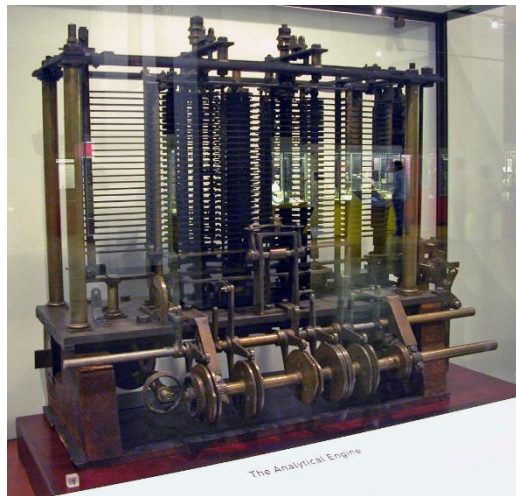


The Impact of Information and Communication Technology (ICT), Big Data, and Artificial Intelligence (AI) on Medicine

A. Hoeft

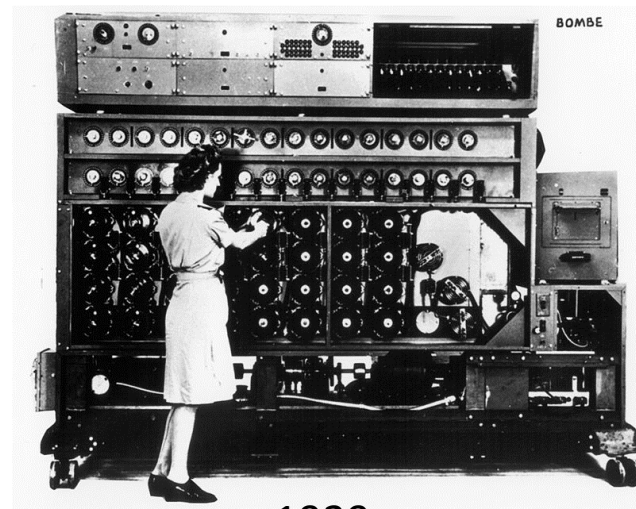
Department of Anesthesiology and Intensive Care Medicine
University Clinic Bonn



