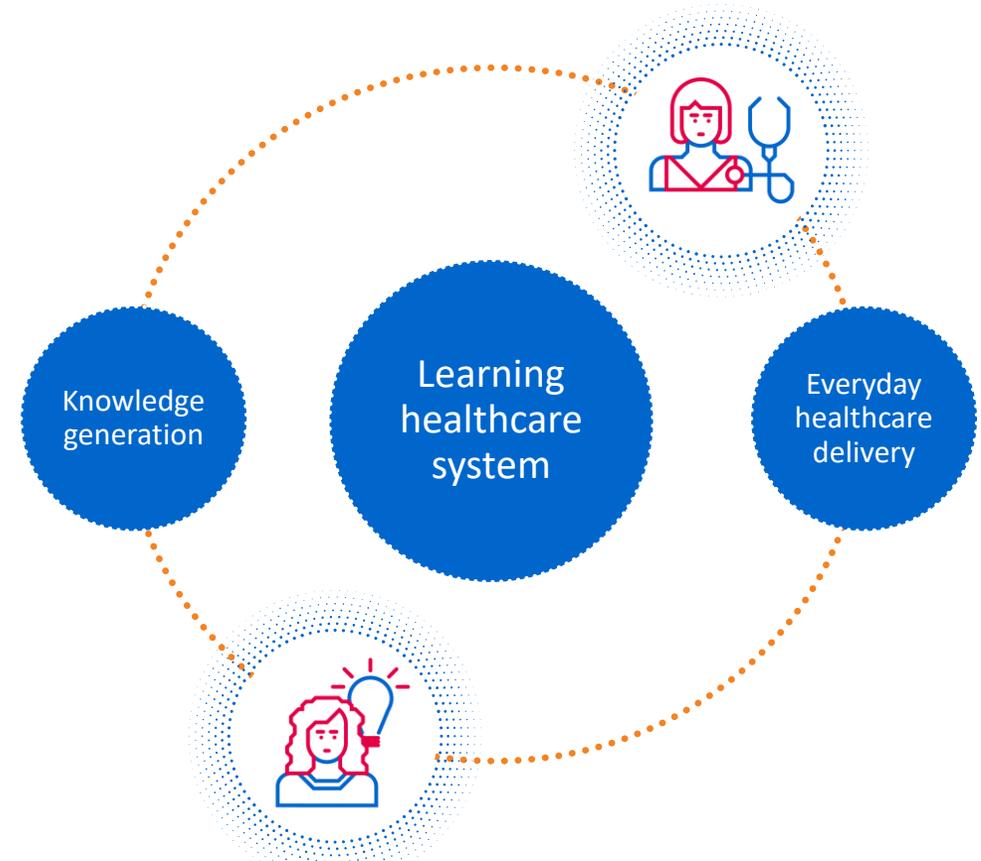
- Better outcomes for patients



- Improved efficiency and sustainability of healthcare



- Greater scope for ongoing and future scientific and medical innovation



# How can public policy help make data-driven personalised healthcare a reality?



**World Cancer  
Leaders' Summit**

# Core policy areas to advance personalised healthcare

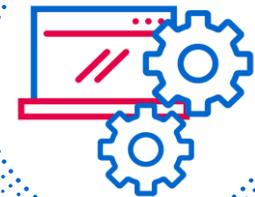
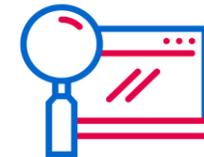
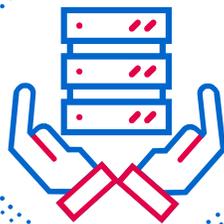
Data  
infrastructure

