

# Biomedical Informatics and Rebellion



Brian E. Chapman, Ph.D.

University of Utah

# Freeman Dyson

- Born 1923
- 1945
  - BA Cambridge
- 1951
  - Faculty Cornell
- 1953-present
  - Institute for Advanced Study
- One of the 20<sup>th</sup> Century's most important physicist and provocateur

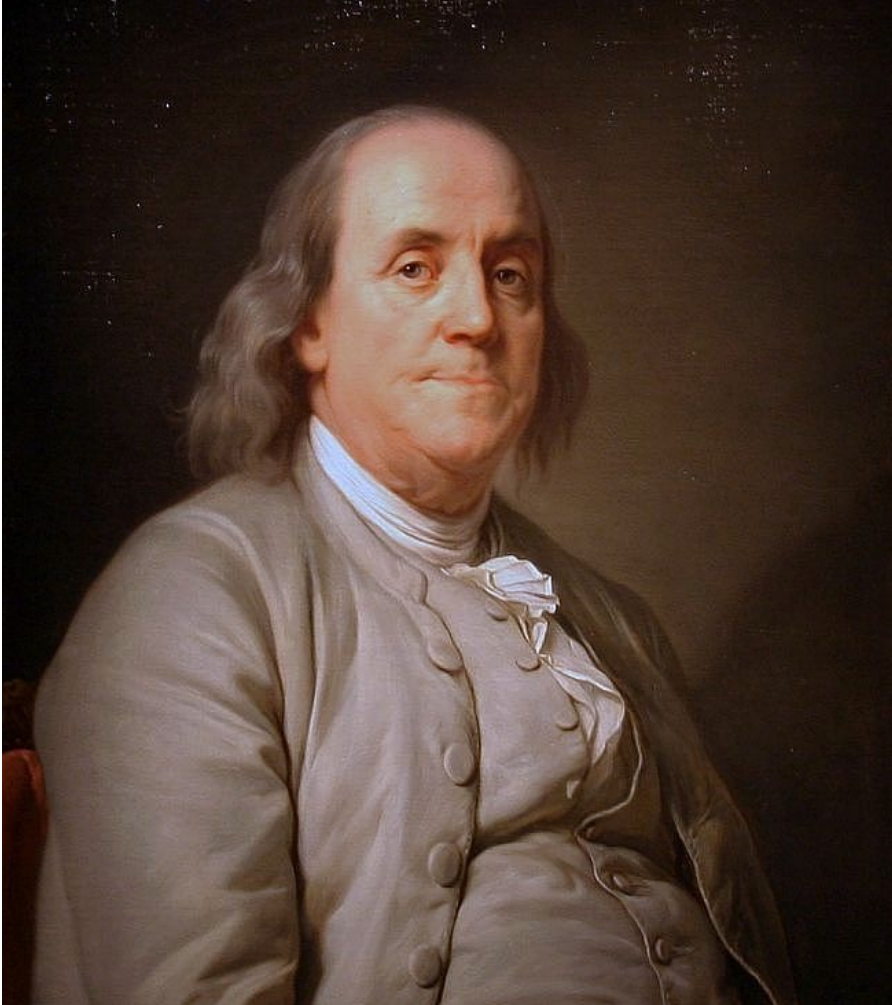


# Dyson on Franklin



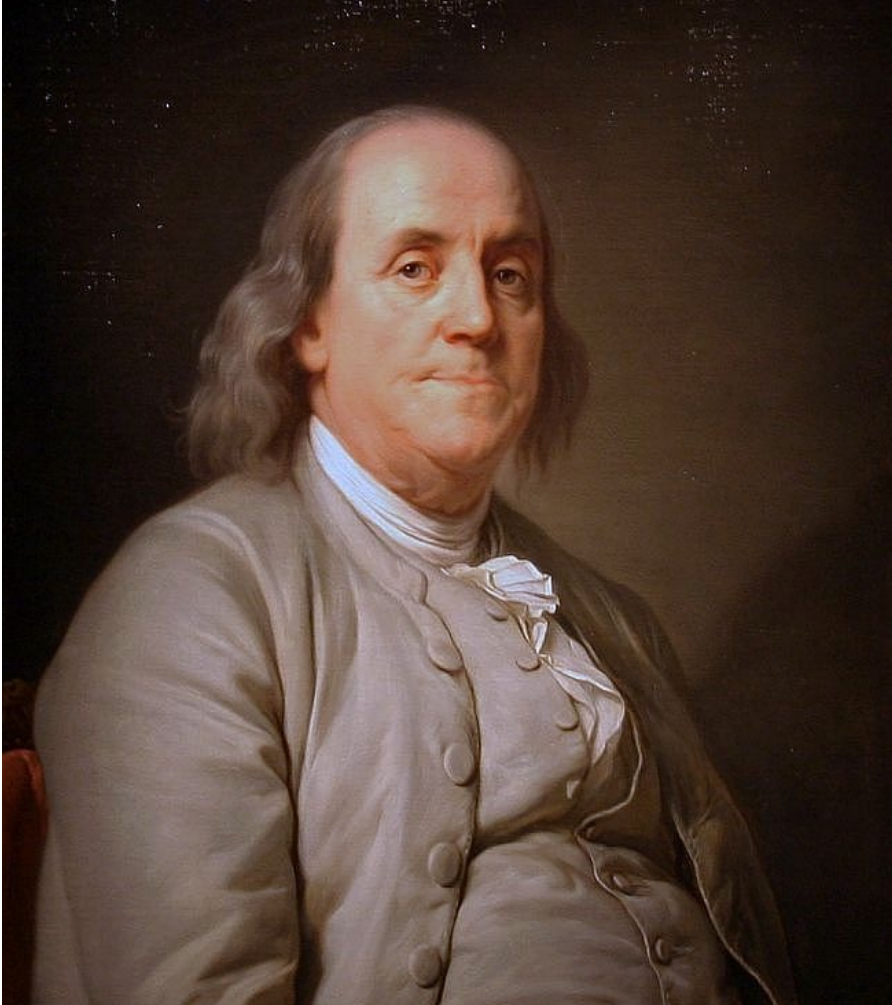
“Benjamin Franklin combined better than anyone else the qualities of a great scientist and a great rebel. As a scientist, without formal education or inherited wealth, he beat the learned aristocrats of Europe at their own game.” (ix)

# Dyson on Franklin



“Franklin’s triumph as a rebel resulted from the fact that his rebellion was not impulsive but was carefully thought out over many years.” (ix)

