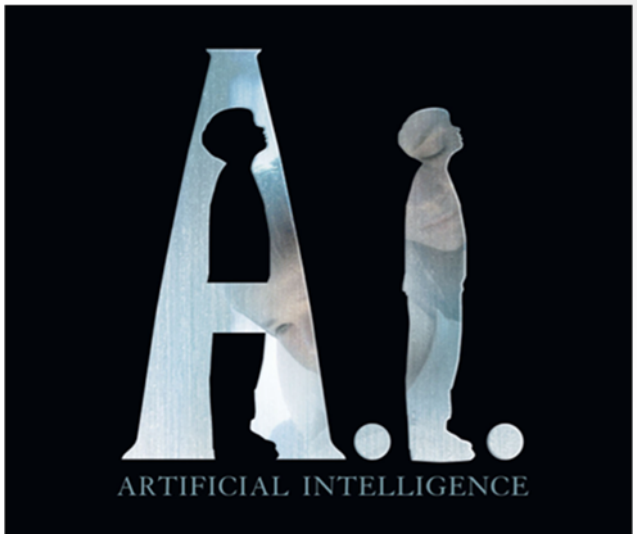

AI in Medicine

Conquer *Medical Errors* with *Artificial Intelligence*

Yu-Chuan (Jack) Li, M.D., Ph.D., FACMI
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李友專，臺北醫學大學，醫學科技學院，醫學資訊研究所

McKinsey: $50 trillion of value to be created by AI and Robotics through 2025

by omohundro

To better understand the likely social impact of AI and Robotics, it's very useful to have an estimate of the economic gains they will create in the near future. The respected consulting firm McKinsey & Company recently released
and the global e
technologies te
To get a better s
the economic im
considered "AI a

- Automation
- Internet of t
- Advanced r
- Autonomou
- 3D printing:

Adding those up
economic impact
ramp up. The sir
of an underestim
neglects the con
divided by 2 and

- Total impac

To account for th
summary of the scale of the likely impact.

By 2025, AI Will Have a 5-Trillion-Dollar Direct Impact on the Workforce

May 5, 2016 By : Kate

An exciting and rapidly developing world of artificial intelligence is humanity. Large tech corporations believe AI is the future and hav implementation.

AI has already been successfully applied across industries that pre management, investment management, advising, insurance, the pr intervention of artificial intelligence and will be transforming in re

Along with tech giants, financial institutions have also been invest leverage the opportunities that machine learning and other areas recently published a report with data on the possible impact of AI global workforce.

According to the report, advances in computing technology, mach significant impact on the labor market and will cost $14 trillion by

Moreover, by 2025, computerization may cost jobs to close to 14(6.7 trillion direct impact in the form of a higher efficiency and outp

Financial services are one of the leading industries to adopt AI. Ro fraud detection, automated underwriting and a range of other ser estimations predict that application of advanced robotics and AI i 25 million workers in a positive way: it will increase the efficiency impact is estimated to hit $0.6–0.8 trillion in 10 years.

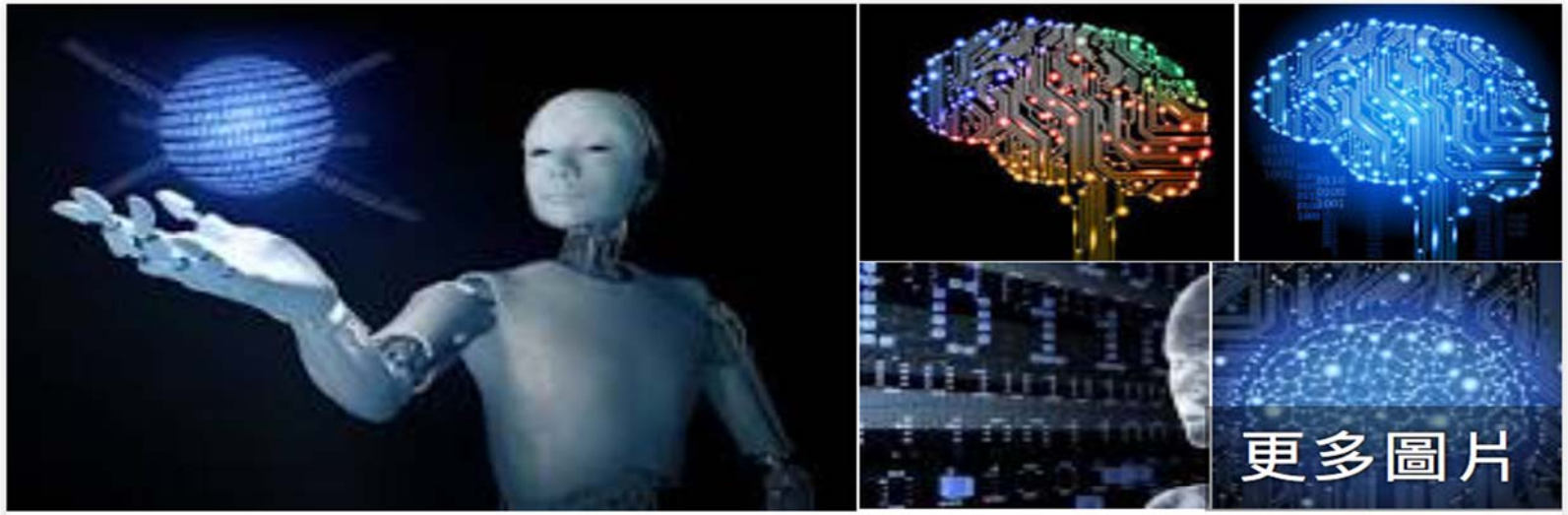
Analysts, Physicians, Lawyers, Teachers

李開復：最大白領失業潮來襲　4種「師」首當其衝

Who is going to lose their jobs first?

圖片來源：劉國泰

Defining AI



Artificial intelligence (AI) is intelligence exhibited by machines.

…

Colloquially, the term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving".

…

"We don't need Artificial Intelligence if we don't have Natural Stupidity!"
- Professor Allan T. Pryor

Defining “Natural Stupidity”

- **“Natural Stupidity” means:**
  Making errors unconsciously and continuously without regret

“Natural Stupidity” in Defense Systems

One dead, two injured!