1822



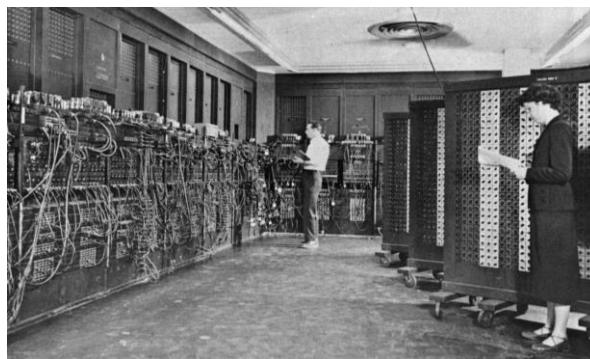
1938



1939



1943



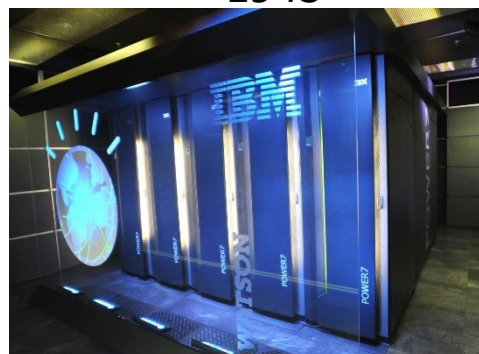
1943



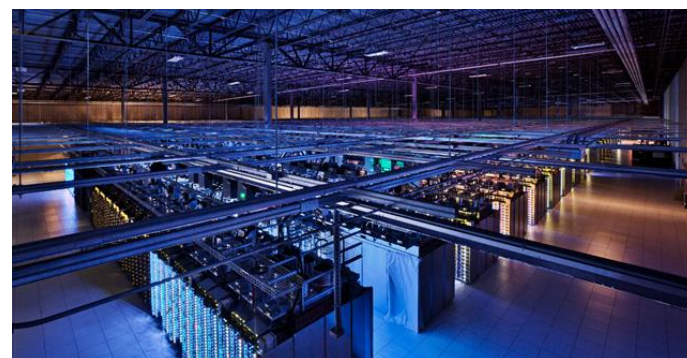
1964



1981

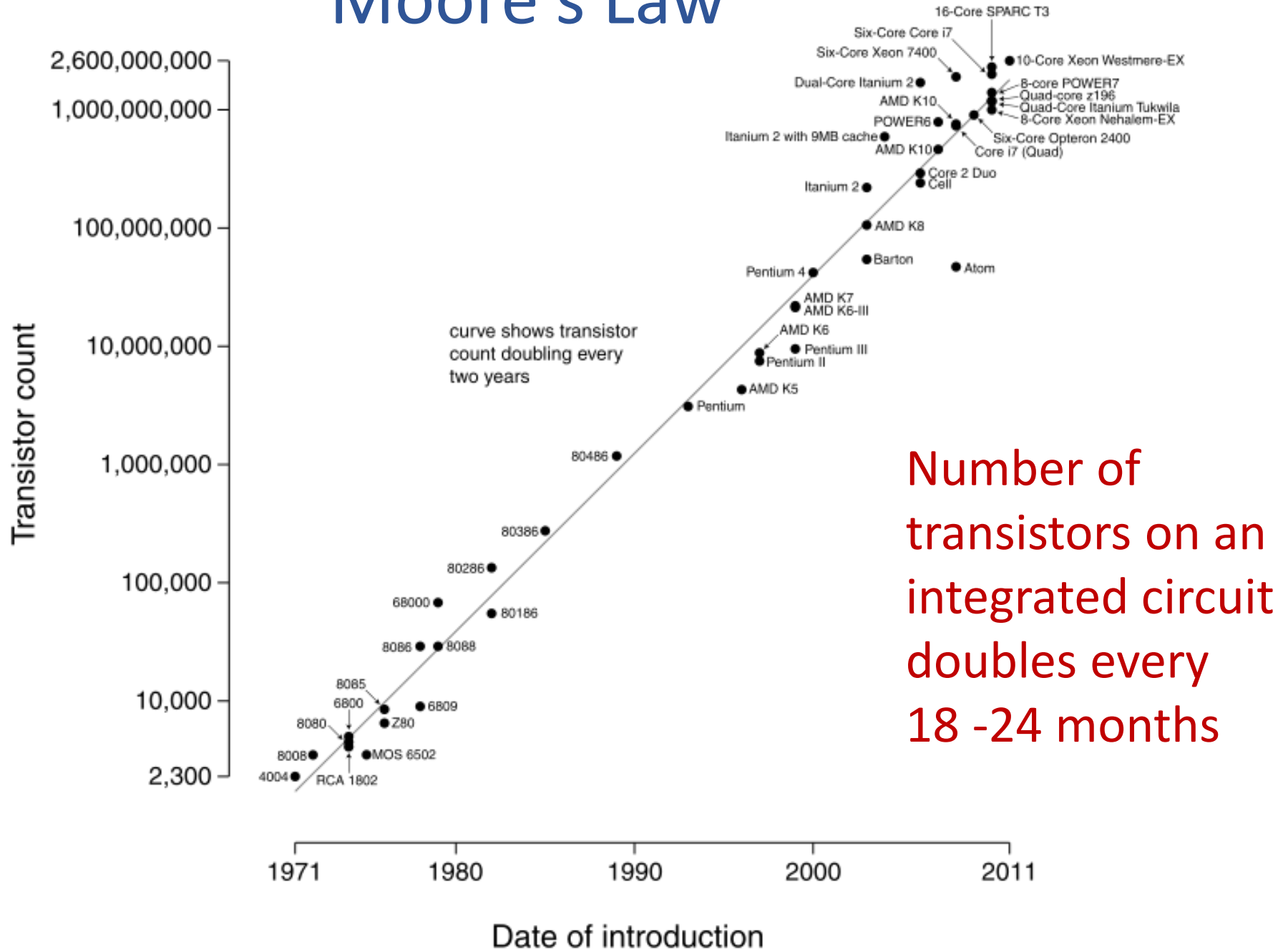


2011



Today

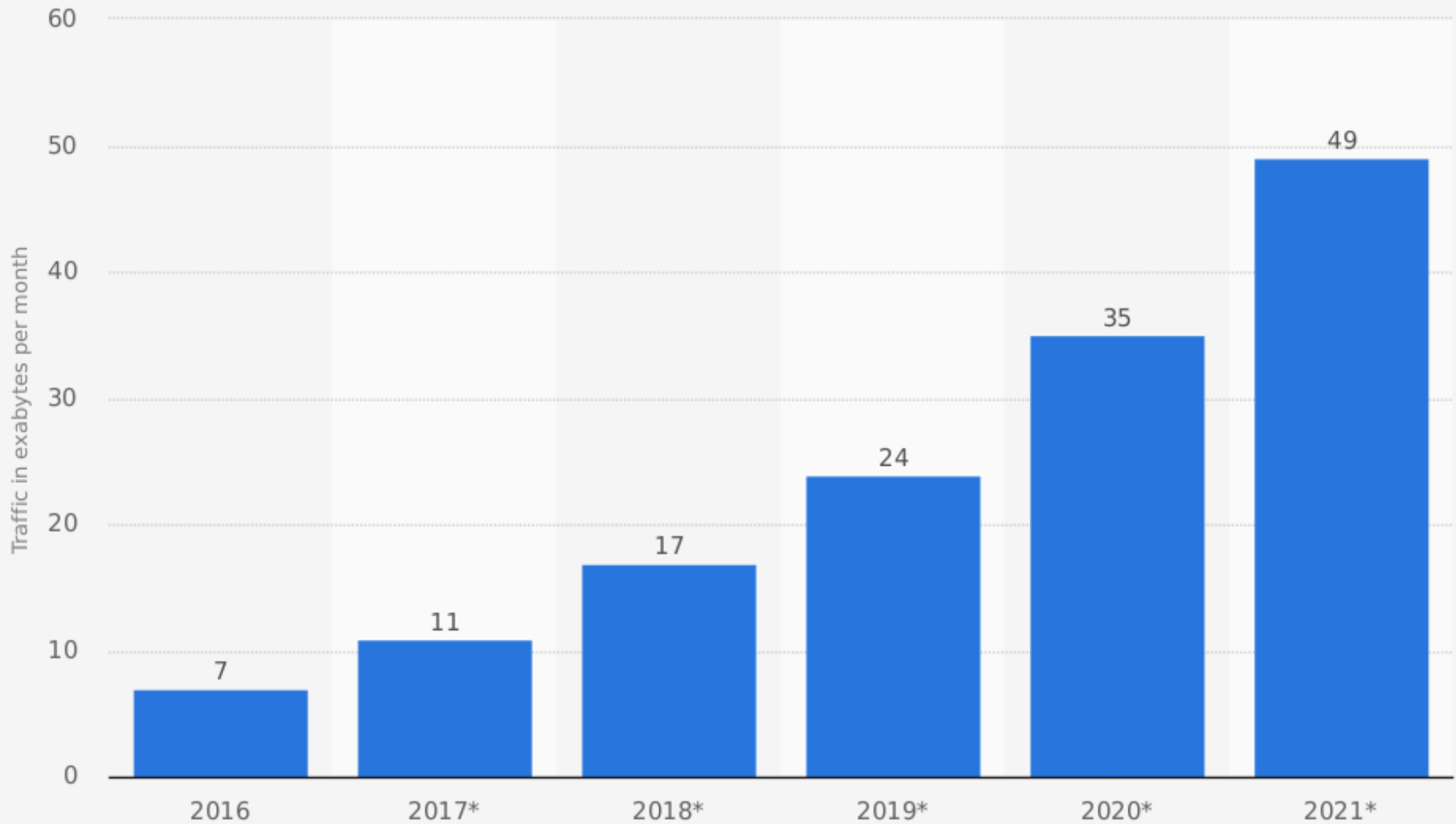
Moore's Law





Moore's Law, Big Data & Global Data Traffic

Global mobile data traffic from 2016 to 2021 (in exabytes per month)



Source:
Cisco Systems
© Statista 2017

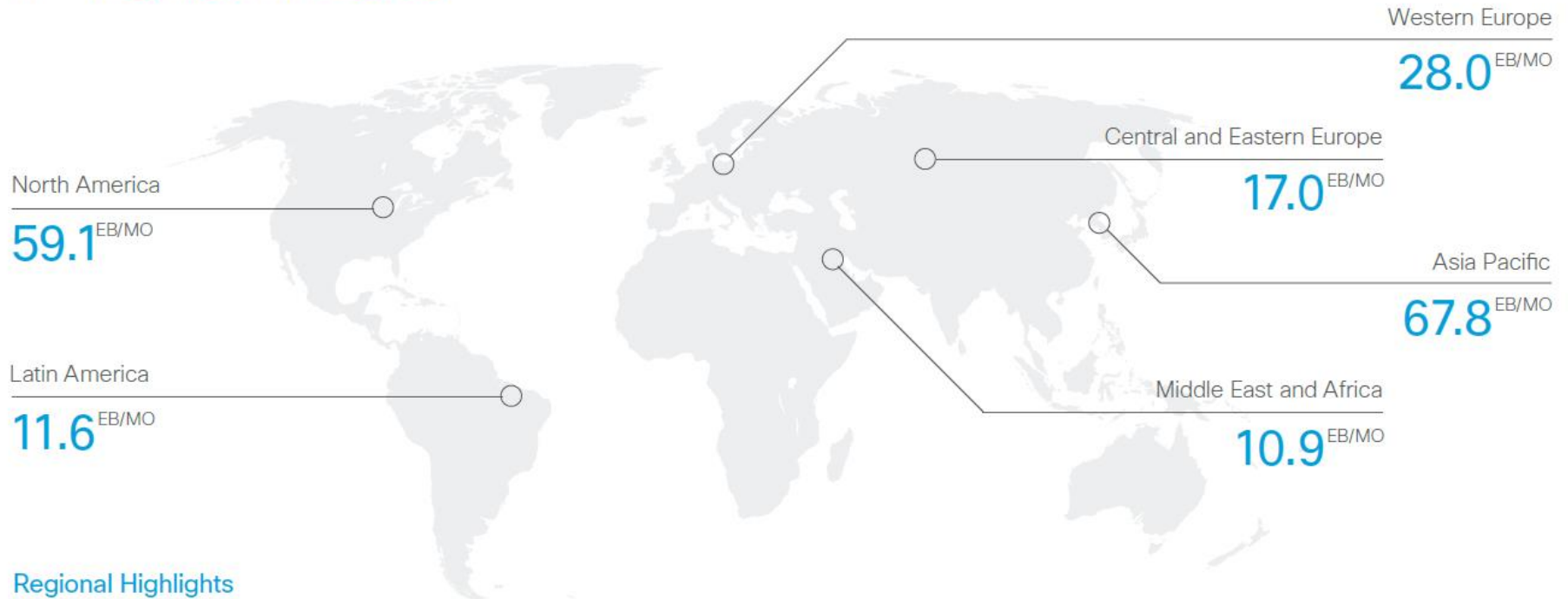
Additional Information:
Worldwide; Cisco Systems; 2016

Exabyte, Zettabyte?

1 Byte	1 Byte = 8 Bit = 0000000/1111111=	One Letter
1 Kilobyte	1.024 Bytes	One Page
1 Megabyte	1.048.576 Bytes	Small Image
1 Gigabyte	1.073.741.824 Bytes	Approx. 8,5 min HD Camcorder Video
1 Terabyte	1.099.511.627.776 Bytes	250.000 MP3-Files
1 Petabyte	1.125.899.906.842.624 Bytes	Storage Capacity of large Data Centers
1 Exabyte	1.152.921.504.606.846.976 Bytes	5x all Printed Books
1 Zettabyte	1.180.591.620.717.411.303.424 Bytes	All Spoken Words in History \approx 42 Zettabyte

Cisco Data IP-Traffic Forecast in Exabyte

IP Traffic in 2020



- Annual global IP traffic / year > 1 ZB in 2016
- > 2.3 ZB in 2020
- will increase nearly x 3 over the next 5 years,
- will have increased x 100 from 2005 to 2020

Big Data ...