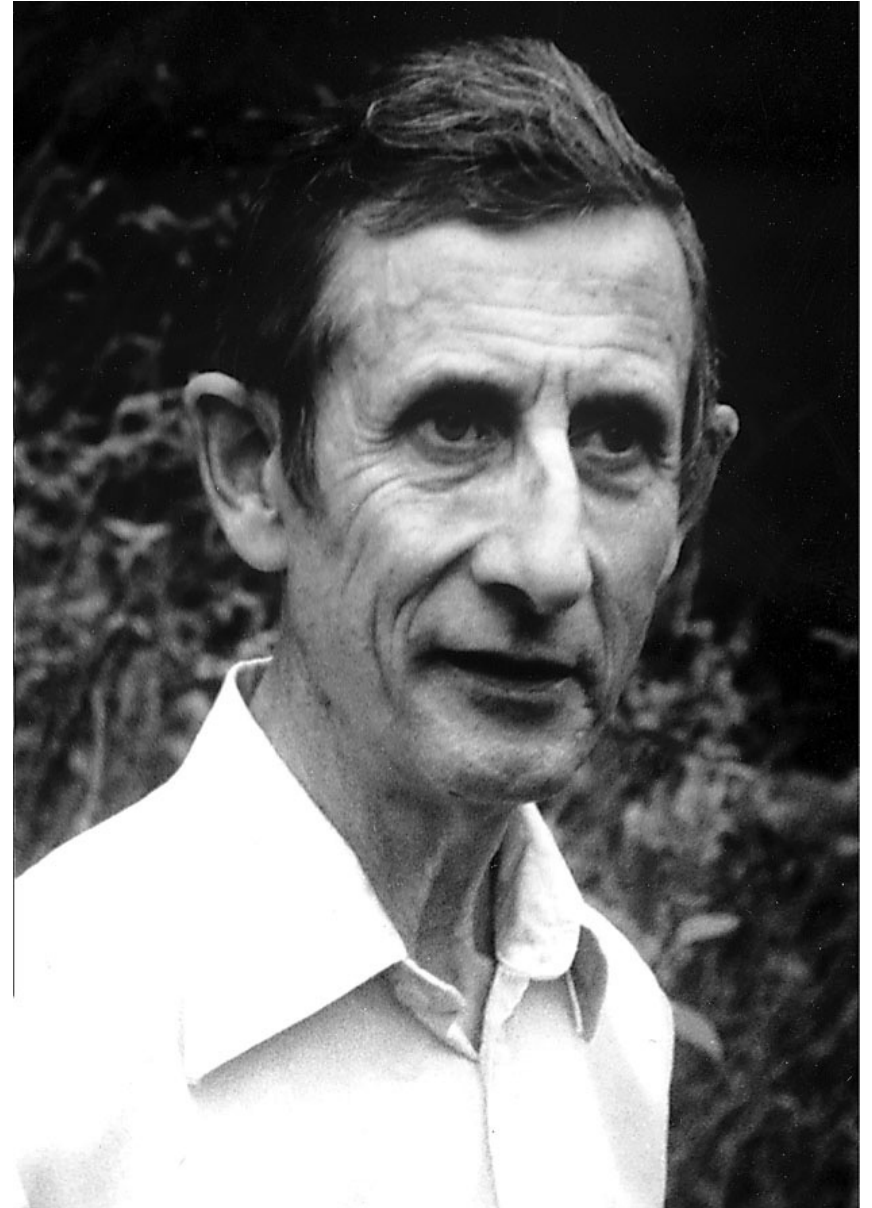
# Dyson on Franklin



“Franklin became a rebel only when he judged the **time to be ripe and the costs to be acceptable.** As a rebel he remained a conservative, aiming not to destroy but to preserve as much as possible of the established order of society.” (x)

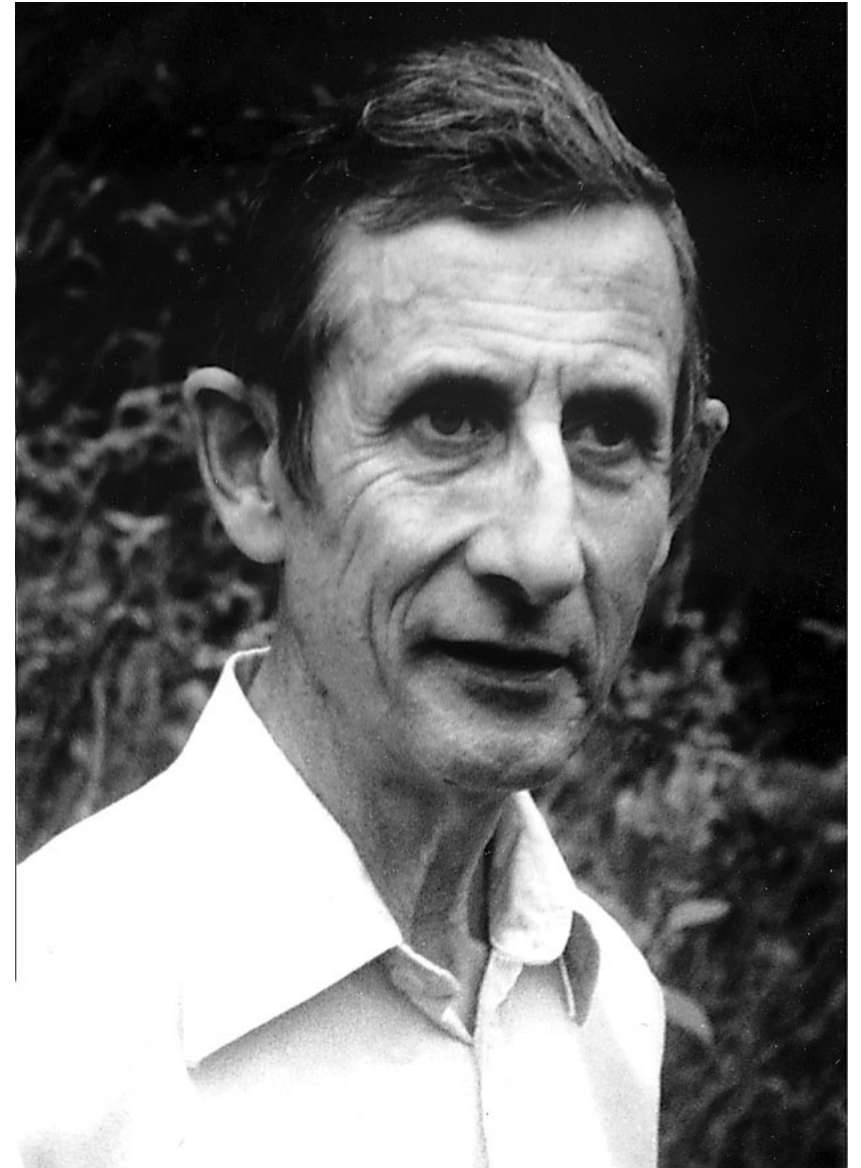
# Science as Rebellion

“Science is an alliance of free spirits in all cultures rebelling against the local tyranny that each culture imposes on its children.” (4)

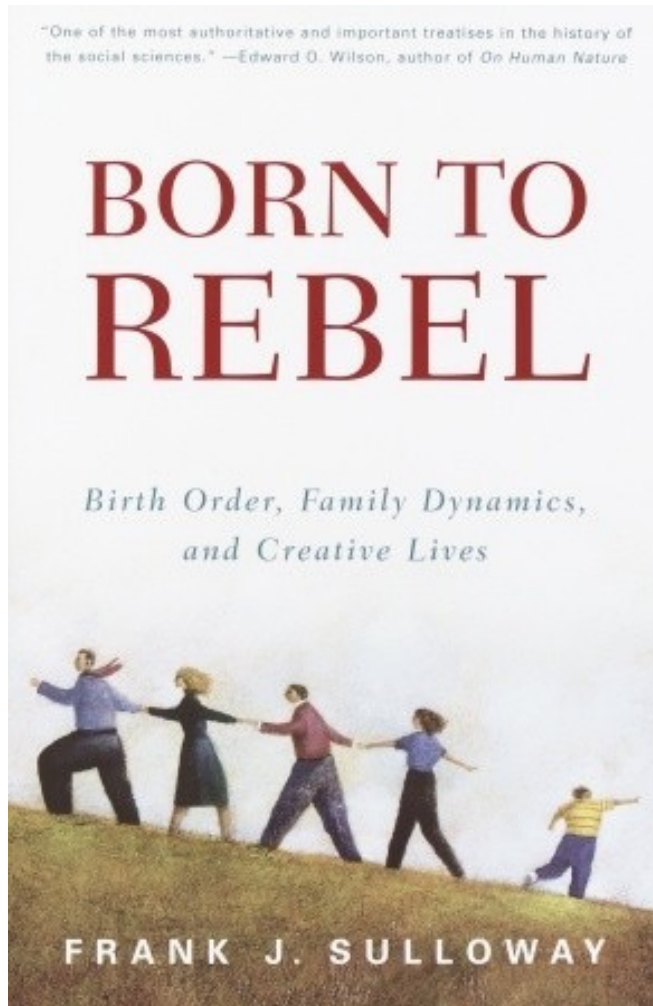


# Science as Rebellion

“If science ceases to be a rebellion against authority, then it does not deserve the talents of our brightest children.” (7)