INSTITUTE OF MEDICINE

Shaping the Future for Health

198,000 die of medical errors every year

TO ERR IS HUMAN:
BUILDING A SAFER HEALTH SYSTEM

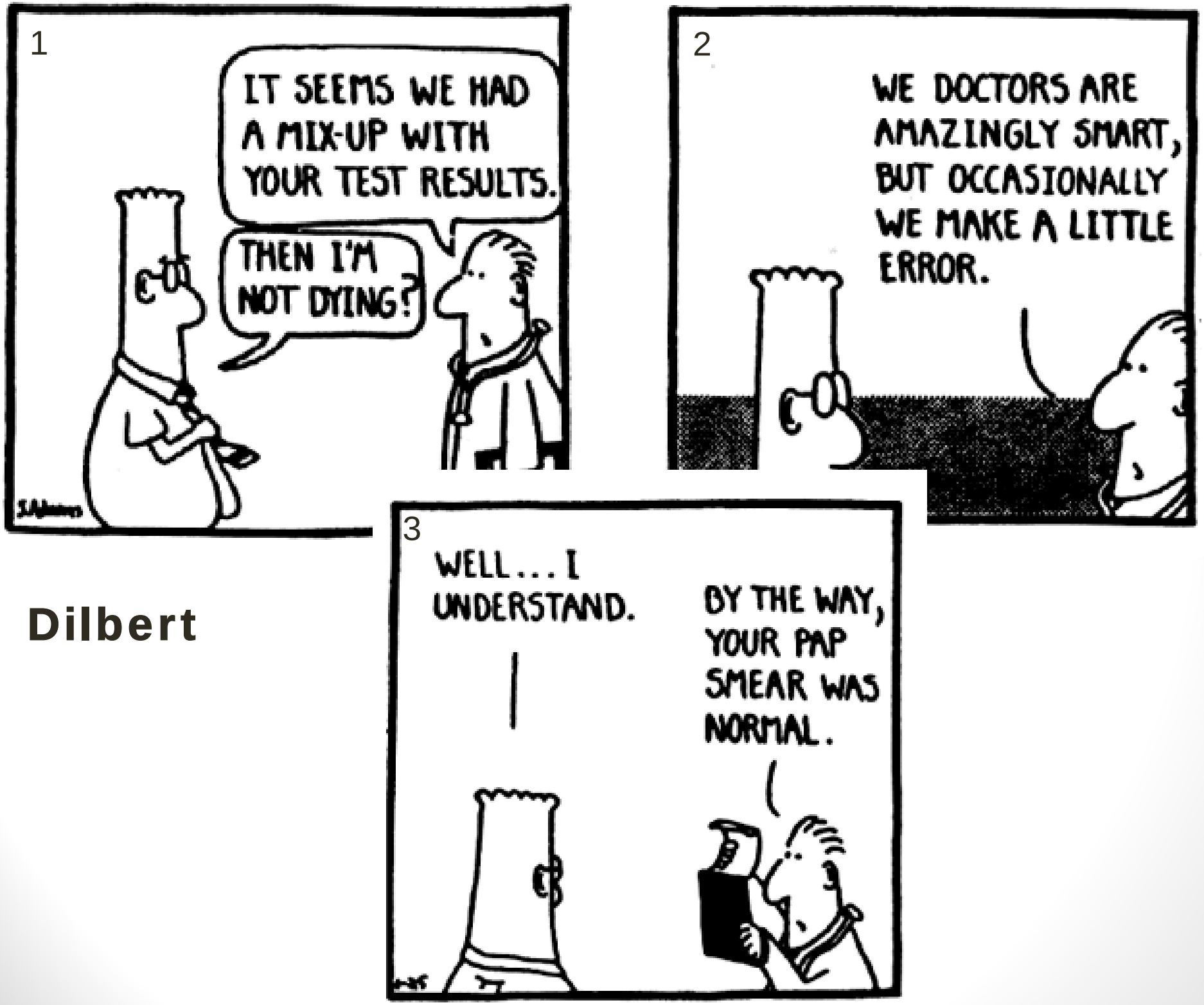
Health care in the United States is not as safe as it should be--and can be. At least 44,000 people, and perhaps as many as 98,000 people, die in hospitals each year as a result of medical errors that could have been prevented, according to estimates from two major studies. Even using the lower estimate, preventable medical errors in hospitals exceed attributable deaths to such feared threats as motor-vehicle wrecks, breast cancer, and AIDS.

Medical errors can be defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. Among the problems that commonly occur during the course of providing health care are adverse drug events and improper transfusions, surgical injuries and wrong-site surgery, suicides, restraint-related injuries or death, falls, burns, pressure ulcers, and mistaken patient identities. High error rates with serious

Current State of Healthcare

- Care is complex
- Care is uncoordinated
- Information is often not available to those who need it when they need it
- As a result patients often do not get care they need or do get care they don’ t need

IOM, Crossing the Quality Chasm


1
IT SEEMS WE HAD A MIX-UP WITH YOUR TEST RESULTS.
THEN I'M NOT DYING?
2
WE DOCTORS ARE AMAZINGLY SMART, BUT OCCASIONALLY WE MAKE A LITTLE ERROR.
3
WELL... I UNDERSTAND.
BY THE WAY, YOUR PAP SMEAR WAS NORMAL.

Dilbert

Poor Quality

- 45% did NOT receive recommended care
  - Pneumonia → 61% X
  - Asthma → 47% X
  - Hypertension → 35% X

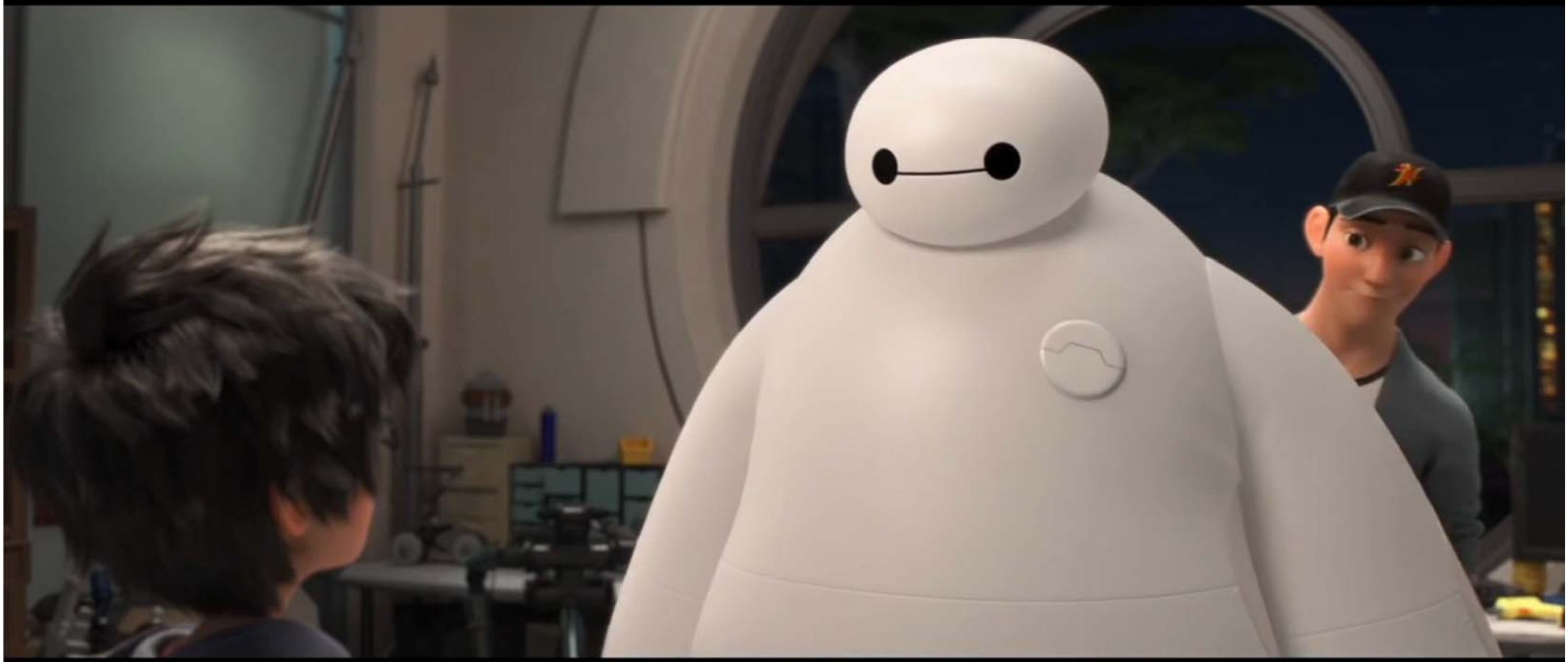
McGlynn et al., New England Journal of Medicine, 2003