Access to data

Innovation

Adoption

Health system  
transformation



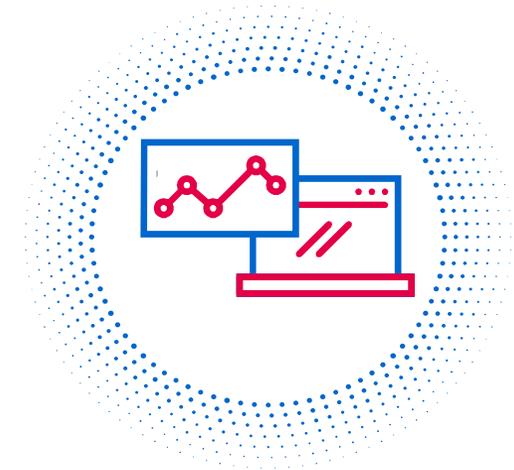
# Priority initiatives in the Middle East to accelerate the delivery and adoption of personalised healthcare



Advance data residency to enable data capturing

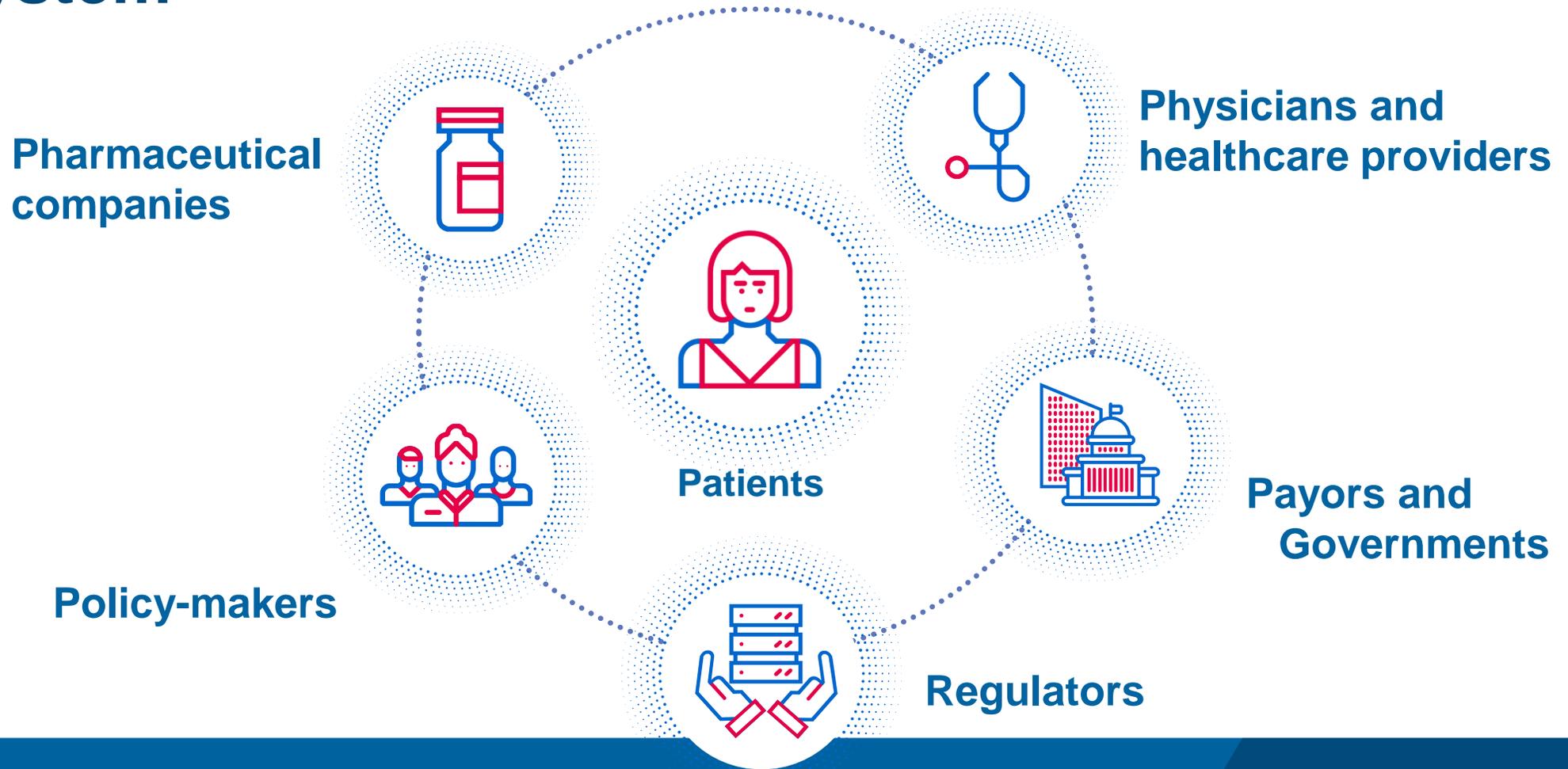