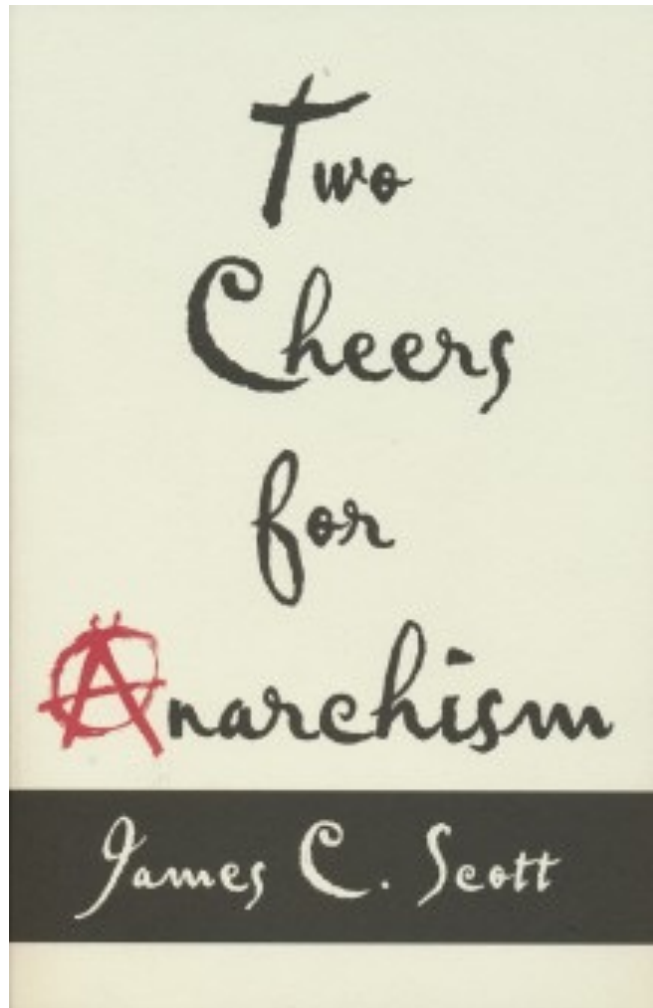
# Who are Revolutionaries?



- No “first born” ever led a major revolution
  - “First born” benefits from the system
- Who benefits from status quo of medical system?



# Are Revolutions Dangerous?



- “It dawned on me...that virtually every major successful revolution ended by creating a state more powerful than the one it overthrew, a state that in turn was able to extract more resources from and exercise more control over the very populations it was designed to serve.”

# Theses

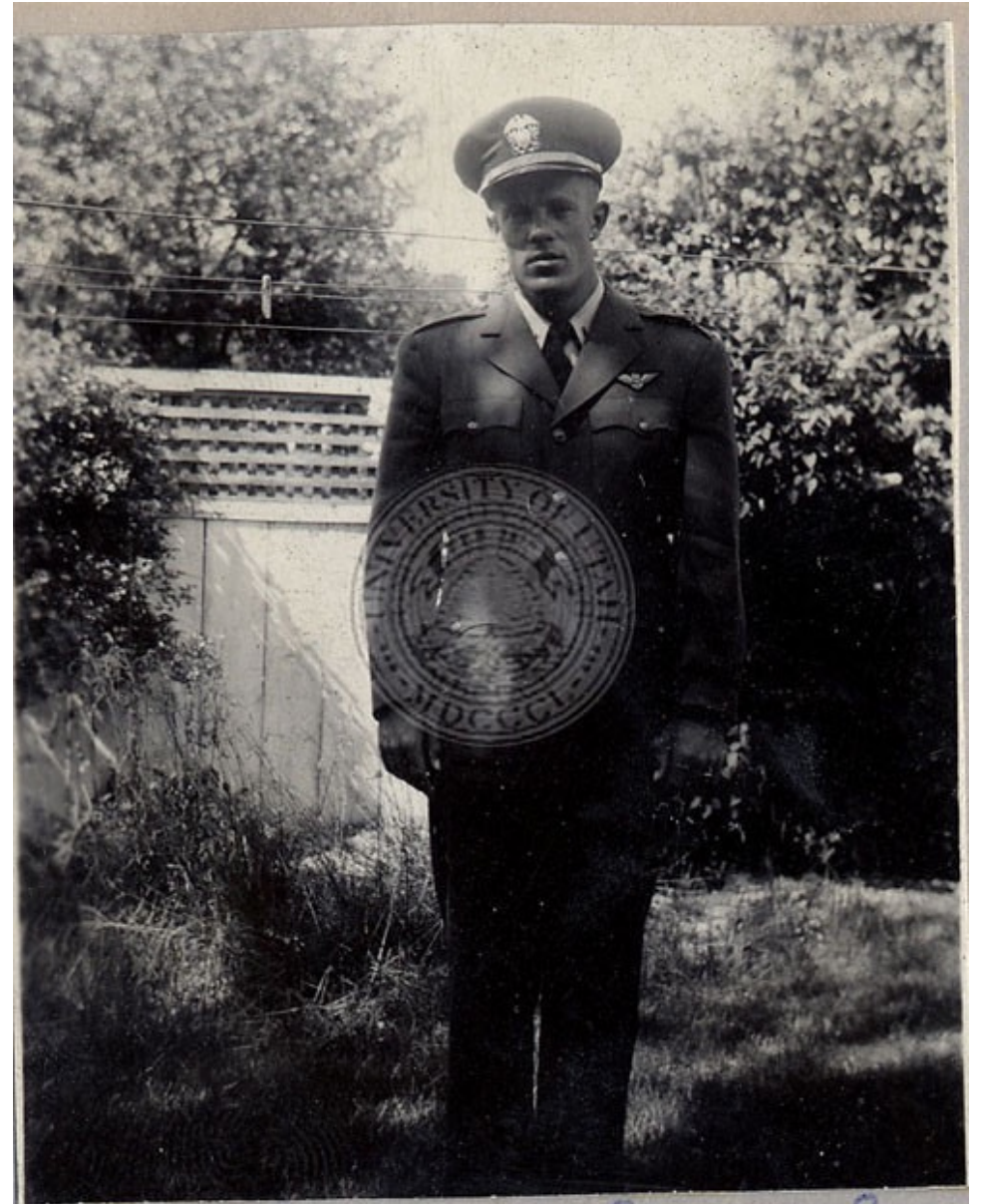
- Biomedical Informatics is a rebellion against the status quo of the health care system
- Regarding
  - Who has information
  - How the information is used
  - What information is used
- Revolutions have instruments and ideologies
  - Computers
  - Instrumentation
- Revolutions have a variety of revolutionaries
  - And opponents

# Theses

- “Successful” revolutions become the status quo requiring in turn a new rebellion

# Informatics Rebel #1: Homer Warner

- Prominent Salt Lake City, Utah, Family
  - Brother car dealer
  - Sister poet and essayist
- University of Utah
  - Football and Zoology
- Navy WWII
- Postwar Medical School