„Big Data are the gold of the future.“

Dr. Christian Cassebaum
COO Allianz-AG

2014 Symposium
„Medicine Meets Business“



What is „Big Data“?

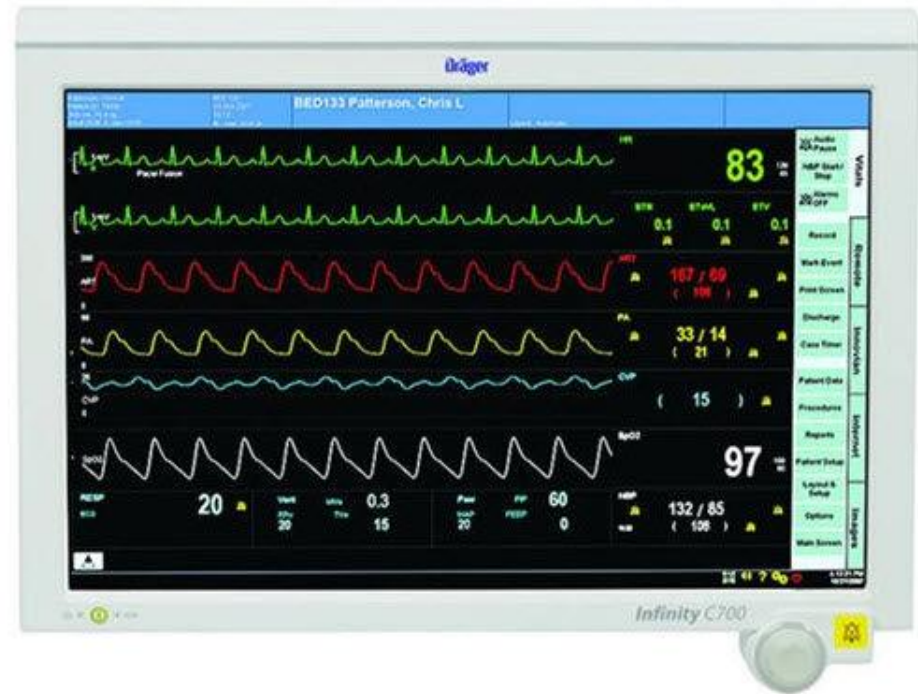
Amounts of Data that are too large or too complex to be processed by classical methods.

- Nuclear Physics
- Meteorology
- Electronic Communication
- Health Data?

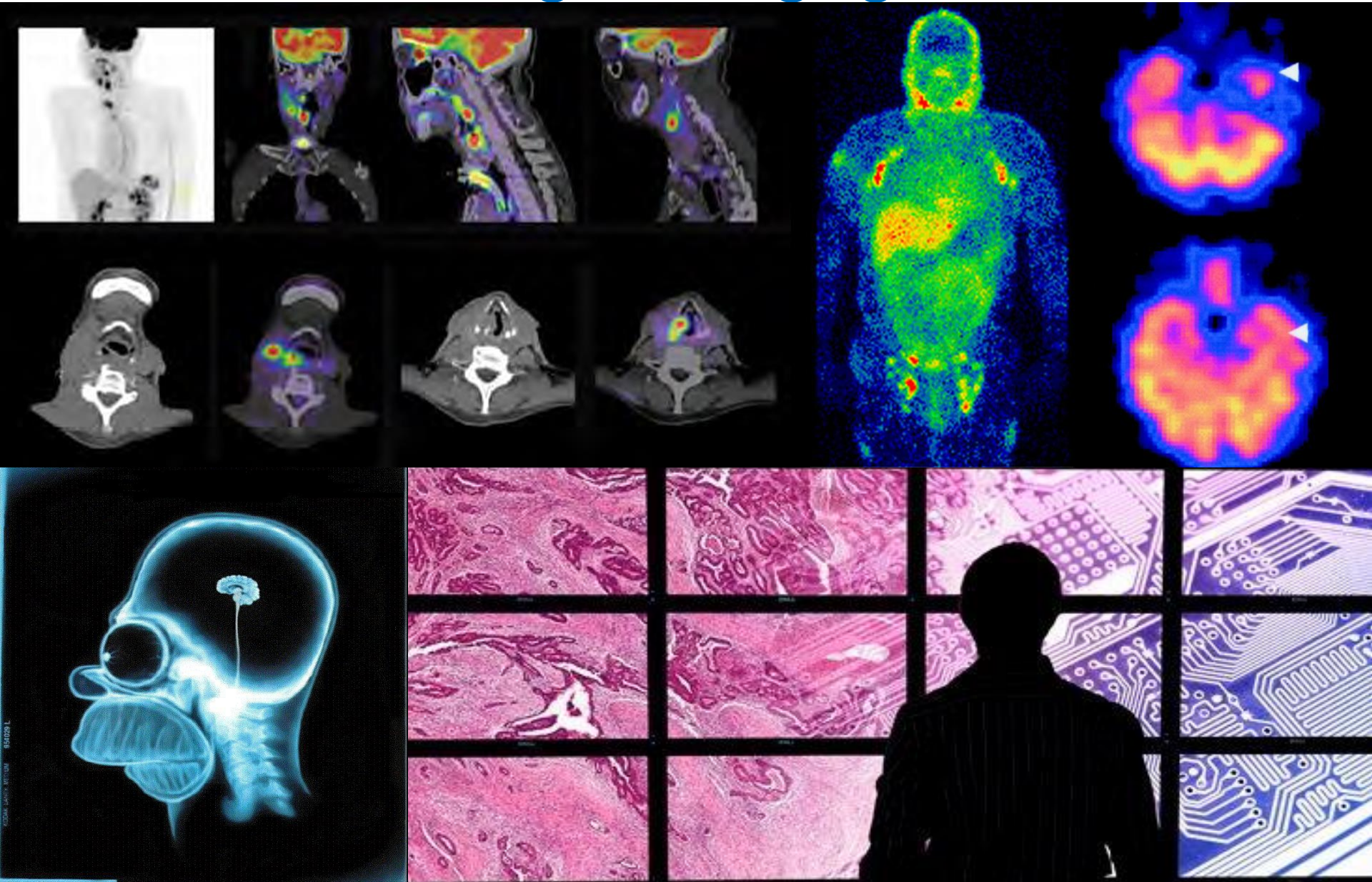
Big Data“ in Medicine?

Data Volume Intensive Care Setting

- 8 Channels of 200
2 Byte Resolution/Sample
- 8 x 200 x 2 x 3600
~ 6 MB/h/Bed
- ~ 50 GB/Bed/Year
- University hospital with 200 ICU-beds: **only 1 TB / year!**
< 1 PB for Germany / year (CERN: 1 PT/sec)



954029 L



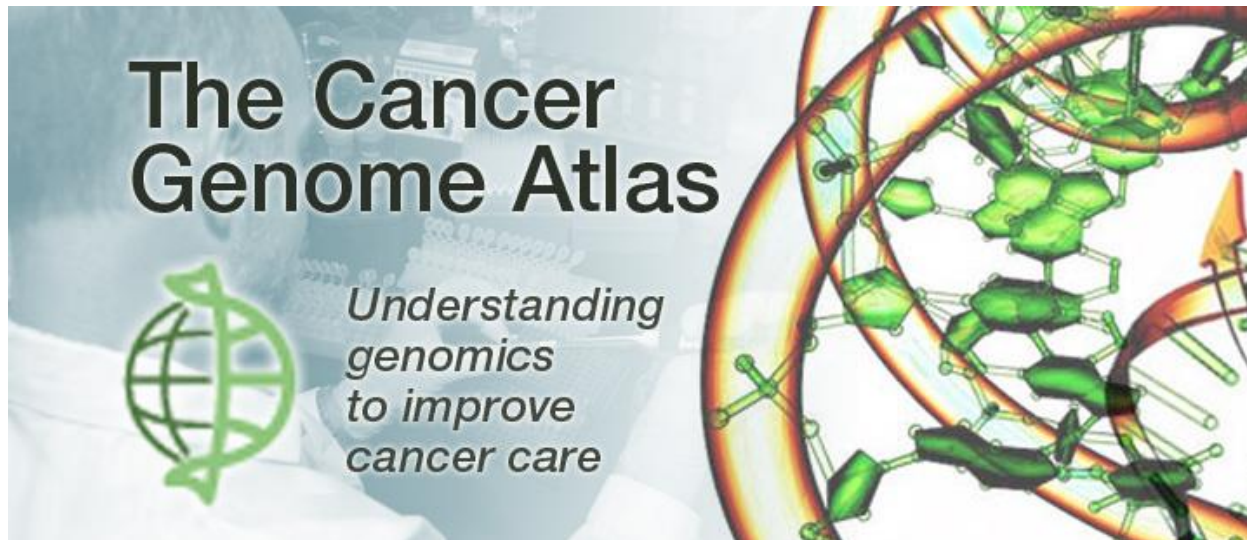
„Real Big Data“ in Medicine: Gen-OMICS!