About Medical Errors

- A leading cause of death
- More common than we thought
- A system problem
- Costly
- Preventable

Computers to the rescue?

- Never tired (especially on repetitive and boring jobs)
- Never forgets
- Always correct and superfast calculation
- 100% Compliant to orders



Artificial Intelligence (AI) can do

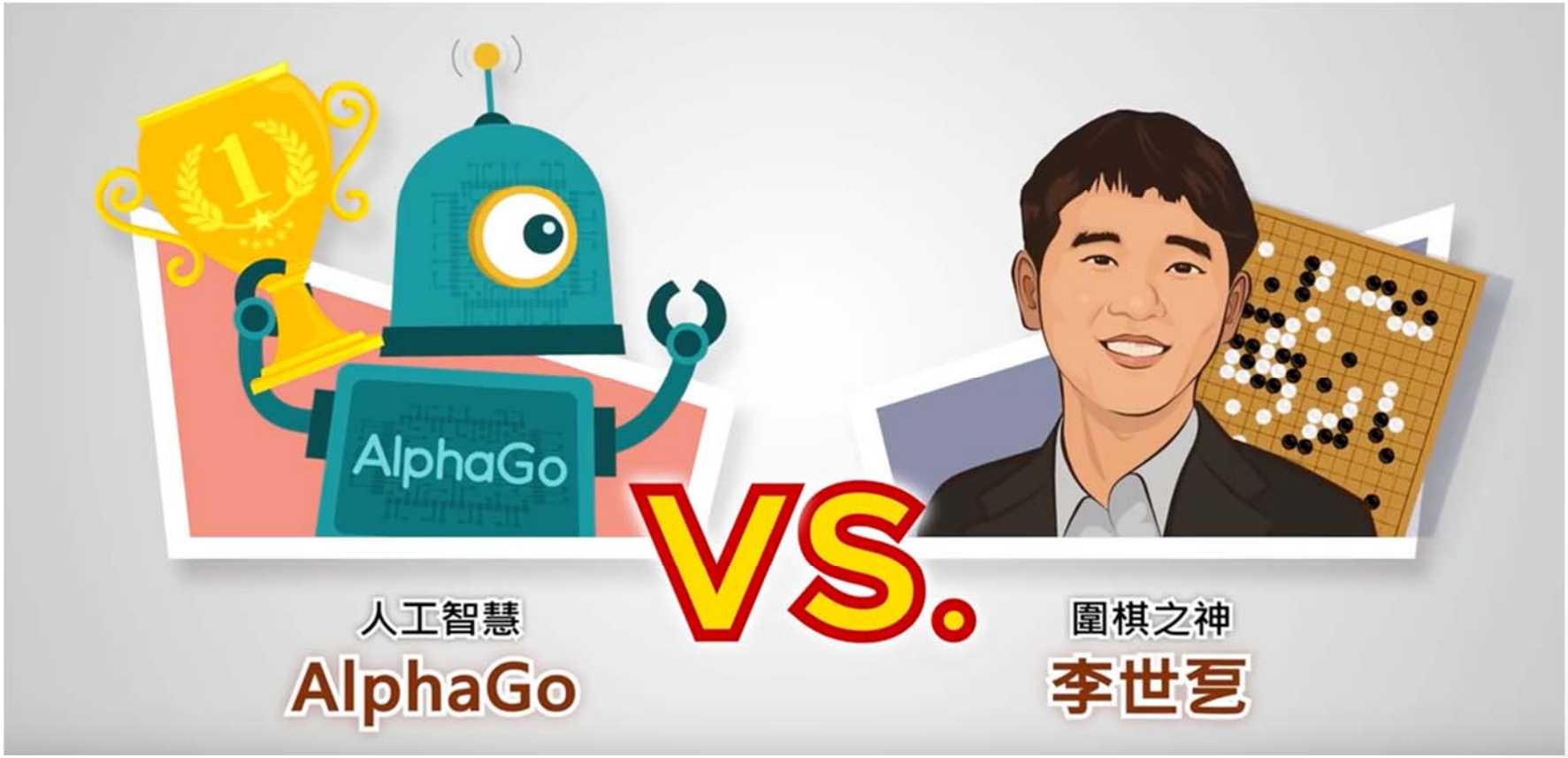
- All of the traditional computer characteristics, plus
  - Capable of decision analysis and support
  - Deal with ambiguity and approximation
  - Can learn new patterns
  - Can change internal parameters, data, knowledge or even programming code through learning

→Not 100% compliant to order

→Can lead to unexpected results

IBM Watson in the Jeopardy show 2011

Google AlphaGo vs Lee Sedo



Medical Knowledge
– from Simplicity to Complexity

Simple

- "Allergic to Penicillin" AND "Prescribe Penicillin"

  → STOP the prescription and alert the doctor

Complex

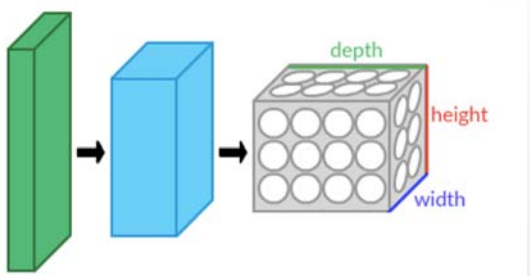
- What is this?