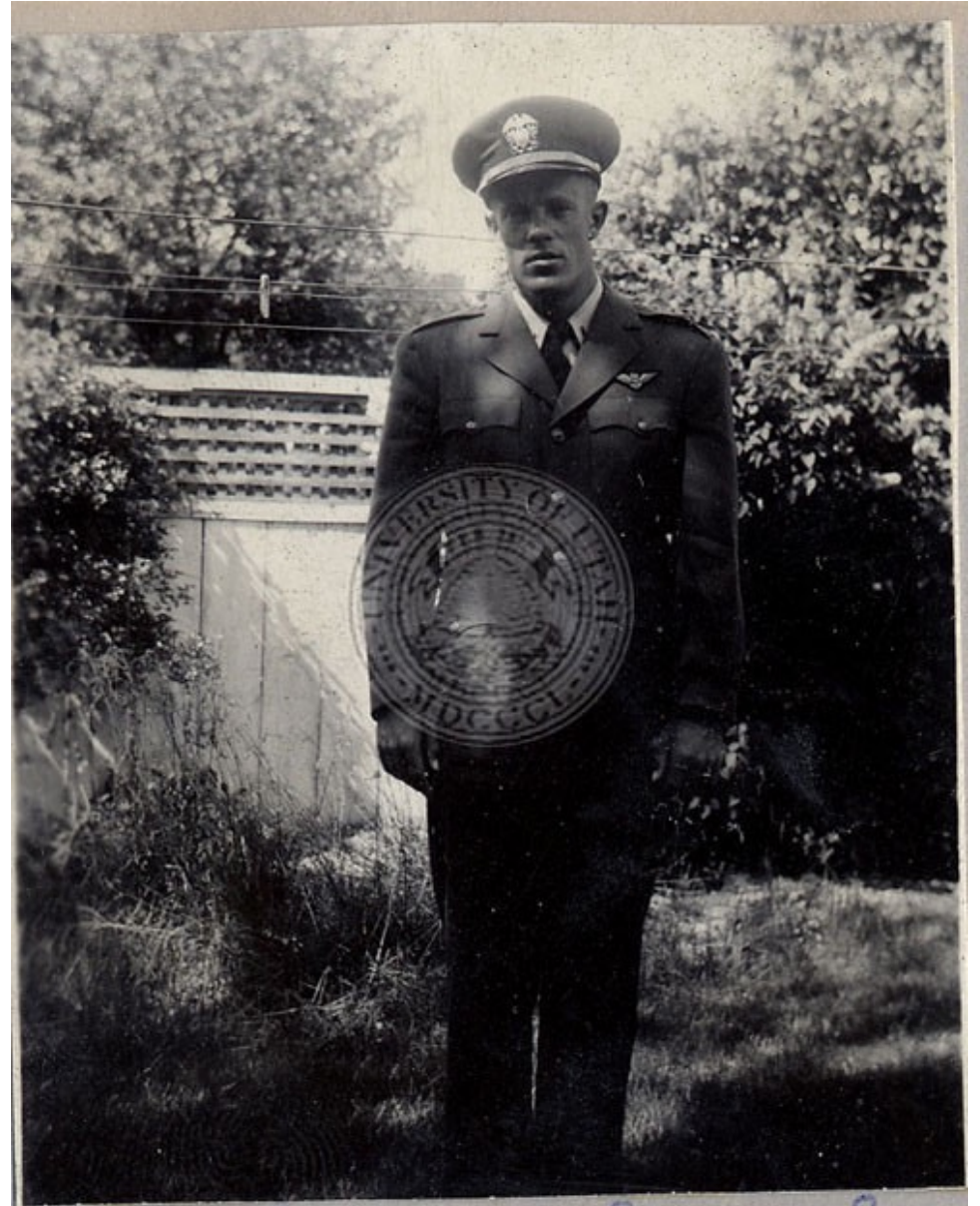
# Rebel #1: Homer R. Warner

- 1950 Started Residency
- 1953 PhD in physiology  
University of Minnesota
- 1954 founded  
Cardiovascular Lab at  
LDS Hospital in Salt Lake  
City, UT



# Rebel #1: Homer Warner

- Very apple-pie American life
- So where does the rebellion come in?



# Rebel #1: Homer Warner

- “When I finished medical school I **thought** I knew everything....”
- “But when I finished my internship I **realized** I didn’t know anything...”
- “And I didn’t want to be in that state.”



My paraphrases from a talk Dr. Warner gave while I was in graduate school.

# Warner: Quantification

- Began with using analog computers to interpret/analyze cardiac pressure waveforms
  - Quantify!
- Still recognizing his ignorance
  - Studied engineering math
- In 1960 University of Utah gets first digital computer
  - “How can I justify learning how to program?”





# Warner: Initial Informatics Efforts

- Model diagnostic process
  - Bayesian diagnosis of congenital heart problems
  - Published in JAMA 1961
  - First paper describing computer-aided decision support with real patient data
- Expanded to computer-aided diagnosis, computer-aided learning



# Rebel #1: Homer R. Warner

“One day Warner went down to visit the ICU and there was a nurse over one of the beds pumping up a blood pressure cuff on the left arm of a patient who had a catheter in the artery on the right arm to monitor the pressure.



# Rebel #1: Homer R. Warner

“There was a yellow light on the panel. The nurse was embarrassed when she saw him watching her and explained she didn’t know what to do next.



# Rebel #1: Homer R. Warner

“They sat down at the computer terminal and looked at all the data both in the computer and in the chart.



# Rebel #1: Homer R. Warner

“They called the resident and jointly decided that the patient probably was having a cardiac tamponade.



# Rebel #1: Homer R. Warner

“They called the surgeon who promptly took the patient back to the operating room.



# Rebel #1: Homer R. Warner

“This experience was another important turning point in Warner’s approach to the application of computers to medicine.



# Rebel #1: Homer R. Warner

“It was clear to him that just providing data and displaying it in a variety of ways may not be an adequate solution to the decision-making problem.





# Rebel #1: Homer R. Warner

“This nurse clearly needed help in the interpretation of the data and that interpretation required more data than just the hemodynamic measurements in the computer....



# Rebel #1: Homer R. Warner

“ [M]ost of all it required that the computer have some medical knowledge. They needed to build some intelligence into the system.” (Clayton, 1995)

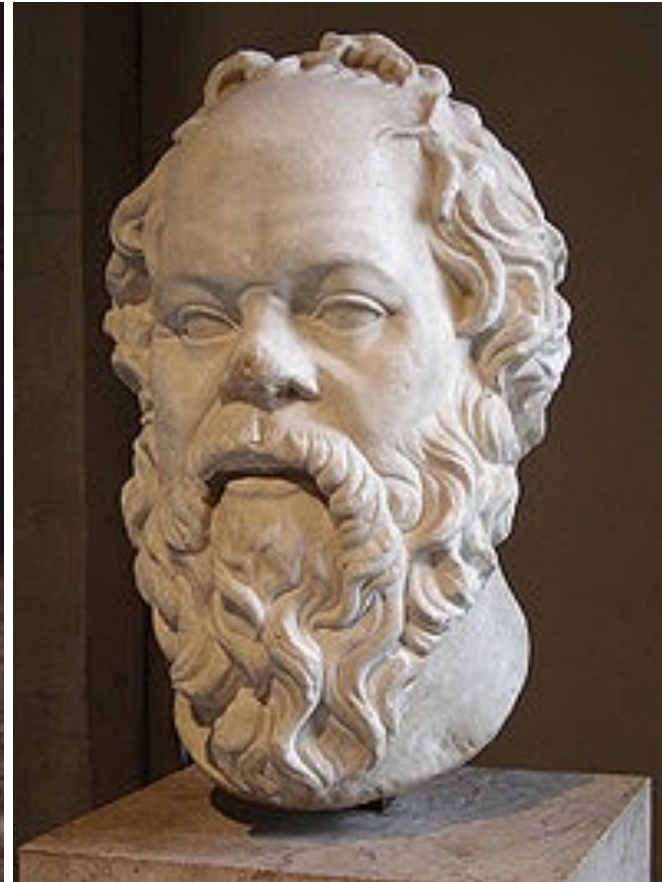
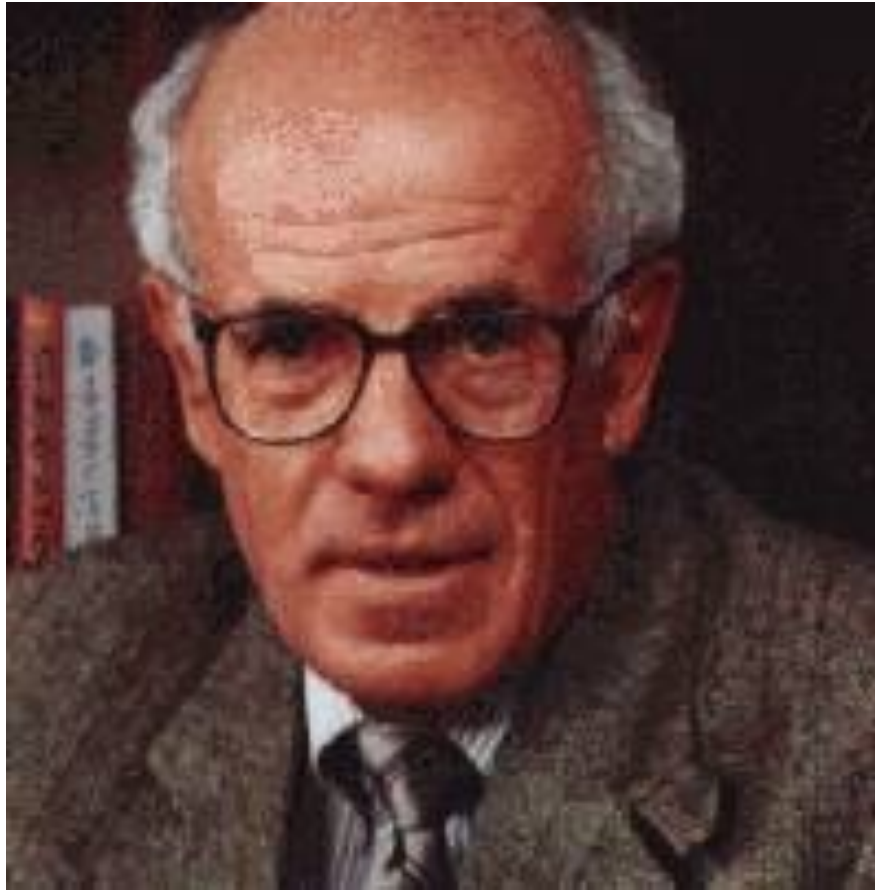