- Genome sequencing = 3 TB
 - First human genome sequencing:
10 Years duration, 3 billion \$
 - Today: few hours < 1000 €
 - Other OMICs data:
TranskriptOMICs, EpigenOMICs,
MetabolOMICs, VariOMICs,
FluxOMICs...)
- 10^{15} Bytes = 1 billion gigabyte



„Real Big Data“: Cancer-Genomics!

- Google & Institute of Systems Biology USA
- Cancer Genome Atlas => Cancer-Mapping
- „Cancer Genomics Cloud“





Data Challenges in Hospitals Today



- Research data double every 6 months
- Up to 60 databases in a hospital, neither flexible nor adaptive

 **Approx. 70% of data in health care and in hospitals are unstructured (Text)!**

semantic analysis of unstructured data (text)

BELIEF - A semiautomatic workflow for BEL network creation

Juliane Fluck^{1*}, Sumit Madan¹, Sam Ansari², Justyna Szostak², Julia Hoeng², Marc Zimmermann¹,
Martin Hofmann-Apitius^{1,3}, Manuel C. Peitsch²

- Biological Expression Language (BEL):
Machine and human readable language for knowledge representation, causal reasoning, and hypothesis generation
- BELIEF: creates BEL from text (publications, health records, etc.)

SET Evidence = "Thrombin receptor mediated signals induce expressions of interleukin 6 and granulocyte colony stimulating factor via NF-kappa B activation in synovial fibroblasts."

SET Cell = "fibroblast"

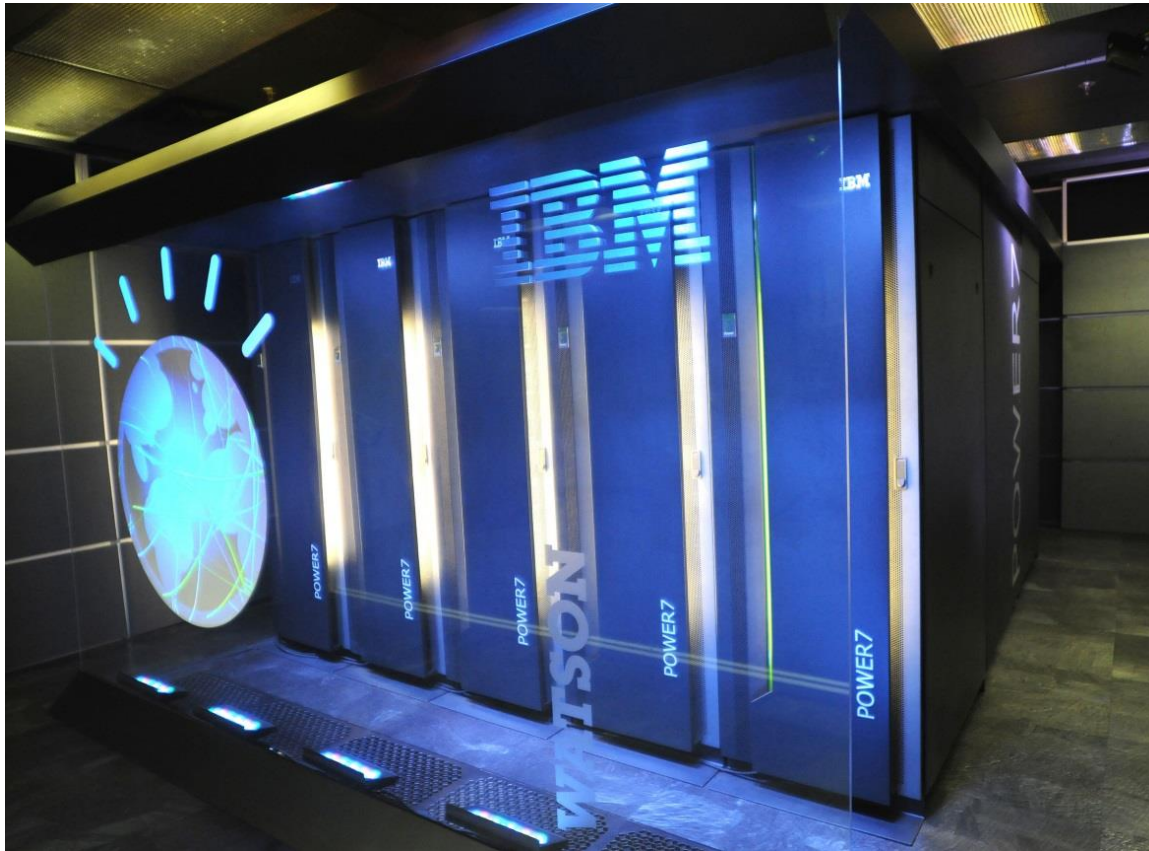
Context annotations

p(HGNC:F2R) -> (p(HGNC:NFKB1) -> r(HGNC:IL6))

BEL statement

AI computers can read papers and health records!

IBM: Watson



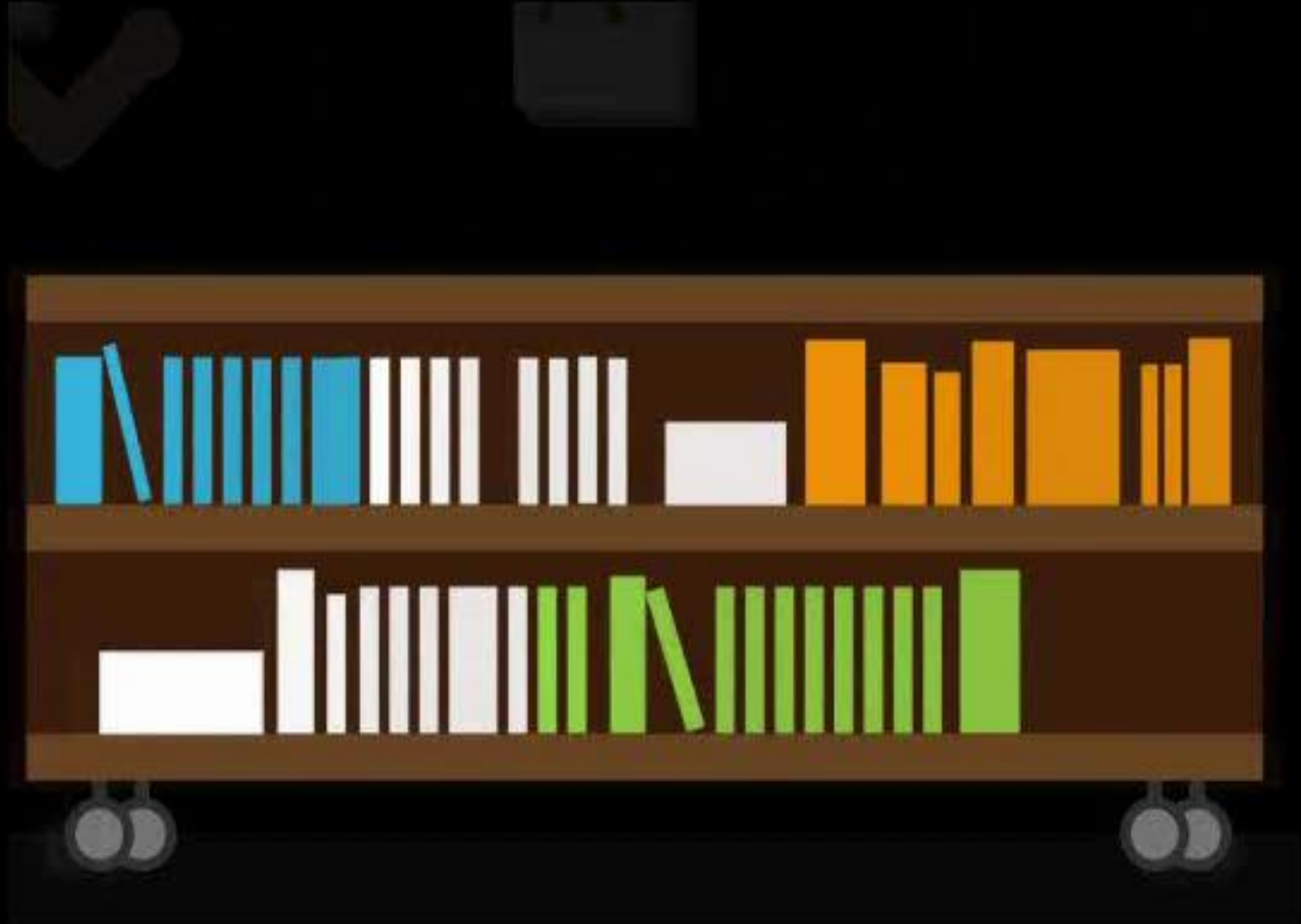
Thomas J. Watson, IBM
1874 – 1956
First CEO of IBM