- "How to treat *chronic radiation fibrotic dermatitis*?"

  → based on textbook and journal reviews – 50% of the patients responded "Pentoxifylline + Tocopherol"

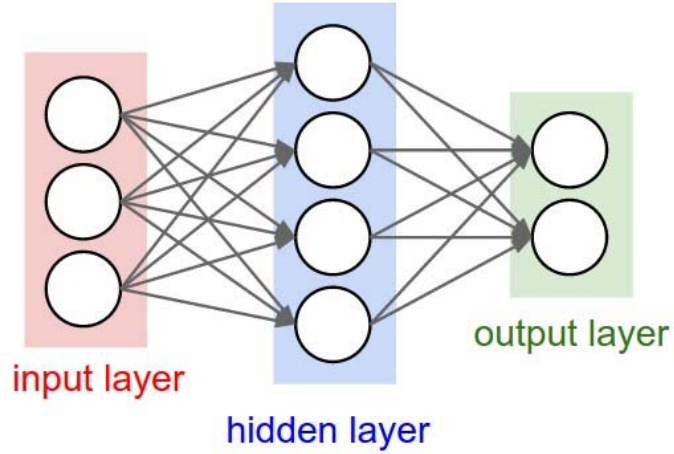
Artificial Intelligence
– from Simplicity to Complexity

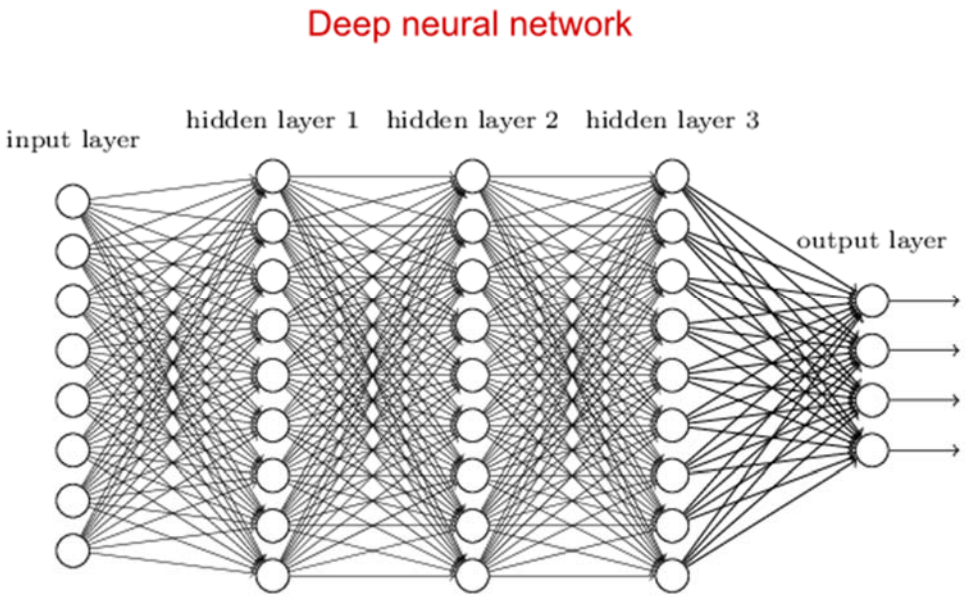
- Rule-based Inference
- Probabilistic Inference
- Statistical Modeling
- Ad Hoc scores
- Machine Learning
  - Neural Networks (類神經網路)
  - Support-Vector Machine…etc.
  - Deep Learning (深度學習)
    - Deep Neural Networks
    - Deep Convolutional Neural Networks (DCNN)
    - Recurrent Neural Networks