# Rebel #1: Homer R. Warner

- Health Evaluation Through Logical Processing (HELP)
  - Create an electronic medical record explicitly to facilitate decision support
  - Still used 40+ years later
- The heresy of HELP
  - Warner generalized from his own ignorance to ignorance of others
  - Use computers to bring “expert” knowledge to “lower level” providers



# Homer and Socrates



“Well, although I do not suppose that either of us knows anything really beautiful and good, I am better off than he is, —for he knows nothing, and thinks that he knows; I neither know nor think that I know. In this latter particular, then, I seem to have slightly the advantage of him.” (Apology)

# Homer Warner: The Insider Rebel

- Working within academic medicine
  - Founding chair of Bioengineering->Biomedical Informatics at the University of Utah
  - Founding editor of Computers and Biomedical Research (now Journal of Biomedical Informatics)
- Is “rebel” an appropriate label?
  - Reed Gardner: “I didn’t ever see Homer as a rebel. Rather, I saw him as a forward thinking person who was willing to try about anything that was plausible.”

## Rebel #2: Larry Weed—The Outsider

“WHEN asked to summarise the significance of Larry Weed's work, Charles Safran, a professor at Harvard Medical School, recalls a story from medical history.”



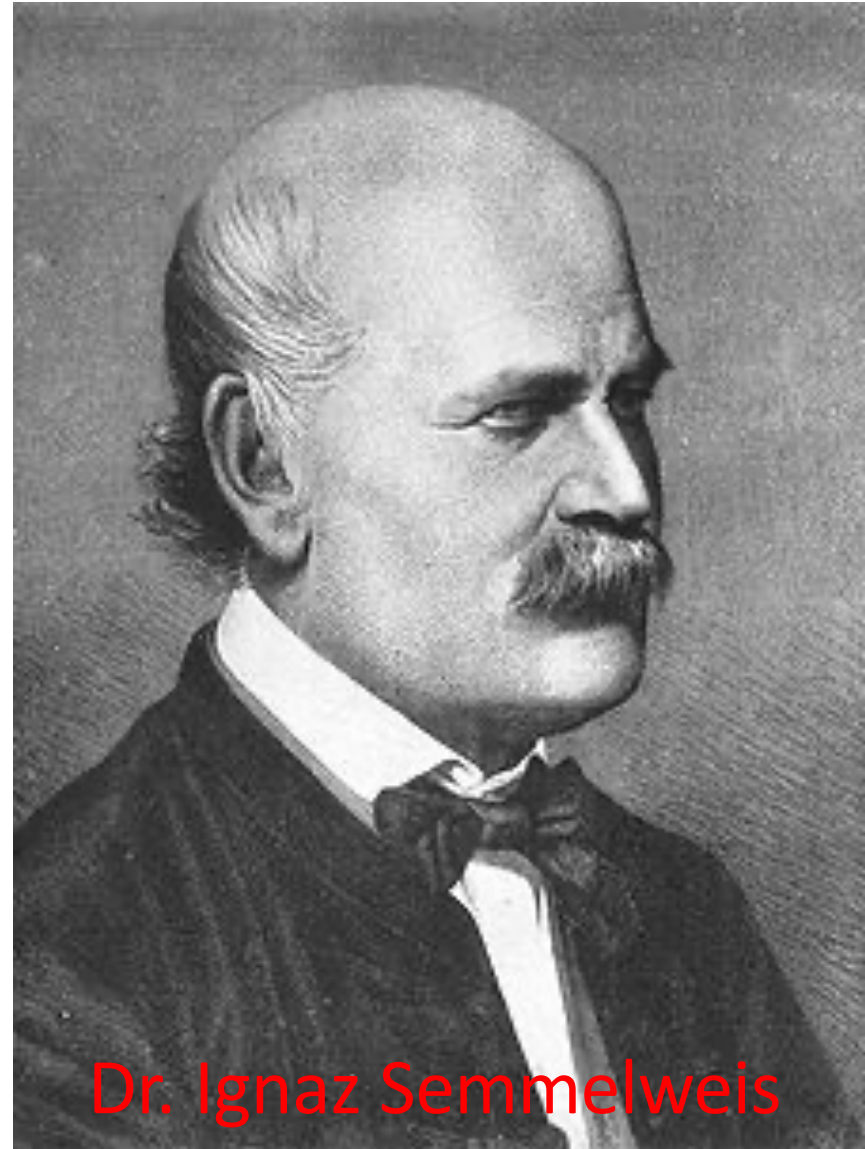
## Rebel #2: Larry Weed—The Outsider

“In the mid-19th century, the mortality rate from puerperal (or “childbed”) fever at Vienna General Hospital's maternity ward was so high that many women, it is said, preferred to give birth in the street.”



## Rebel #2: Larry Weed—The Outsider

“Then a doctor called Ignaz Semmelweis achieved a dramatic reduction in deaths by insisting that doctors wash their hands between autopsies and obstetrical examinations.”

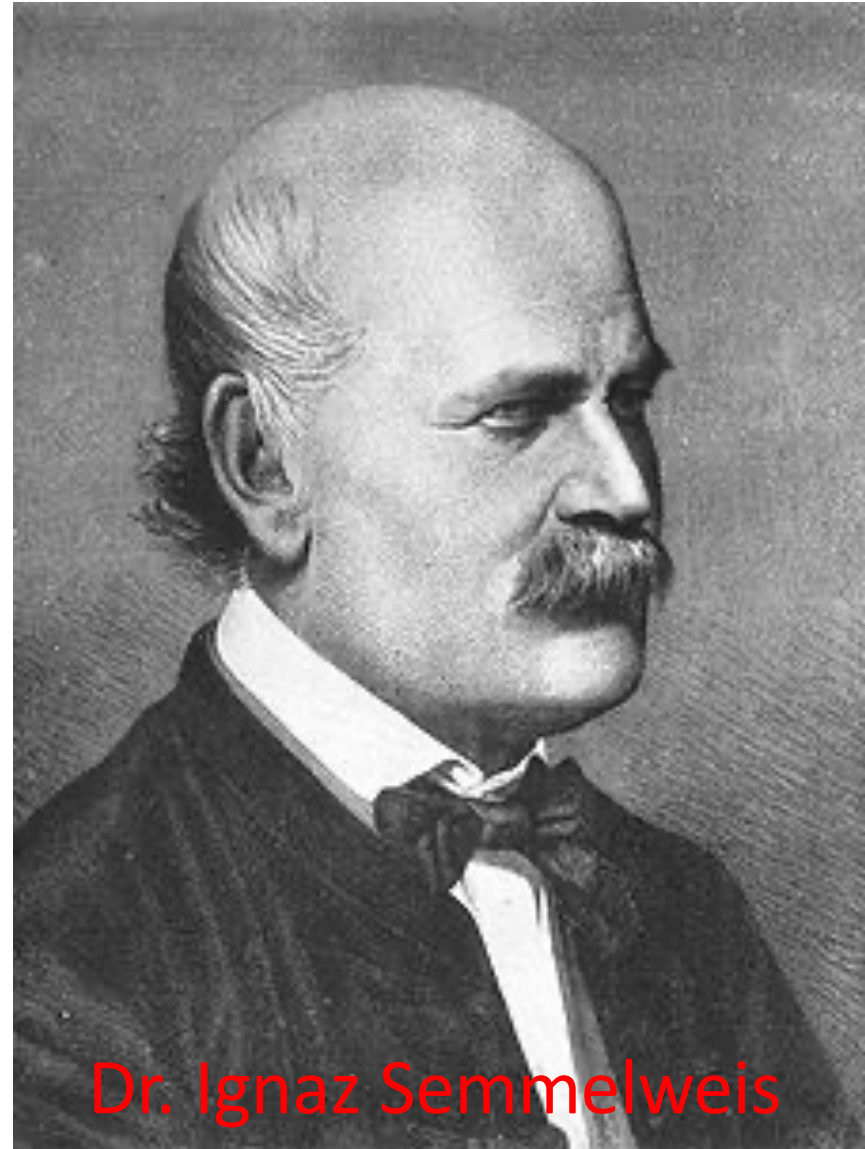


Dr. Ignaz Semmelweis



## Rebel #2: Larry Weed—The Outsider

“But other doctors refused to believe that their own hands transferred disease. Besides, they grumbled, hand-washing was far too time-consuming. Dr Semmelweis was widely ridiculed and eventually fired.”