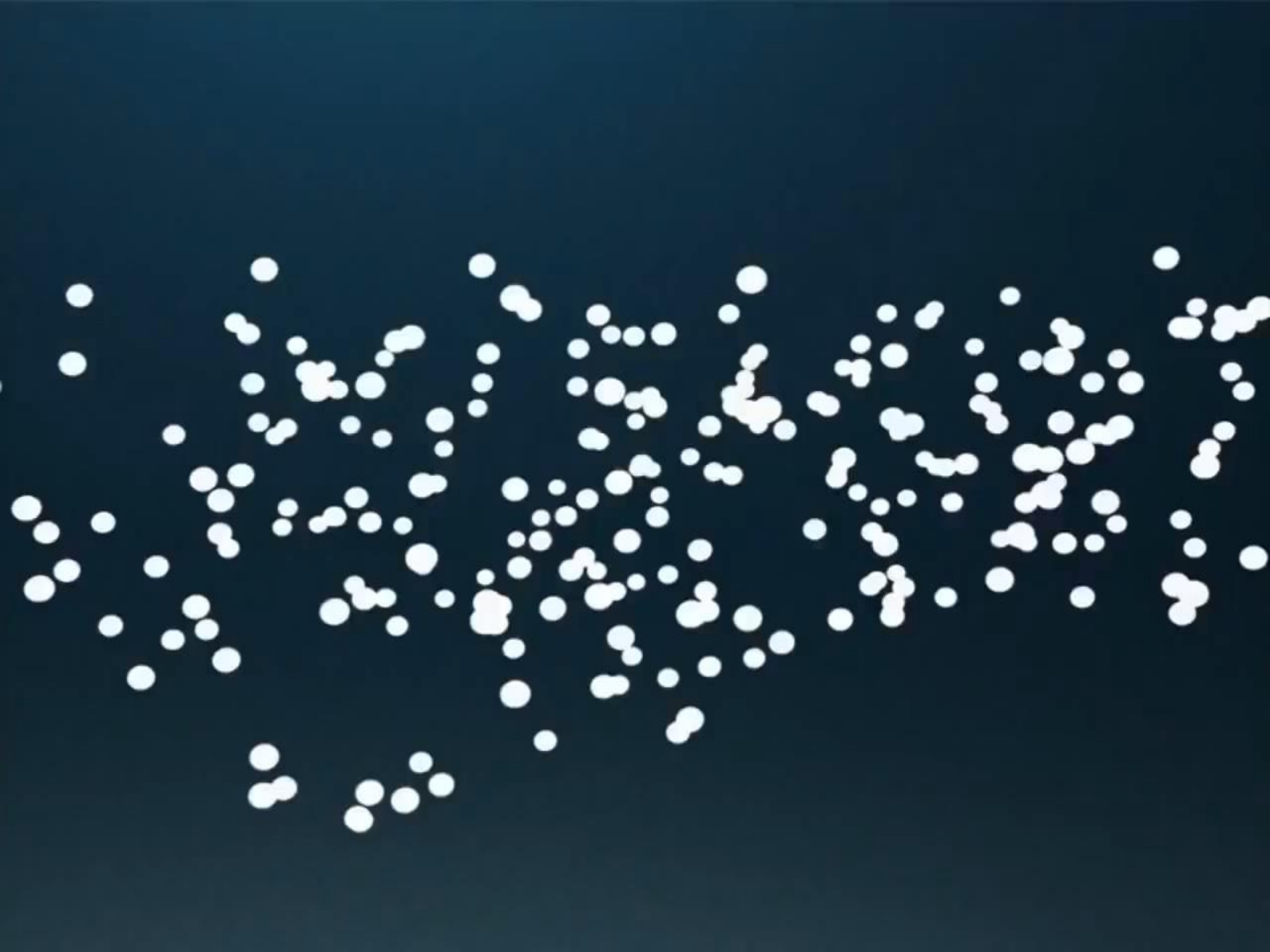
Watson Cognitive Computing
2011

COLDFUSTION TV SPECIAL!



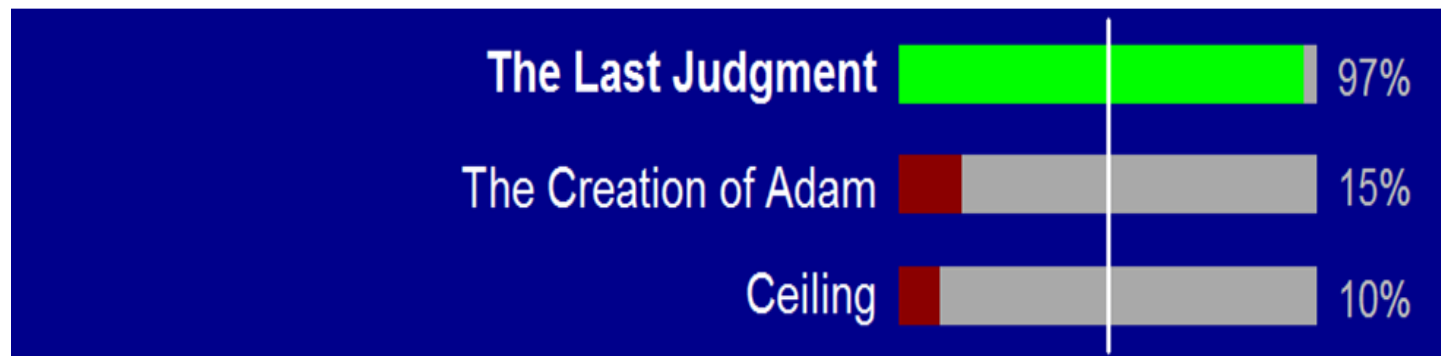
all of Wikipedia, all classic novels, all modern novels, trivia databases, dictionaries, several thesauri, the Internet Movie Data Base, all newspaper and magazine archives and many others