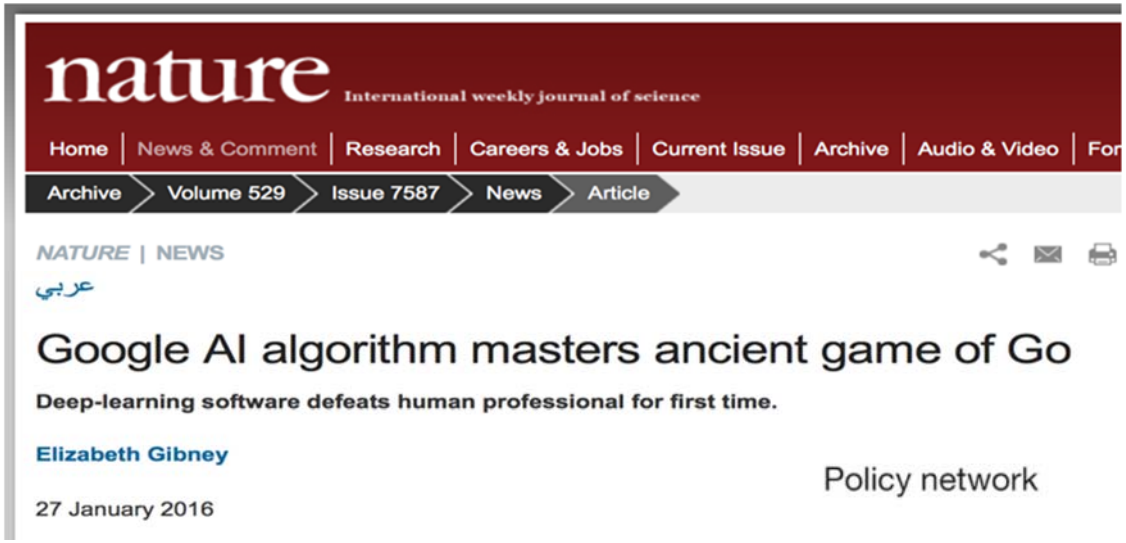
Artificial Neural Networks

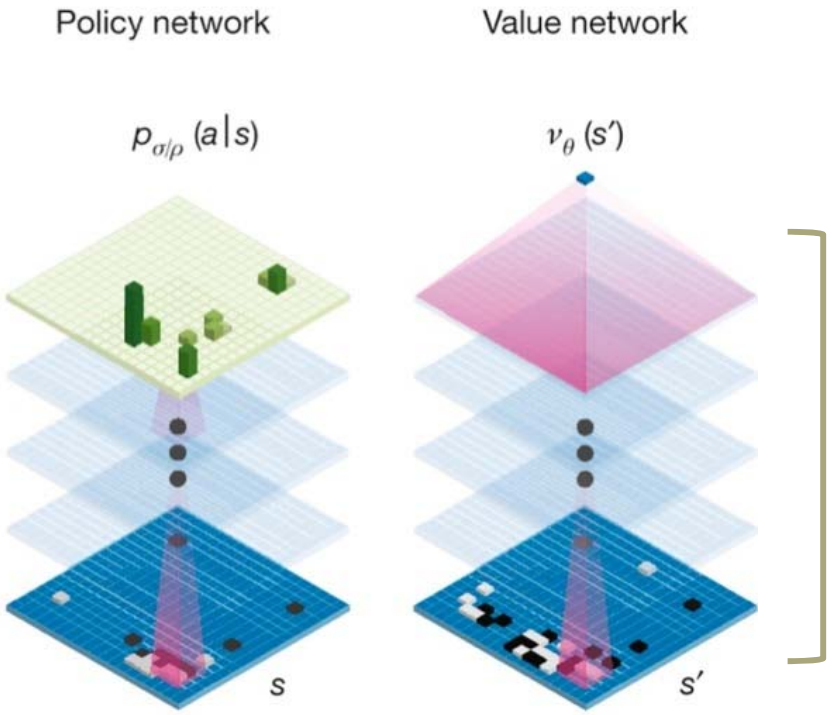
- A main stream method for Machine Learning
- Deep Learning
  - Deep Neural Networks
  - Deep Convolutional Neural Networks (DCNN)…