Dr. Ignaz Semmelweis

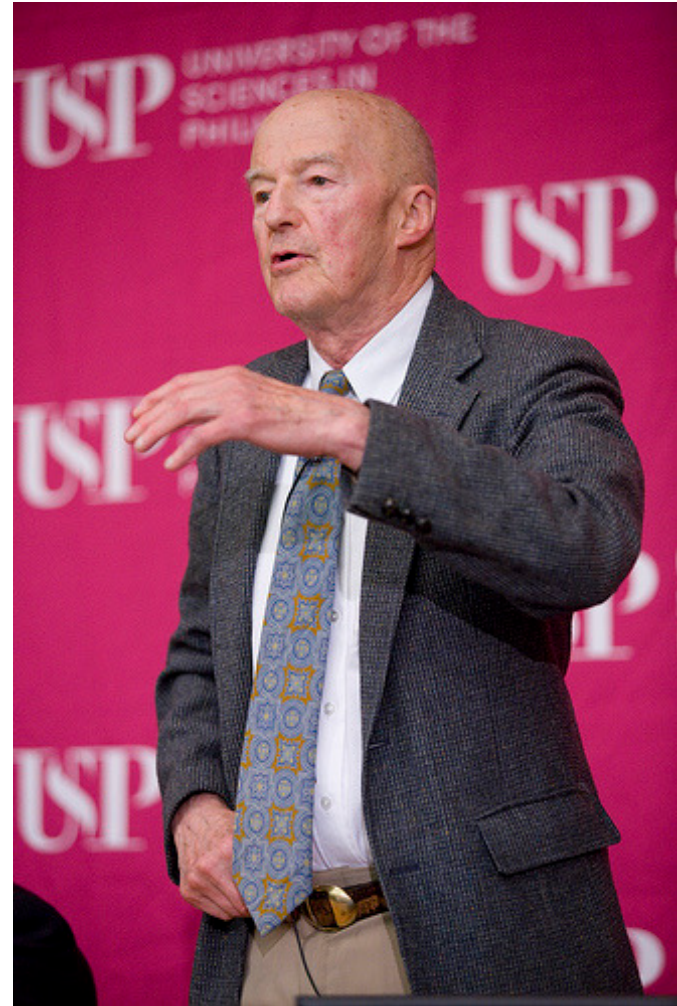
# Rebel #2: Larry Weed

- Navy during WWII
- MD 1947 Columbia
- Residency JHU
- Taught at
  - Yale
  - Case Western
  - UVM
- Like Warner an apple-pie life



# Rebel #2: Larry Weed

- In 1969 Published paper regarding the Problem-Oriented Medical Record
  - Scientific Reasoning in note keeping
  - SOAP
  - Developed over the previous decade



# Rebel #2: Larry Weed

- “[Larry Weed] is one of the giants of the last 500 years in medical thinking.”

~Don Detmer, M.D. Medical Director  
for Advocacy and Health Policy of the  
American College of Surgeons  
Professor Emeritus the University of  
Virginia



# Rebel #2: Larry Weed

- Also in 1969 Received NIH grant to develop a computer version of POMR
- In 1982 left UVM to form Problem-Knowledge Coupler Corporation



# Rebel #2: Larry Weed

- Weed's rebellion initiated by the contrast between
  - The careful, thoughtful methodology of his lab work
    - “I worked with one or two problems until I understood them, wrote up my findings, and got them published in a journal. “
  - And the chaotic, multitasking of the clinic

## Rebel #2: Larry Weed

- “The beginning clinical clerk, the new intern, and the practicing physician are confronted with an apparent contradiction. Each is asked, as a ‘whole’ physician, to accept the obligations of meeting many problems simultaneously and yet ...”

## Rebel #2: Larry Weed

- “...to give to each the single-minded attention that is fundamental to developing and mobilizing his or her enthusiasm and skill—for these two virtues do not arise except where an organized concentration upon a particular subject is possible.”



# Rebel #2: Larry Weed

- Whereas Warner and Franklin is/was conservative
  - “a conservative, aiming not to destroy but to preserve as much as possible of the established order”
- Weed is not a conservative
  - His latest book: *Medicine in Denial*

# Rebel #2: Larry Weed

- *We're doing it all wrong!*
  - “The diplomas they grant and the licensing exams the states give could not possibly mean and guarantee what the public thinks they mean.”  
(Weed, “Idols of the Mind”)

# Rebel #2: Larry Weed

- *We're doing it all wrong!*
  - *Psychologists proved in the 50's that doctors cannot do their job. (paraphrase of Weed talk I heard at IHC while in graduate school)*

# Rebel #2: Larry Weed

- *We're doing it all wrong!*
  - Practicing medicine without computers is “like trying to send people up on the space shuttle with pencil and paper,” says Charles Burger, a doctor based in Bangor, Maine.
  - “There is no other profession that tries to operate in the fashion we do. We go on hallucinating about what we can do.”

# Rebel #2: Larry Weed

- **Uwe Reinhold:** He hasn't read Dale Carnegie's *How to Win Friends and Influence People*.
- **The Economist:** "Genius and dedication aside, the good doctor can be as caustic as he is charming, as bombastic as he is brilliant, as scathing as he is skilled."

# Rebel #2: Larry Weed

- **Don Detmer:** “He doesn't suffer fools gladly. He's a totally consistent personality—this is a delight to those of us who find him inspiring, and tedious to those who wish he would go away.”



## Rebel #2: Larry Weed

- “The unaided human mind is not a reliable instrument for this processing of information in the solution of patients’ problems. Yet medical education and licensure permit physicians to try exactly that.”

# Francis Bacon: Idols of the Mind

- Universal mental limitations
  - “inherent in human nature”
- Acquired beliefs of human problem solvers
  - “corrupts the light of nature”





# Francis Bacon: Idols of the Mind

- The limits of language
  - “throw everything into confusion”
- Developed systems of thought
  - “which have become inveterate by tradition, implicit credence and neglect.”



## Rebel #2: Larry Weed

- “For the past 40 years, research by psychologists has confirmed the writings of Bacon.”
  - “The greatest obstacles to using external aids may be the difficulty of convincing ourselves that we should take precautions against ourselves.”  
(Robyn Dawes)

# Weed's Declaration of Revolution

Weed hopes his work “help us accept and get on with the **radical changes that must now be made** in medical education and medical practice.”

# Revolution Revisited

- Can a revolution be mainstream?
- Is there a need for revolution within revolutions?
- Weed critical of mainstream medical informatics
  - Reliance on probabilistic reasoning
  - Information retrieval

# Revolution Revisited

"It is a profoundly erroneous truism -that we should cultivate the habit of thinking about what we are doing. The precise opposite is the case. Civilization advances by extending the number of important operations which we can perform without thinking about them." (A. N. Whitehead)

# Revolution and Timing

- Franklin revolted when he “judged the **time to be ripe and the costs to be acceptable.**”
- The heyday of Warner and Weed’s work was 40 years ago
  - Was the time ripe?
  - Were the tools of the revolutionaries sufficient?

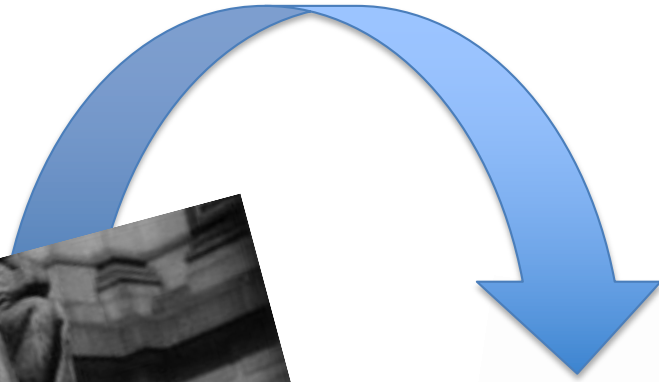
# What Facilitates the Revolution?