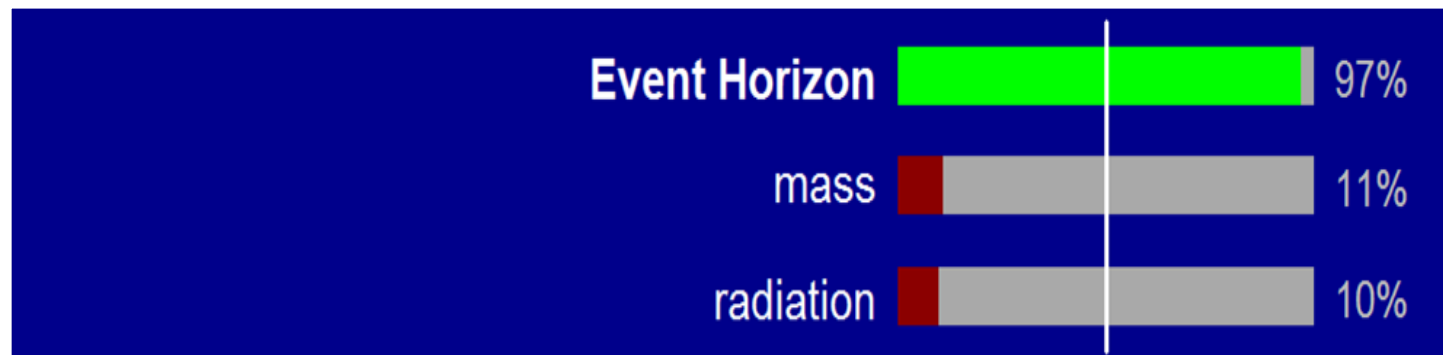


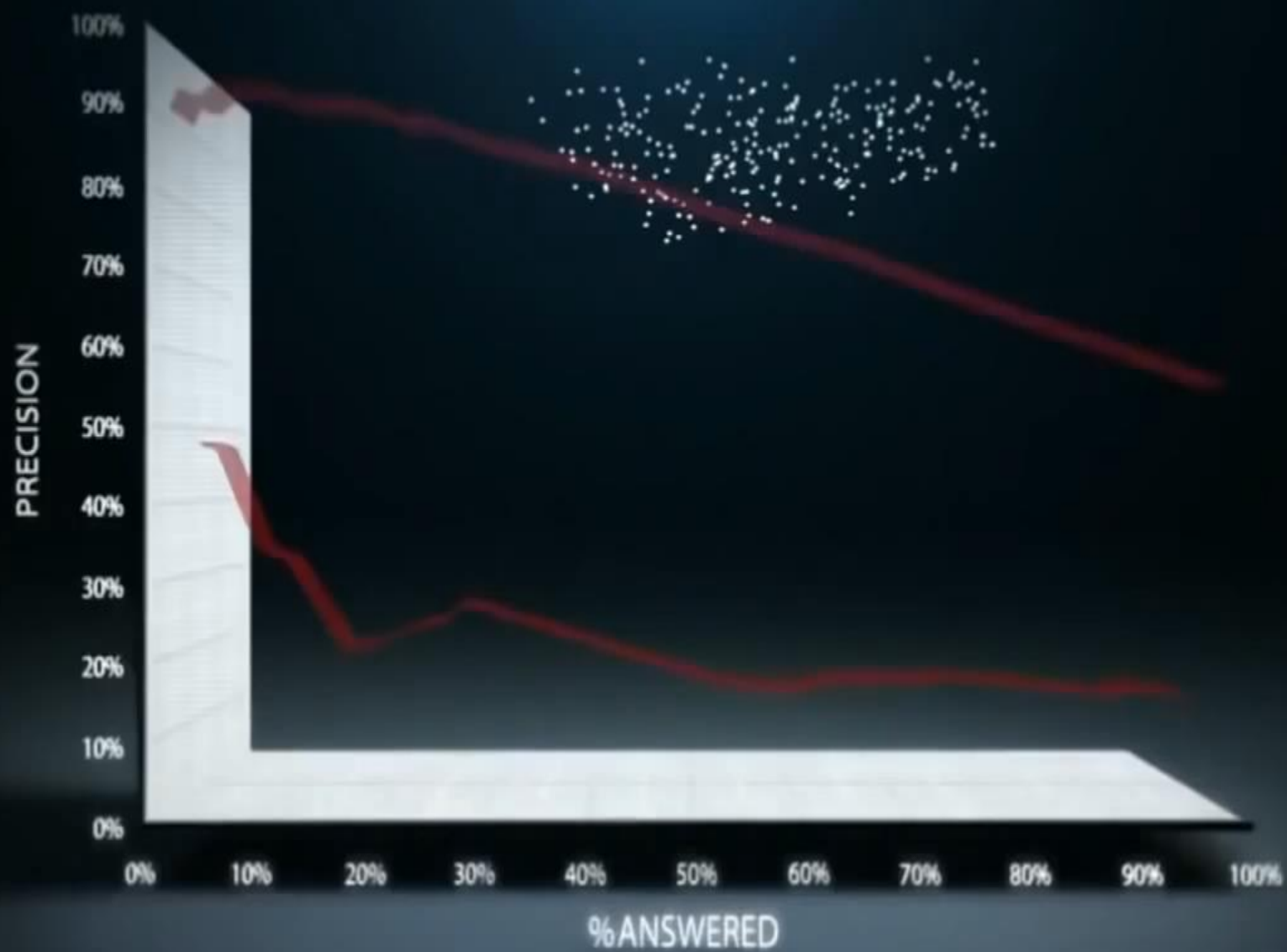
Machine Learning

IT'S MICHELANGELO'S FRESCO ON THE WALL OF THE SISTINE CHAPEL, DEPICTING THE SAVED & THE DAMNED



TICKETS AREN'T NEEDED FOR THIS
"EVENT", A BLACK HOLE'S BOUNDARY
FROM WHICH MATTER CAN'T ESCAPE





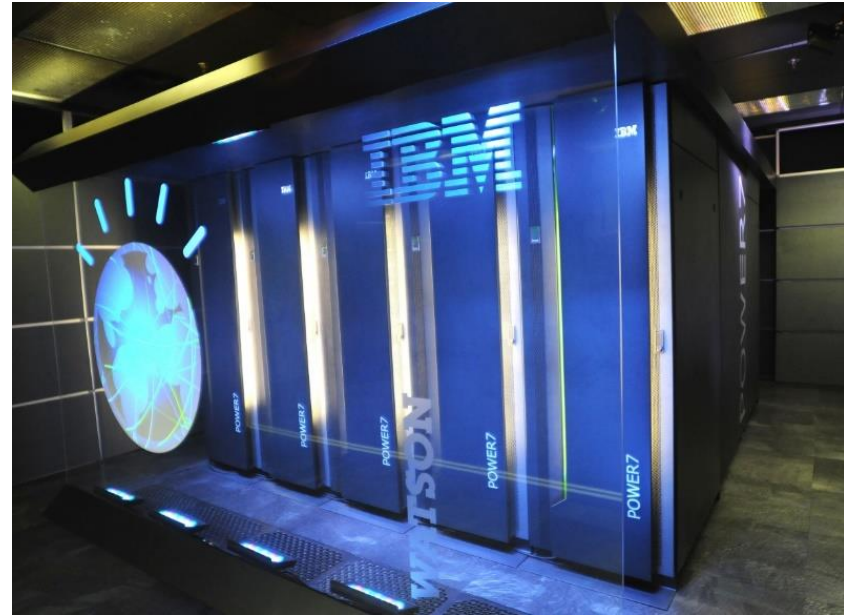
Watson & Jeopardy

2011



Ken Jennings & Brad Rutter

vs.



Watson

COLDFUSTION TV SPECIAL!



Watson in Medicine?



The University of Texas MD Anderson Cancer Center

IBM Watson helps accelerate translation of cancer-fighting knowledge to cutting edge medical practices

- Implementation of „Cognitive computing“ by IBM
- MD Anderson Cancer Center, Houston
- Cleveland Clinic, Memorial Sloan-Kettering
- Objectives:
 - Individualized, personalized therapy for patients
 - Improved decision making of physicians
 - Evidence-based data for specific problems within short time

Watson in Medicine

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UNITED KINGDOM

Edition: UK ▼

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IBM's Watson AI Saves Woman's Life By Diagnosing Rare Form of Leukaemia

It took the artificial intelligence just 10 minutes to spot...