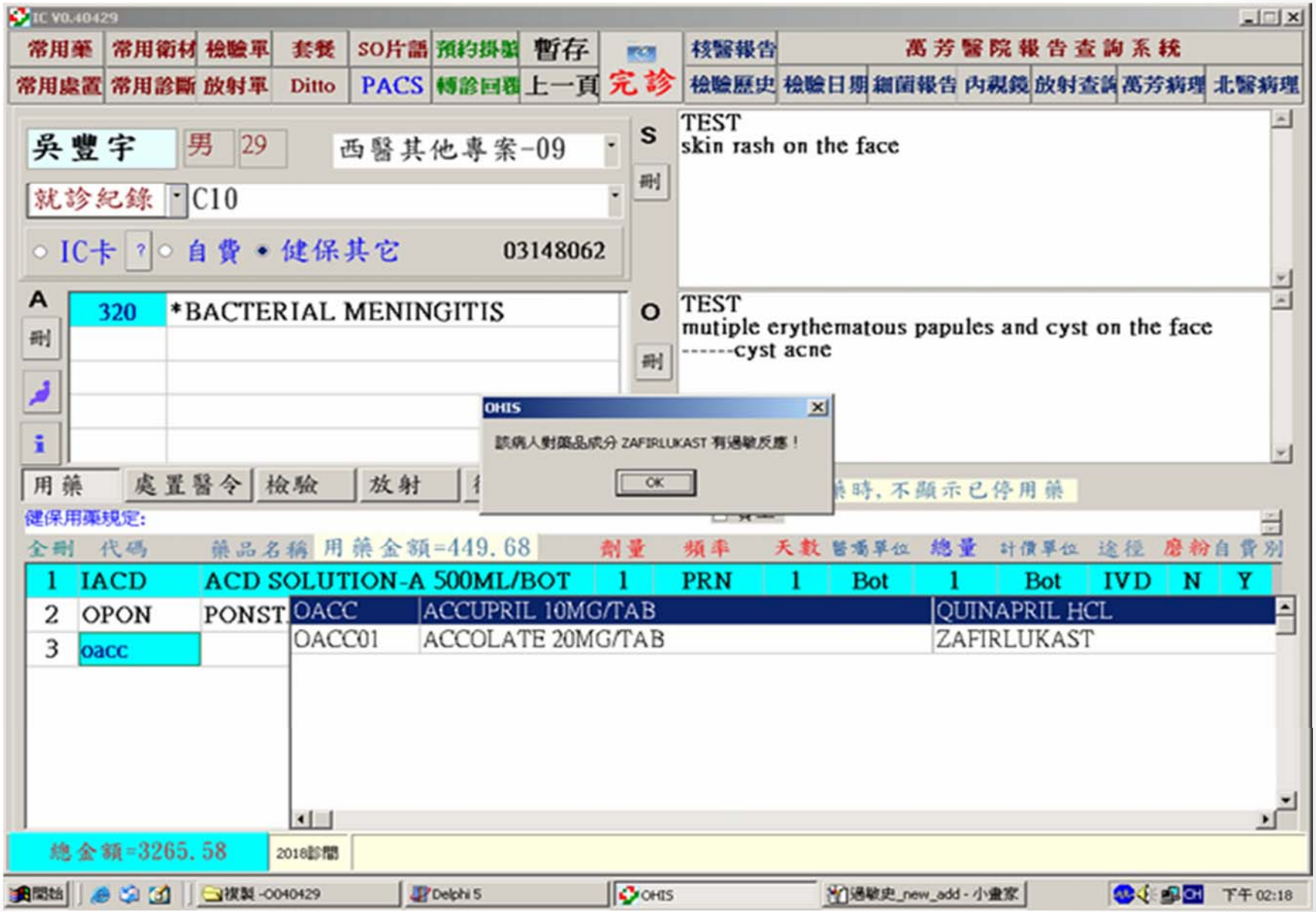


AlphaGo Architecture from Google DeepMind

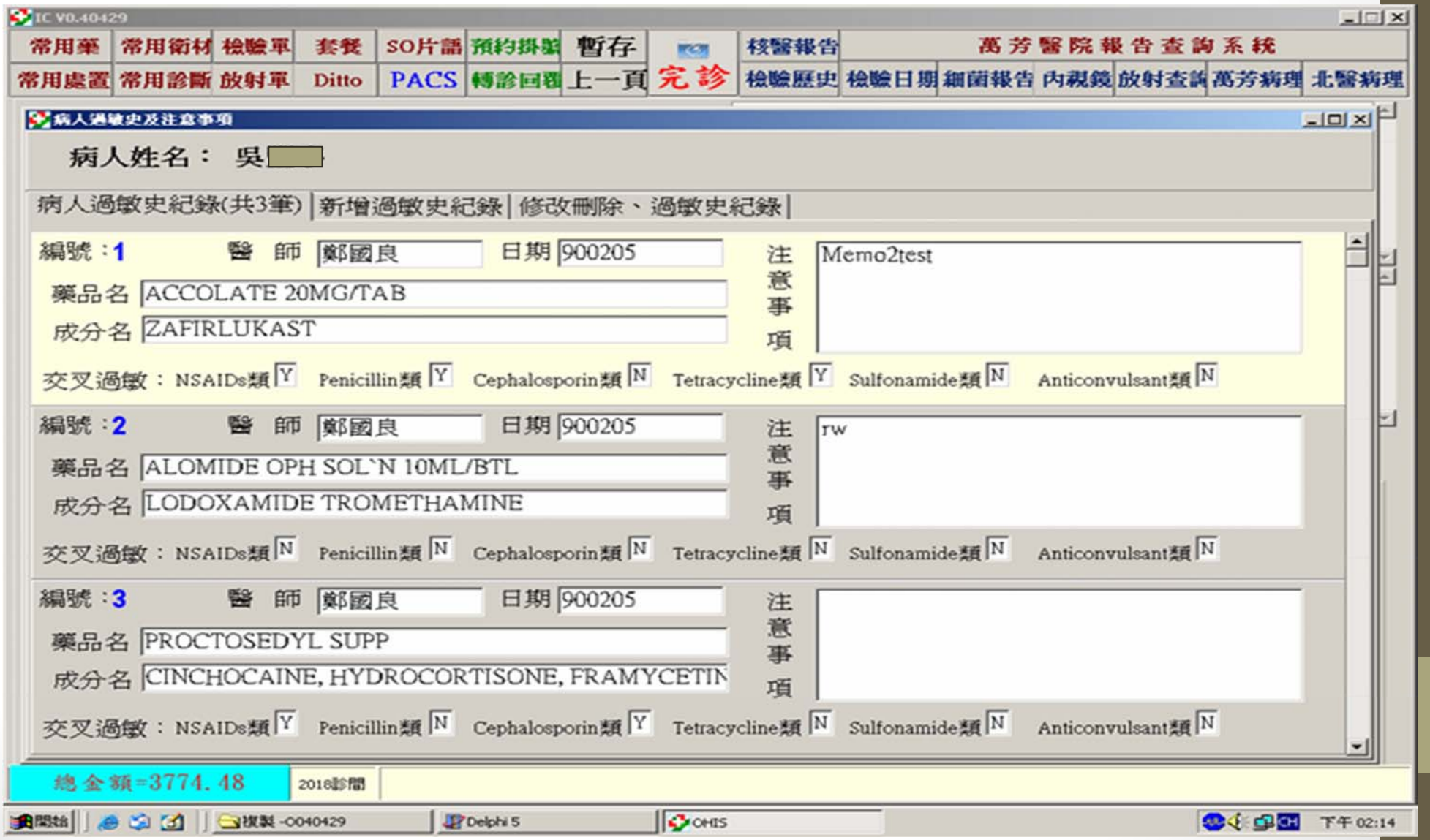




Drug Allergy Alerts



Cross Drug Allergy Alerts



Advanced Electronic Safety of Prescriptions (AESOP) System

⚠ Drug-Diagnosis Reminder

Under the diagnoses of "X", "Y", "Z", it is uncommon to prescribe the following drugs:

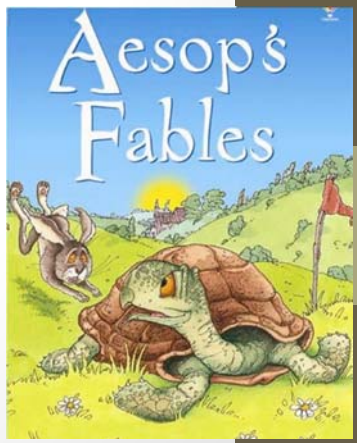
*) Medication 1…

*) Medication 2…

Do you want to modify your order?

YES NO

After AESOP analyzed 100 million prescriptions, it is capable of determine whether a prescription is correct up to an accuracy of 95%.



The Beginning of “The END”?

BBC Sign in News Sport Weather Sho

NEWS

Home Video World Asia UK Business Tech Science

Stephen Hawking: 'AI could spell end of the human race'

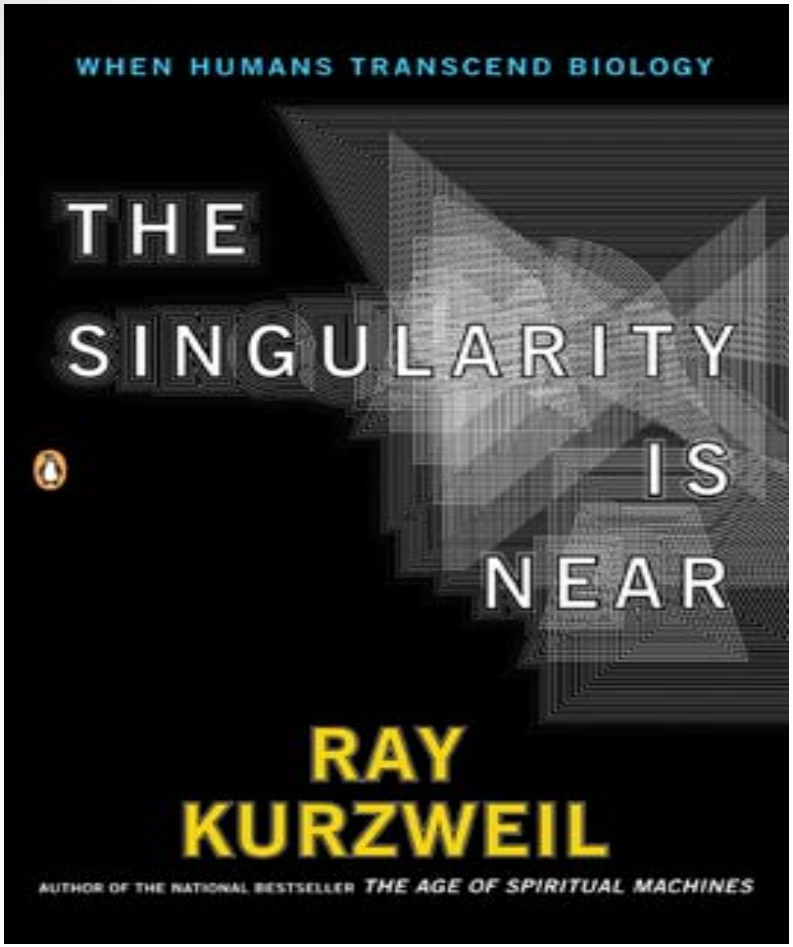
2 December 2014 Last updated at 15:28 GMT

Professor Stephen Hawking has told the BBC that artificial intelligence could spell the end for the human race.

In an interview after the launch of a new software system designed to help him communicate more easily, he said there were many benefits to new technology but also some risks.