Unlock access to comprehensive genomic profiling



Best-practice exchange enabling governmental initiatives

# Personalised healthcare benefits the entire healthcare ecosystem



**Thank you**

**Pakinam ElSaadani**

Pakinam.elsaadani@roche.com



**World Cancer  
Leaders' Summit**

15-17 October 2019  
Nur-Sultan, Kazakhstan

# A new vision for cancer: data, technology and human touch

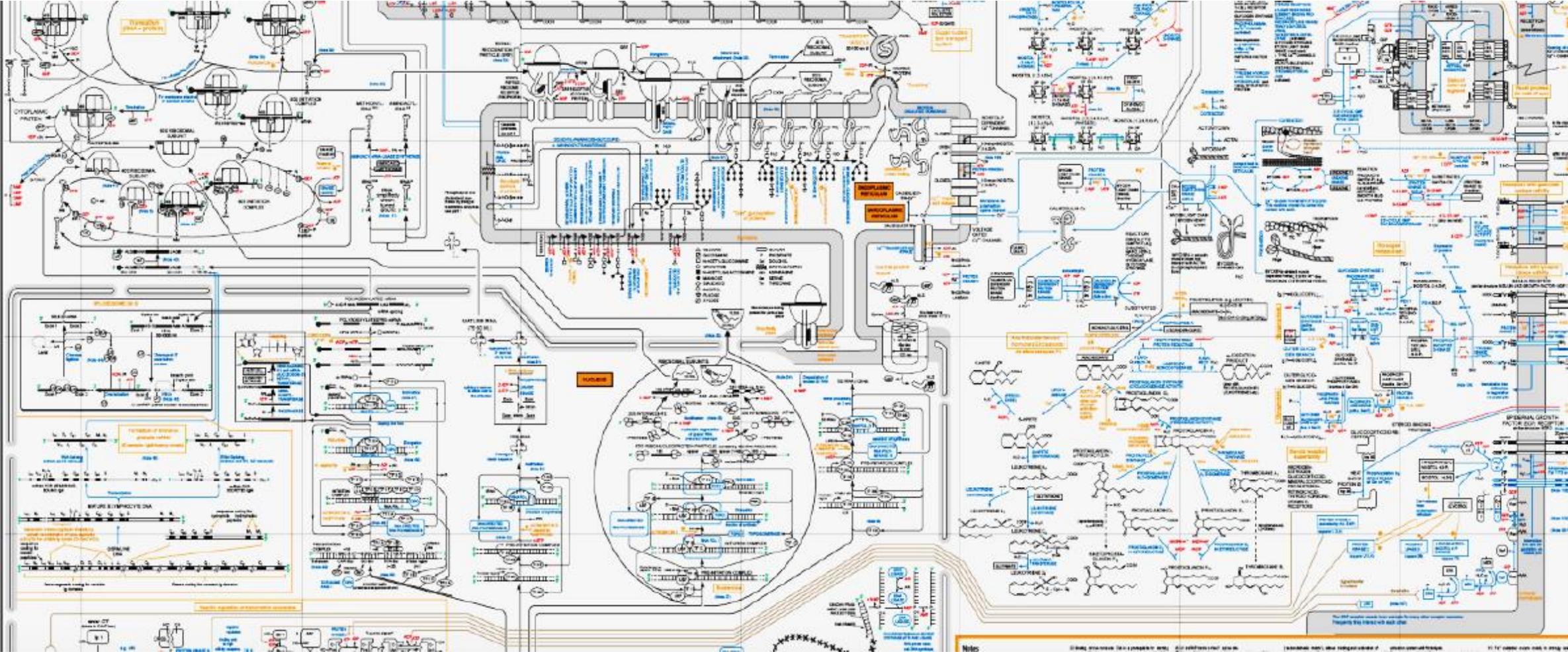
Marius Geanta, MD

President, Centre for Innovation in Medicine  
Romania



**World Cancer**  
Leaders' Summit

# Cancer: heterogeneous environment



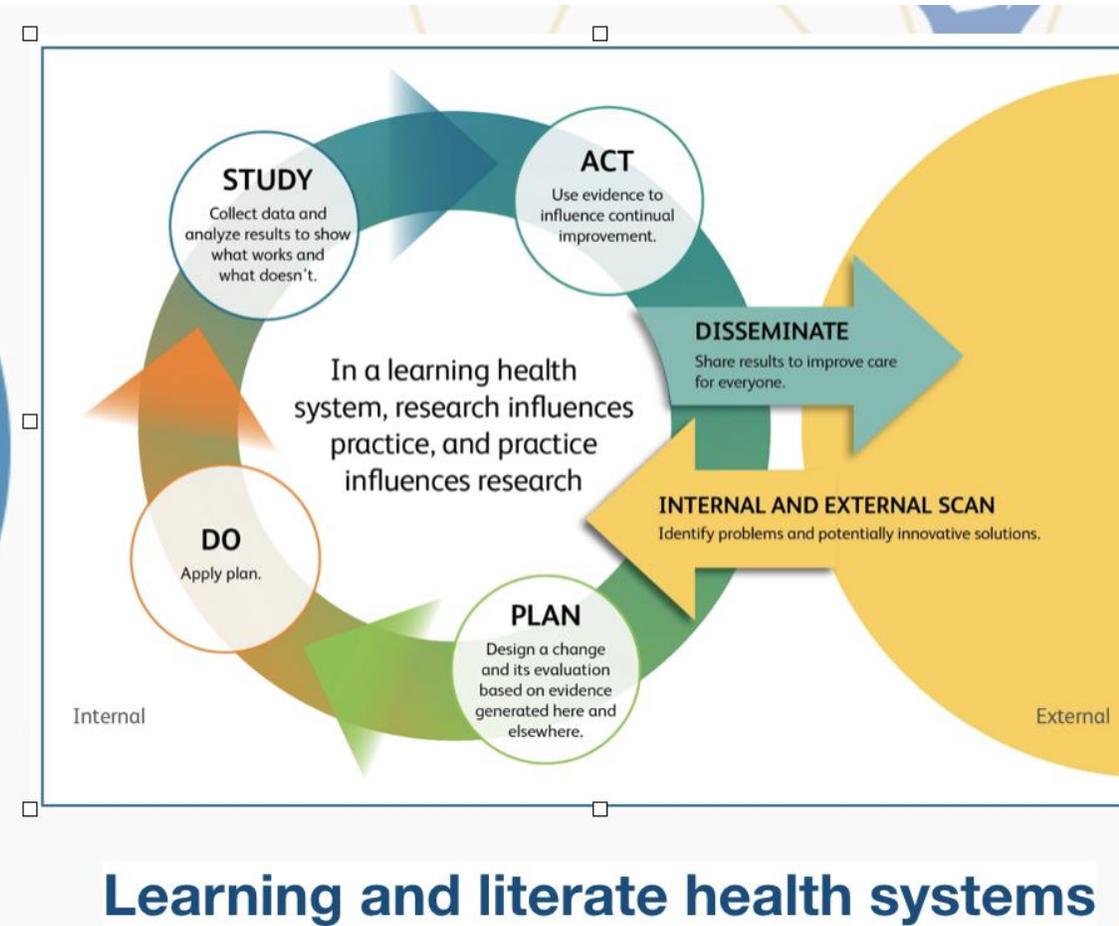
# Romanian Presidency of EU Council 2019