SETH WENIG/AP

PubMed

ibm watson healthcare outcomes

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Review

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Items: 2

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Filters: [Manage Filters](#)

New feature

Try the new Display Settings option -
[Sort by Relevance](#)

Find related data

Database:

Search details

```
ibm[All Fields] AND
watson[All Fields] AND
("delivery of health
care"[MeSH Terms] OR
("delivery"[All Fields]
AND "health"[All
```

[See more...](#)

From Watson to Dr. Siri ... ?



iTriage



Blood Pressure



Airstrip
Patient Monitoring



My Ideal Weight



Glucose Monitor



Pedometer



From Dr. Watson to Dr. Siri?



„Dr. Siri is coming!

2014 Symposium

„Medicine Meets Business“

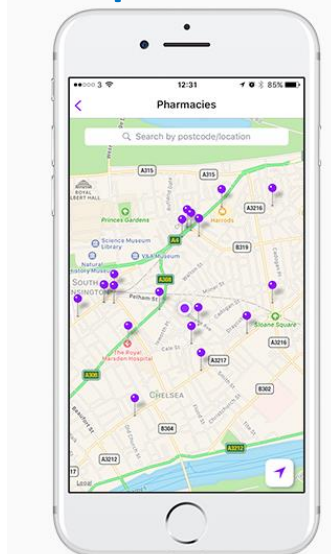
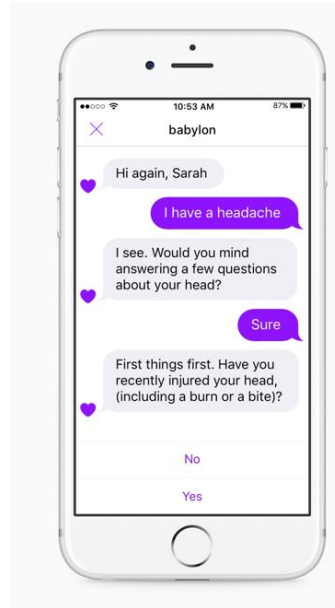
Timotheus Höttges, CEO Deutsche Telekom AG

Predecessors of Dr. Siri...?



Combination of AI
with online video
physicians

Prescriptions sent to
local pharmacies



MONTHLY	Our best value plan YEARLY	ONE-OFF
£5 minimum 3 months	£50 2 months free	£25 per consultation
<ul style="list-style-type: none">✓ Unlimited GPs✓ Plus Free account	<ul style="list-style-type: none">✓ Unlimited GPs✓ Plus Free account	<ul style="list-style-type: none">✓ Free account included✓ £5 first appointment (use promo code FIRSTGP)

THE FUTURE OF EMPLOYMENT: HOW SUSCEPTIBLE ARE JOBS TO COMPUTERISATION?*

Carl Benedikt Frey[†] and Michael A. Osborne[‡]

Social Intelligence

Creativity

Perception and manipulation

Other skills for process classification

THE FUTURE OF EMPLOYMENT: HOW SUSCEPTIBLE ARE JOBS TO COMPUTERISATION?*

Carl Benedikt Frey[†] and Michael A. Osborne[‡]

Rank	Occupation	probability of disappearance
1	recreational therapist	0.0028
.....		
8	healthcare social workers	0.0035
.....		
15	physicians and surgeons	0.0042
.....		
695	tax preparers	0.99
.....		
699	mathematical technicians	0.99
.....		
702	telemarketers	0.99

~ 47% of US employment is at risk

Predicting the Future — Big Data, Machine Learning, and Clinical Medicine

Ziad Obermeyer, M.D., and Ezekiel J. Emanuel, M.D., Ph.D.



The NEW ENGLAND
JOURNAL of MEDICINE

Machine learning has become ubiquitous and indispensable for solving complex problems in most sciences. The same methods will open up vast new possibilities in medicine.

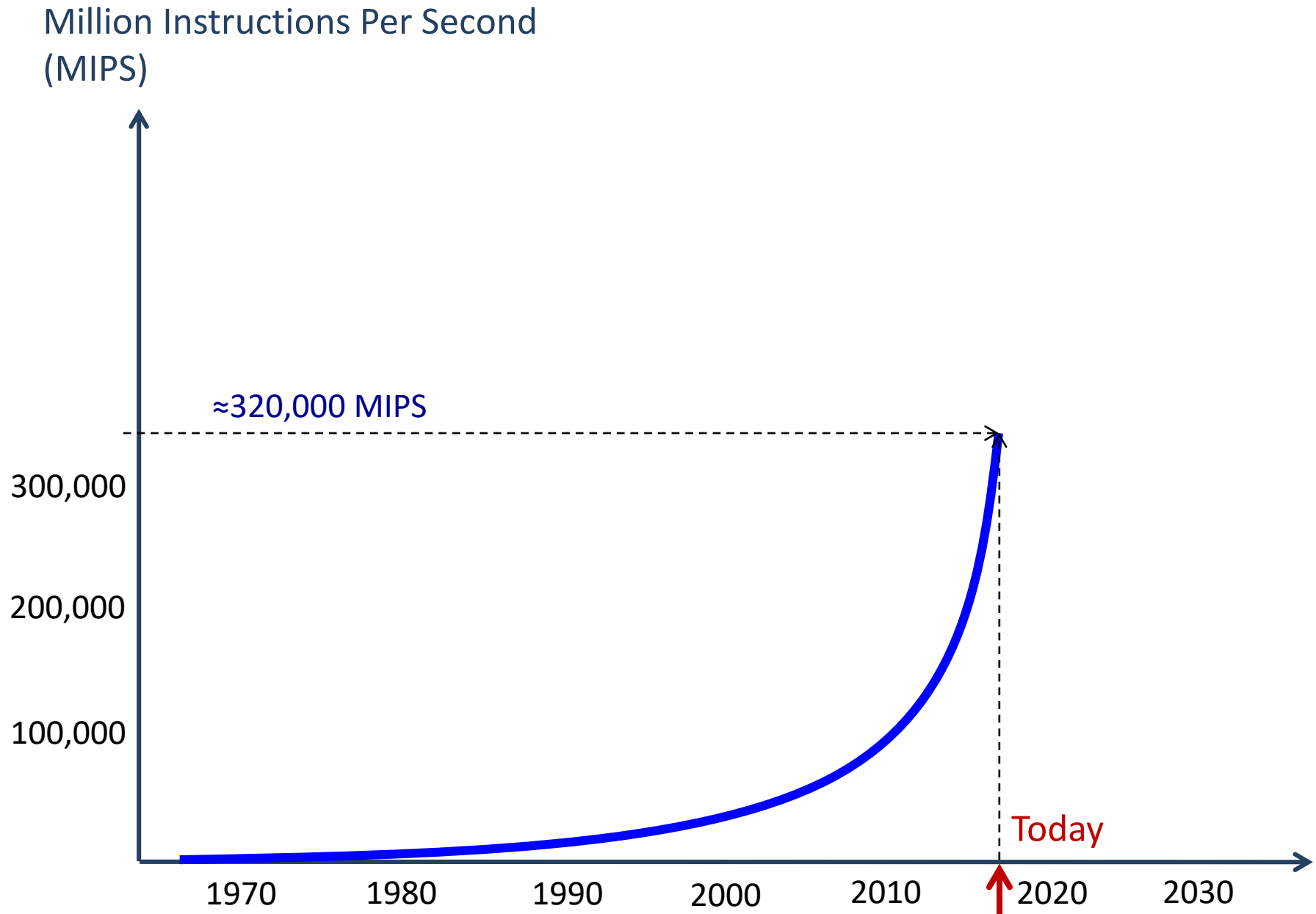
medicine. First, machine learning will dramatically improve the ability of health professionals to establish a prognosis. Current prog-

Second, machine learning will displace much of the work of radiologists and anatomical pathologists. These physicians focus