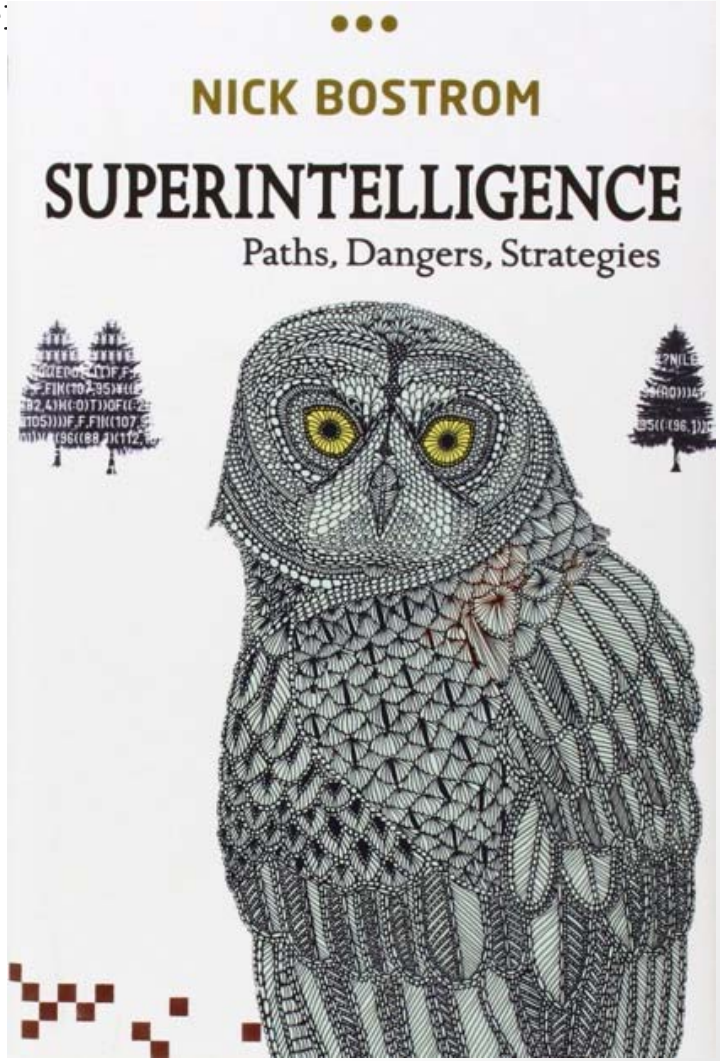
Superintelligence

"any intellect that greatly exceed the cognitive performance of humans in virtually all domains of interest."