# What Facilitates the Revolution?



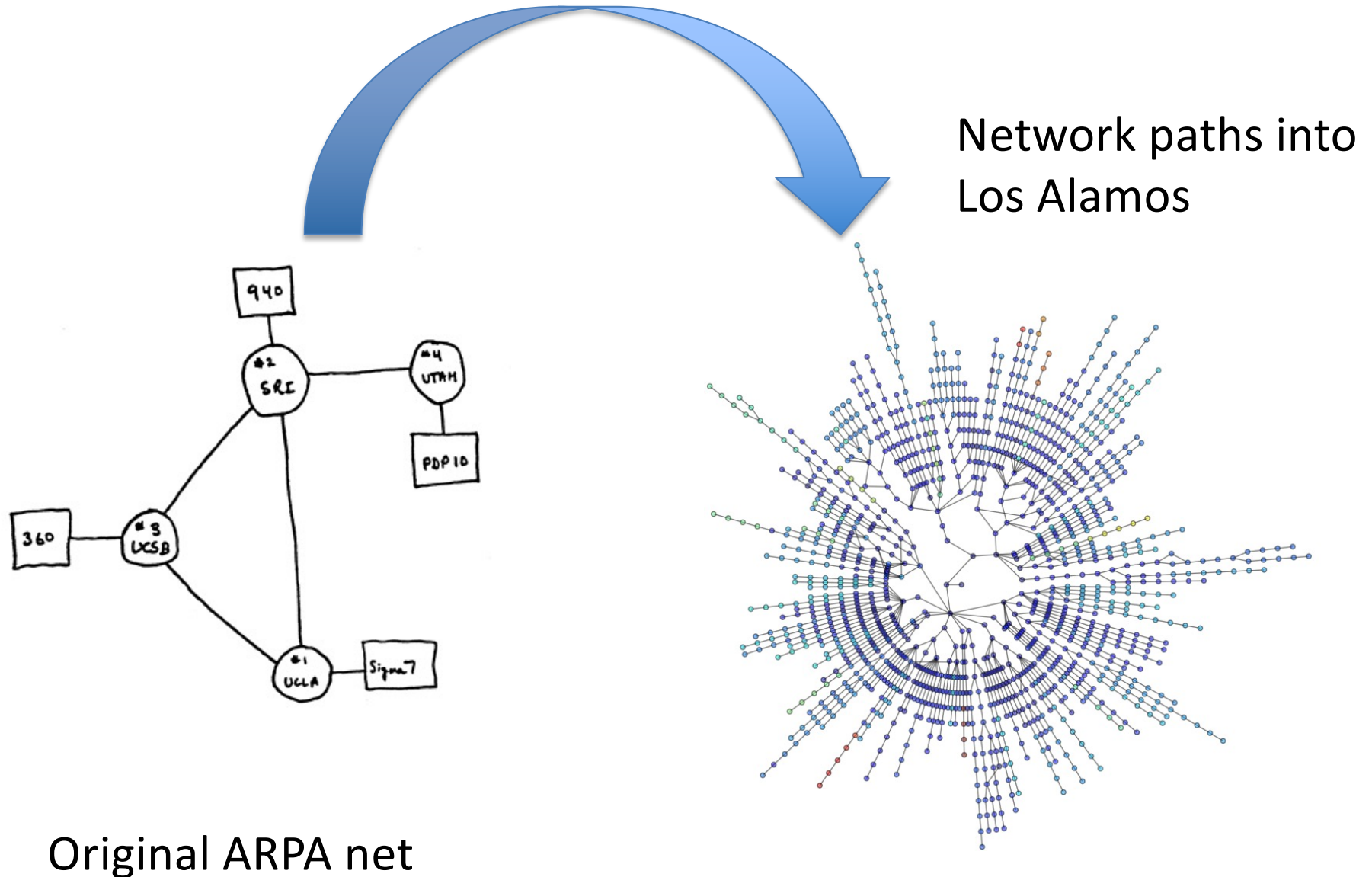
WWII Computers



SDSC Supercomputer



# What Facilitates the Revolution?

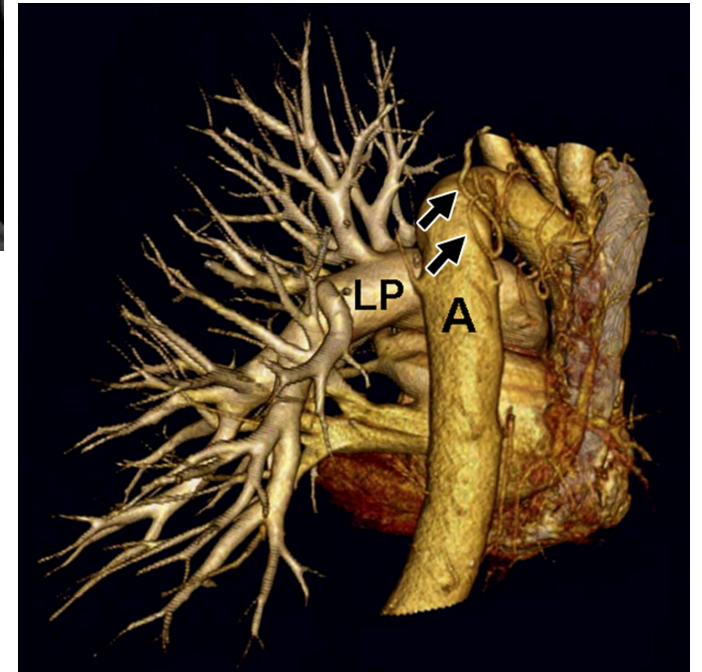
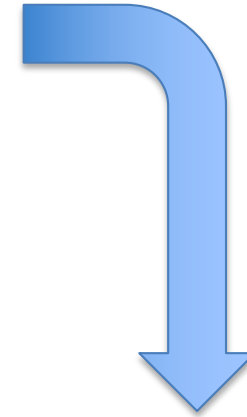
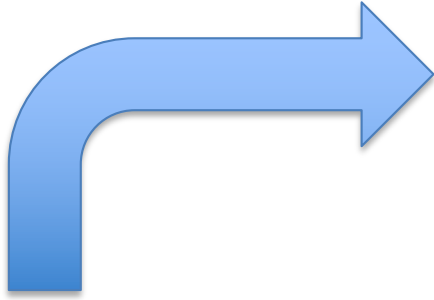


# The Rise of the Internet (ARPANET)

- Motivation:
  - Time constrained decision support with high consequences
  - Detecting and responding to an ICBM attack
  - Immediately became popular for e-mail

“There was a belief in the heads of a number of people—a small number—that people could become very much more effective in their thinking and decision making if they had the support of a computer system, good displays, and so forth, good data bases, computation at your command.” (J.C.R. Licklider)

# What Facilitates the Revolution?

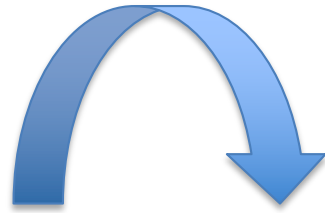


# What Facilitates the Revolution?



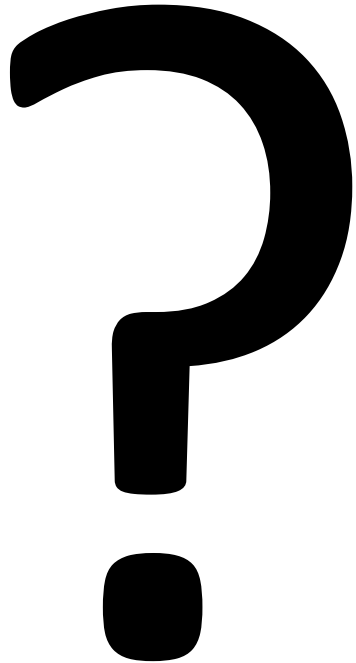
# What Facilitates the Revolution?