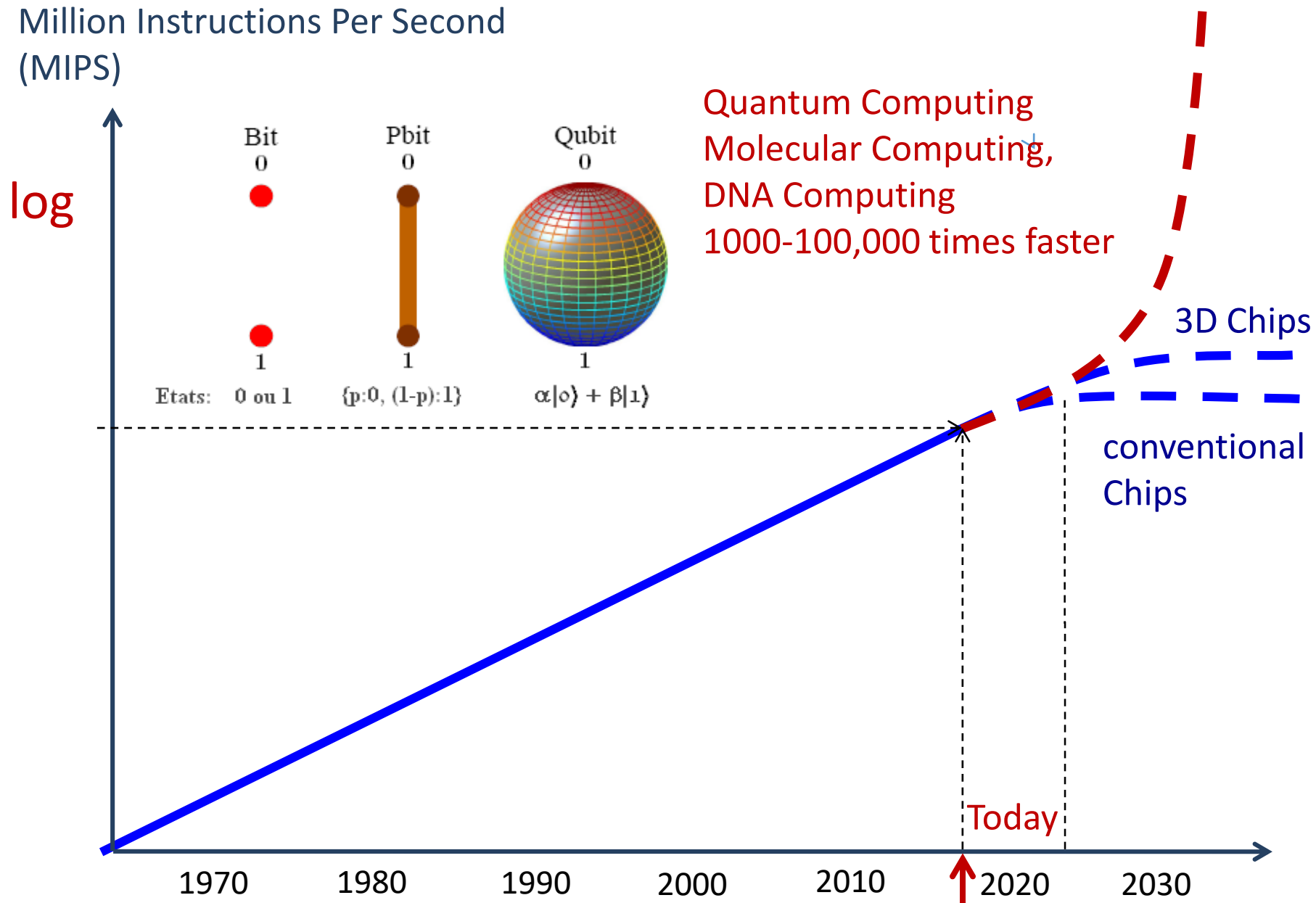
Third, machine learning will improve diagnostic accuracy. A

But we are optimistic that patients, whose lives and medical histories shape the algorithms, will emerge as the biggest winners as machine learning transforms clinical medicine.

The Future of ICT, Big Data and AI: Moore's Law?

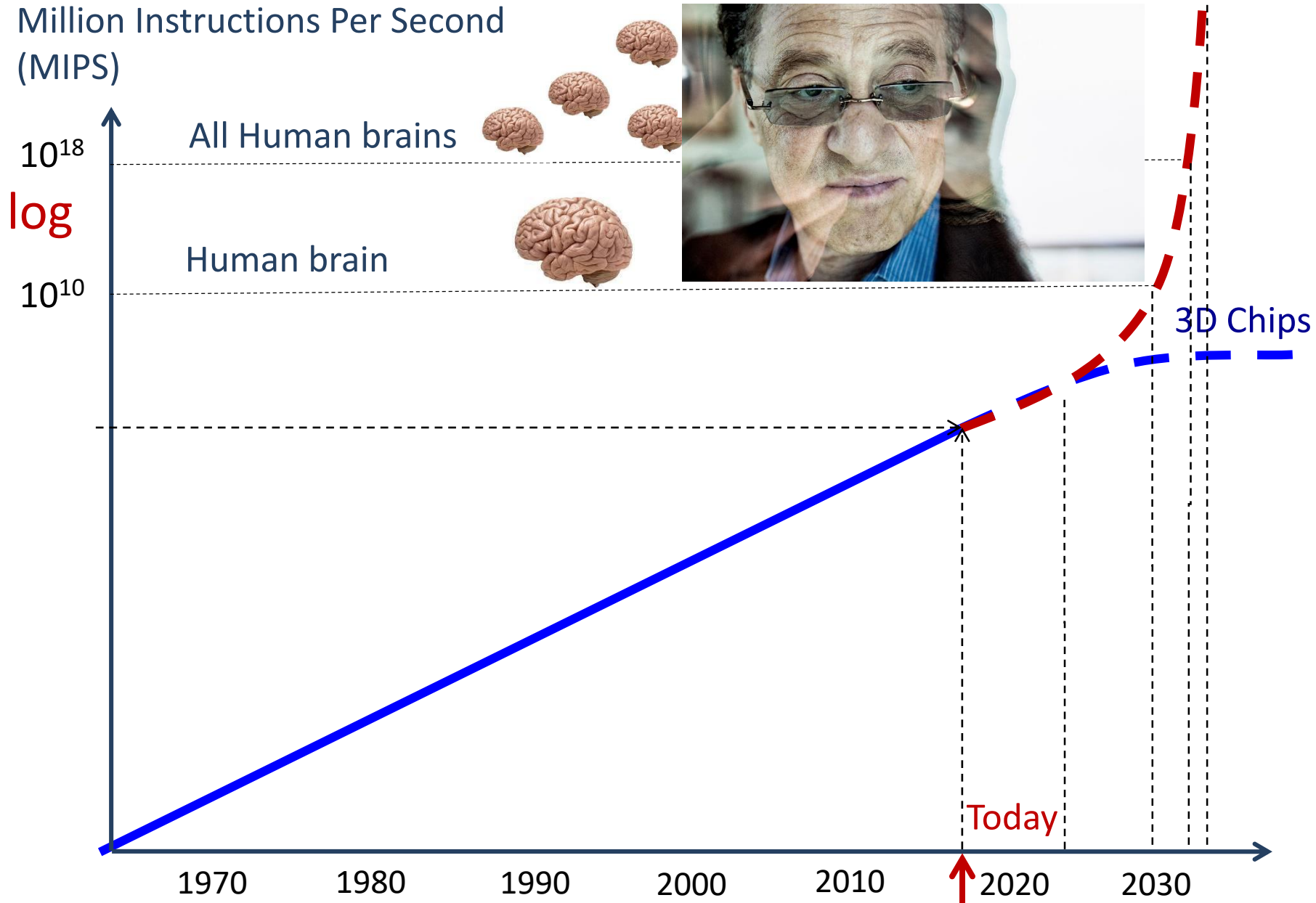


The Future of ICT, Big Data and AI: Moore's Law?



The Future of ICT, Big Data and AI: Moore's Law?

Kurzweil's Singularity



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Stephen Hawking warns artificial intelligence could end mankind

By Rory Cellan-Jones
Technology correspondent

🕒 2 December 2014 | Technology | 📄

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"The development of full artificial intelligence could spell the end of the human race."

The Impact of ICT, Big Data and AI on Medicine



Prediction is very difficult,
especially about the future!

1885 - 1962

Thank you very much
for your attention

Andreas Hoeft

Klinik für Anästhesiologie
und operative Intensivmedizin
Universitätsklinikum Bonn