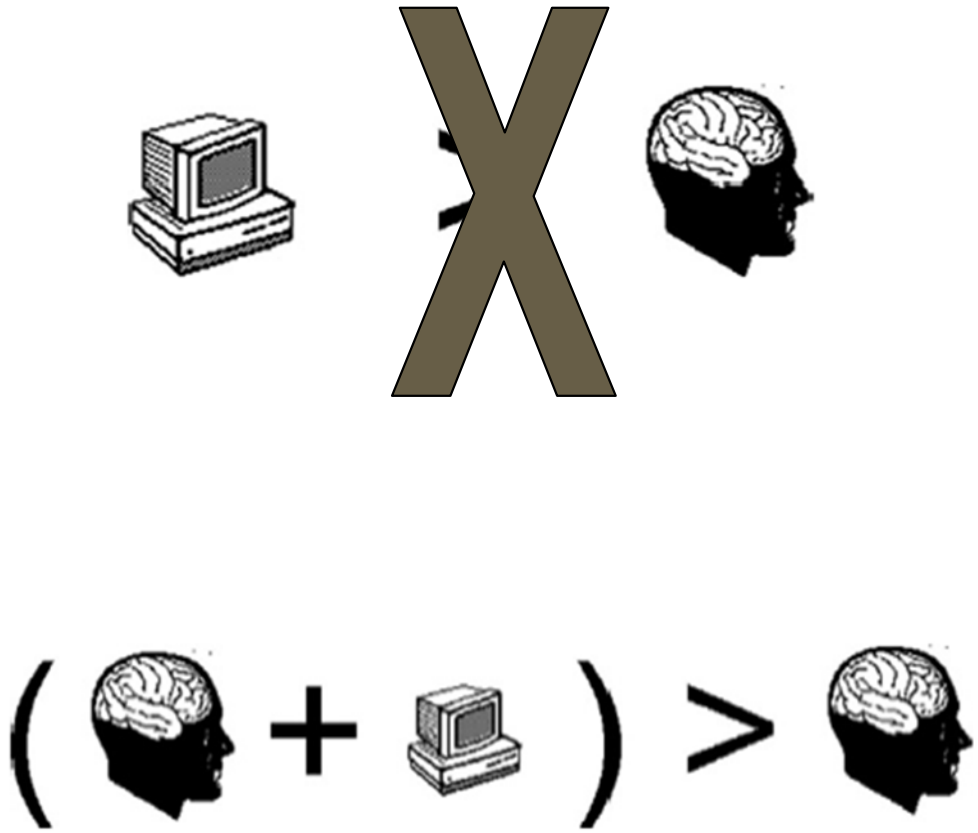


2045: Singularity

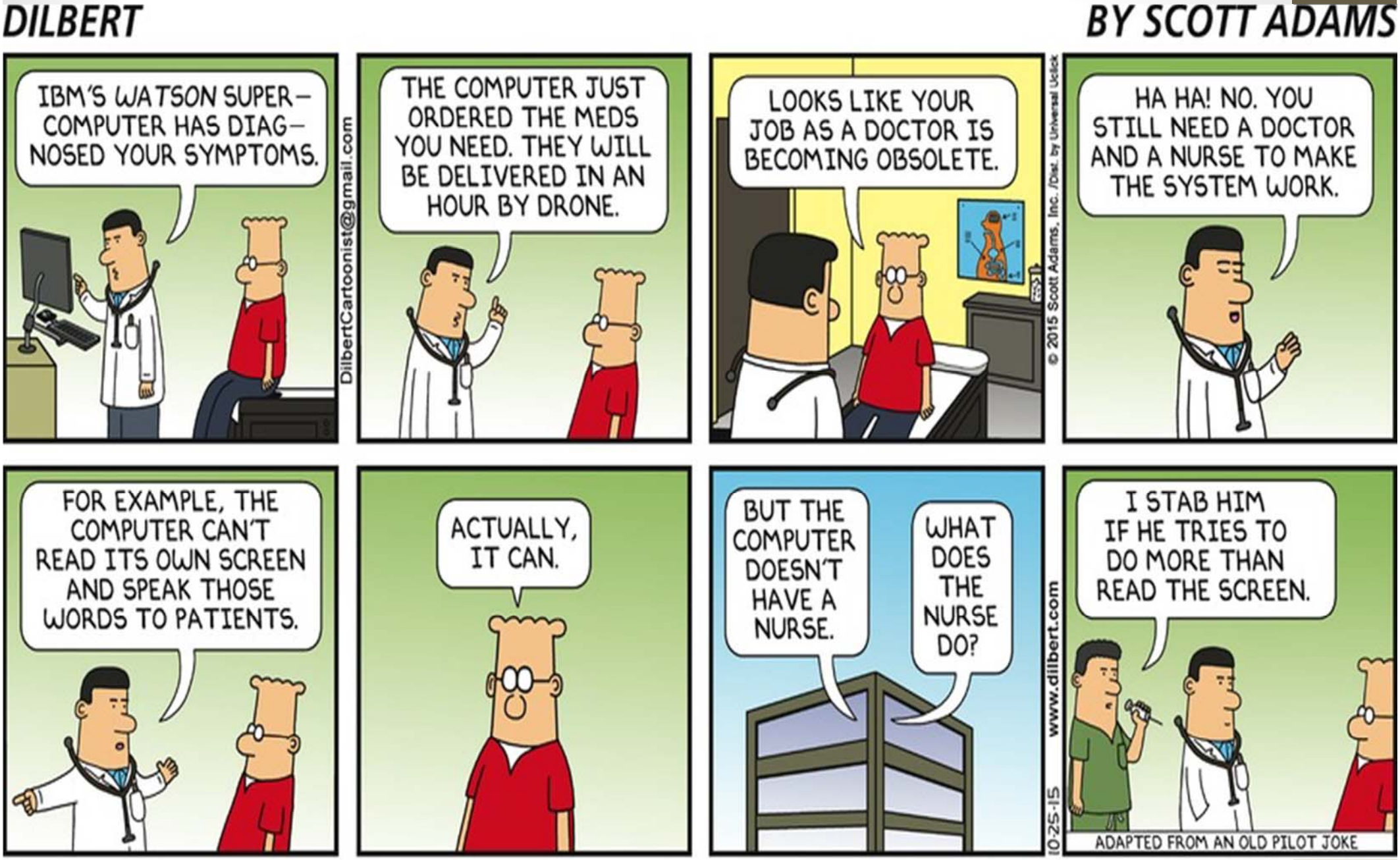
- $1,000 USD can buy computers with the capacity of billion brains
- When AI surpasses human intellige



AI and Medicine – for NOW



From: Charles P. Friedman. ***J Am Med Inform Assoc.*** *2009;16:169 –170.*


DILBERT
BY SCOTT ADAMS
IBM'S WATSON SUPER-COMPUTER HAS DIAG-NOSED YOUR SYMPTOMS.
DilbertCartoonist@gmail.com
THE COMPUTER JUST ORDERED THE MEDS YOU NEED. THEY WILL BE DELIVERED IN AN HOUR BY DRONE.
LOOKS LIKE YOUR JOB AS A DOCTOR IS BECOMING OBSOLETE.
© 2015 Scott Adams, Inc. /Dist. by Universal Uclick
HA HA! NO. YOU STILL NEED A DOCTOR AND A NURSE TO MAKE THE SYSTEM WORK.
FOR EXAMPLE, THE COMPUTER CAN'T READ ITS OWN SCREEN AND SPEAK THOSE WORDS TO PATIENTS.
ACTUALLY, IT CAN.
BUT THE COMPUTER DOESN'T HAVE A NURSE.
WHAT DOES THE NURSE DO?
10-25-15
www.dilbert.com
I STAB HIM IF HE TRIES TO DO MORE THAN READ THE SCREEN.
ADAPTED FROM AN OLD PILOT JOKE

Current Problems

- The current “Smart hospitals” are mostly:
  - Me-too systems
  - Too many false positives (FP) it’s anti-productive
  - Unknown number of false negatives (FN)
  - Users lose faith and ignore even true positives (TP)
  - NOT smart at all
- The real cost of not-so-smart reminder systems is ignored
- No central intelligence, only fragmented, on-demand alerts and pop-ups.

Conclusion

- We need infuse more intelligence into healthcare systems – artificial or natural
- Traditional computers have helped tremendously in medicine and healthcare
  - It's time for AI to pick up the baton
  - IoT → Big Data → Artificial Intelligence
- Big Data + Artificial Intelligence = Big Data Intelligence (BDI)
- Quality and Patient Safety (QPS) will benefit immensely from BDI

對台灣醫療人權的肯定！世界醫師會宣布「台北宣言」

記者李鴻典 / 台北報導

世界醫師會大會在22日通過「台北宣言」（Declaration of Taipei），內容是對於health databases 及 biobanks 的倫理規範。醫師公會全聯會難掩興奮之情在臉書發文，「這是這次大會重大的決定，也是很多年努力研討的成果。同時也讓『台北』留名醫學史，就像日內瓦、赫爾辛基...一樣。主席 Dr. Hoven宣佈的那一刻，令人興奮和感動！！」

民進黨籍立委、醫師公會全聯會理事長邱泰源表示，此宣言效力就與《赫爾辛基宣言》、《日內瓦宣言》一樣重要，能選在台北順利通過，是對台灣醫療人權的肯定。

WMA Declaration of Taipei on Ethical Considerations regarding Health Databases and Biobanks

Adopted by the 53rd WMA General Assembly, Washington, DC, USA, October 2002

and revised by the 67th WMA General Assembly, Taipei, Taiwan, October 2016

PREAMBLE

1. The Declaration of Helsinki lays down ethical principles for medical research involving human subjects, including the importance of protecting the dignity, autonomy, privacy and confidentiality of research subjects, and obtaining informed consent for using identifiable human biological material and data.

2. In health care provision, health information is gathered by physicians or other members of the medical team to record health care events and to aid physicians in the on-going care of their patient.

3. This Declaration is intended to cover the collection, storage and use of identifiable data and biological material beyond the individual care of patients. In concordance with the Declaration of Helsinki, it provides additional ethical principles for their use in Health Databases and Biobanks.

This Declaration should be read as a whole and each of its constituent paragraphs should be applied with consideration of all other relevant paragraphs.

4. A Health Database is a system for collecting, organizing and storing health information. A Biobank is a collection of biological material and associated data. Biological material refers to a sample obtained from an individual human being, living or deceased, which can provide biological information, including genetic information, about that individual. Health Databases and Biobanks are both collections on individuals and population, and both give rise to the similar concerns about dignity, autonomy, privacy, confidentiality and discrimination.

5. Research using Health Databases and Biobanks can often significantly accelerate the improvement in the understanding of health, diseases, and the effectiveness, efficiency, safety and quality of preventive, diagnostic and therapeutic interventions. Health research represents a common good that is in the interest of individual patients, as well as the population and the society.

6. Physicians must consider the ethical, legal and regulatory norms and standards for Health Database

Thank you for your attention