*Handwritten medical notes in German, likely a patient history or physical exam report. The text is dense and cursive, typical of 19th-century medical documentation.*



A screenshot of an Epic EMR system interface. The browser address bar shows the URL: https://phones-stage.caregroup.org/epic/epic/pwms32.cdr?KVALFN=TCBY. The patient name is Xzmct, Thirt. The interface displays various tabs and sections: Profile, Problems, Results, Reports, Notes, Medications, Orders, Sheets, and HomeOnc Clinic. The Profile section includes patient information such as Address (50 ELM STREET, GROVE HALL, MA, US), Phone (617-555-1234), and Work Phone (617-555-1212). The Medications section lists drugs like REGULAR, MEDICARE, and BLUEBERRY/DONOR BUBBLE. The Orders section lists various medical orders and procedures. The interface is designed for efficient data entry and retrieval in a clinical setting.

# What Facilitates the Revolution?



# The HITECH Act of 2009

- Widely seen/viewed as an Informatics Revolution
- What counter-revolution is now required?
  - Remember Scott's warning about successful revolutions.
- Be wary of the informatics status quo

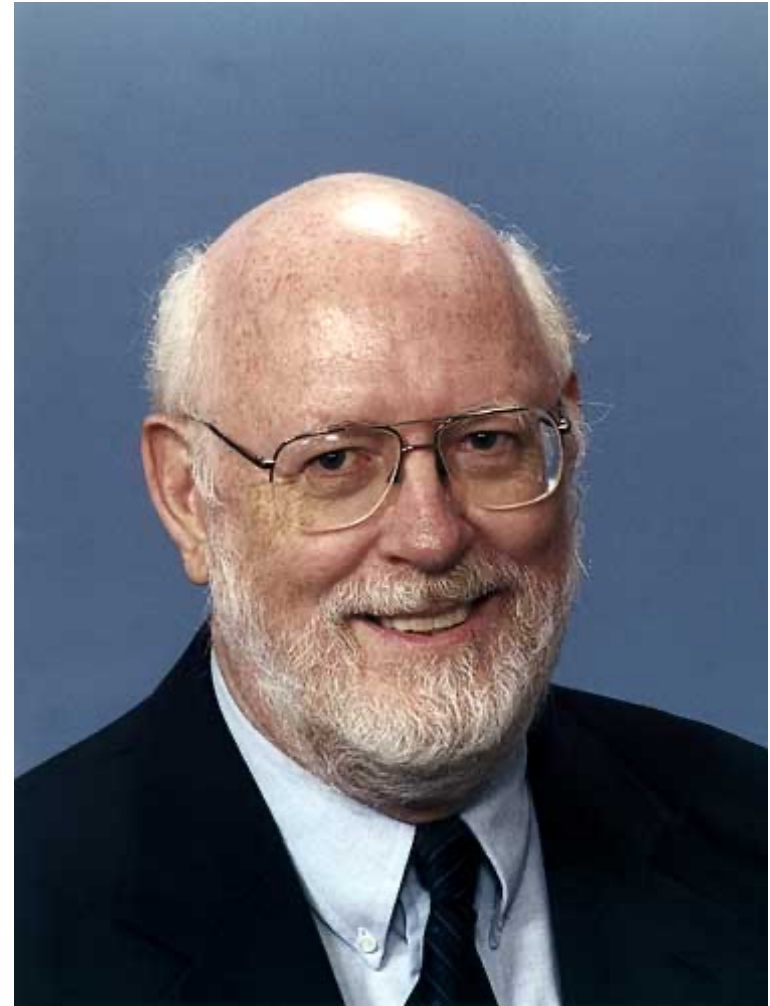
Let's be fair, it's not all about Rebellion

- What draws people to a profession?



# What Draws People to a Profession?

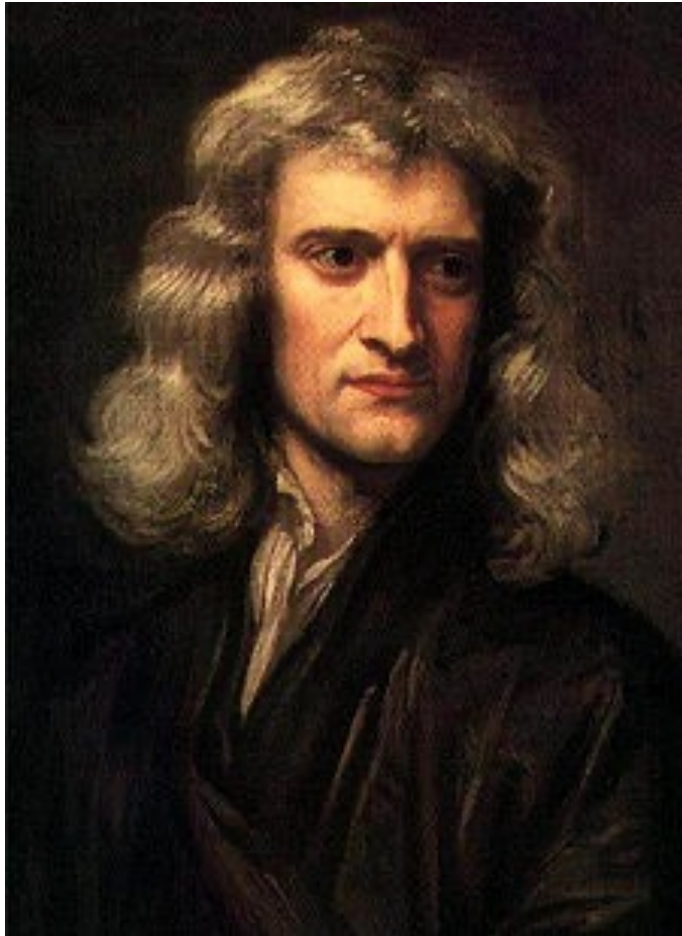
- Air conditioning



J. D. Callen, Ph.D.

# What Draws People to a Profession?

- Curiosity



Of Colours  
6. The reason of Pellucid bodies is white see is a cluster of small bubbles of air, y<sup>e</sup> scummings of black or straw some. &c. because of y<sup>e</sup> multitude of reflecting surfaces see are bodies will are full of flaws, or holes whose parts lye not very close together (as Metals, Marble, y<sup>e</sup> Oculus Mundi Stone &c) whose pores betwixt their parts admit a grosse Air into y<sup>e</sup> y<sup>e</sup> pores in their parts, hence  
7. Most Bodies (viz. those into which water will soake as paper wood marble, y<sup>e</sup> Oculus Mundi Stone, &c) become more darke & transparent by being soaked in water [for y<sup>e</sup> water fills up y<sup>e</sup> reflecting pores] (B) &c

8. I took a bodkin y<sup>e</sup> I put it betwixt my eye & y<sup>e</sup> bone as neare to y<sup>e</sup> ~~end~~ backside of my eye as I could: & pressing my eye w<sup>th</sup> y<sup>e</sup> end of it (soe as to make y<sup>e</sup> curvature a bedef in my eye) there appeared several white darke & coloured circles 1, 2, 3, 4, &c. Which circles were plainest when I continued to rub my eye w<sup>th</sup> y<sup>e</sup> point of y<sup>e</sup> bodkin, but if I held my eye & y<sup>e</sup> bodkin still, though I continued to press my eye w<sup>th</sup> it yet y<sup>e</sup> ~~circles~~ circles would grow faint & often disappear untill I renewed y<sup>e</sup> by moving my eye or y<sup>e</sup> bodkin.

9. If y<sup>e</sup> experiment were done in a light room so y<sup>t</sup> though my eyes were shut some light would get through their lids there appeared a ~~bluish~~ bluish darke circle outmost (as ts) & w<sup>th</sup> in that another light spot soe when colour was much like y<sup>t</sup> in y<sup>e</sup> rest of y<sup>e</sup> eye as at R. Within w<sup>th</sup> spot appeared still another bluish spot &

A diagram of a human eye in profile, showing the cornea, iris, and lens. A hand is shown holding a bodkin (a sharp tool) against the back of the eye. A dashed line indicates the path of light or the position of the bodkin. The diagram is labeled with letters 'R' and 'S'.

# Biomedical Informatics and Wonder

“For this experience which is characteristic of a philosopher, this wondering: this is where philosophy beings and nowhere else.” (Plato, “Theatetus” 155d3)