**InoMed**  
Centre for Innovation in Medicine

romania2019.eu

**A new vision for cancer in European Union.**  
**Data, technology and human touch**

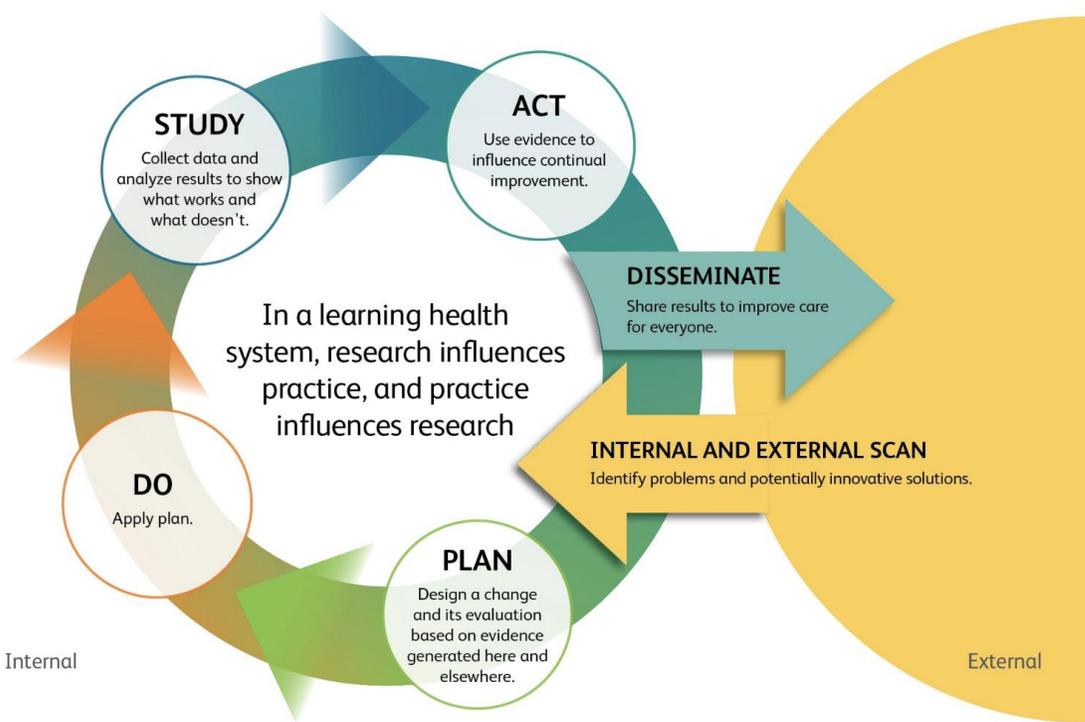
**Position Paper**  
Published by Centre for Innovation in Medicine in the context of Romanian Presidency of Council of European Union



## Digital Twins

**Will every human in the Future have his/her personal model as protection against dangers, as aid for the doctor to personalise therapy and prevention and as support in wellness (“pursuit of happiness) applications?**

# Learning and literate health systems



- Bismarck or Beveridge? *“The same dinosaur”*
- Institutional innovation
- Financing and efficiency of spending
- Lack of leadership and (human) resources
- Political will / coherence
- *“Old habits die hard”*

# Our model

## Building the ecosystem around BigData and Analytics

- Environment (leading Romanian health communication platform)
- Agenda setting (Science meets Politicians, State of Innovation in Romania, Personalised Medicine Conference)
- Targeted interventions (Personalised Medicine Committee, E-Health Agency)

### Up Next

Bucharest Health Innovation Cluster to be launched in December 2019

**Thank you**

**Marius Geanta**

marius.geanta@ino-med.ro



**World Cancer  
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15-17 October 2019  
Astana, Kazakhstan