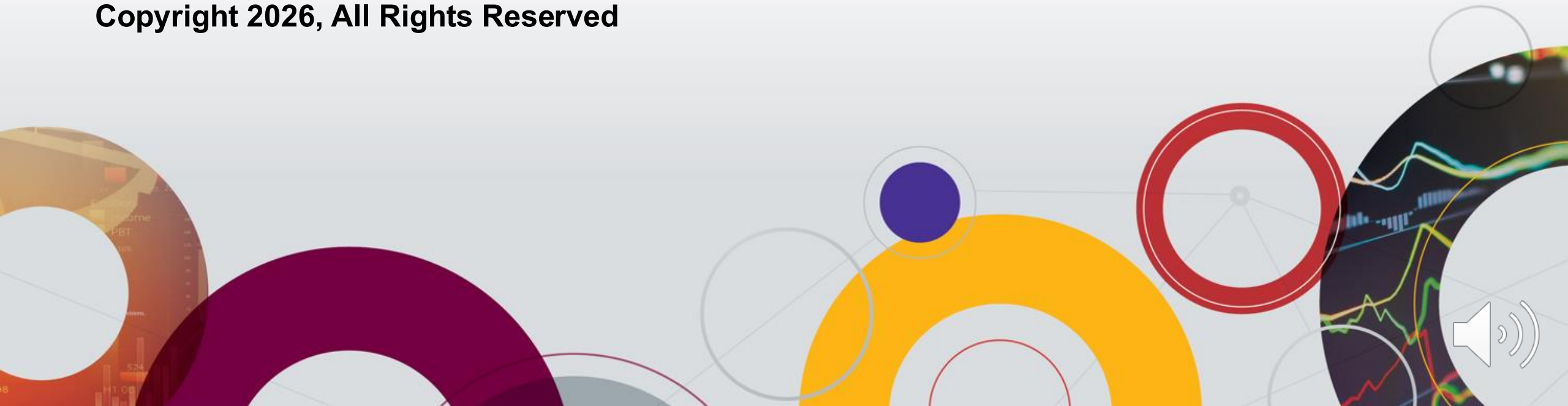


2.1 Types of Computers

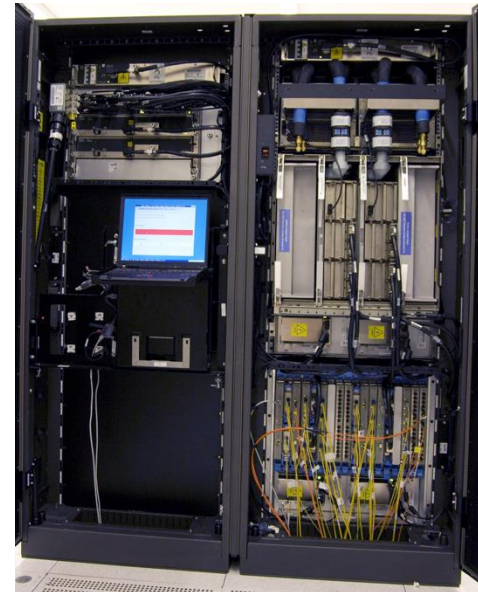
10x10 – Introduction to Biomedical Informatics & Artificial Intelligence
William Hersh, MD, FACMI, FAMIA, FIAHSI
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What is a computer?

Types of computers

- Mainframes
- Servers
- Personal computers
- Mobile computers
 - Tablets
 - Smartphones
- Wearables
 - Watches
 - Sensors



Computers from the high end

Most powerful

- Mainframes – largest and most expensive computers that serve mission-critical needs and many users (Shein, 2025)
- Supercomputers – powerful computers designed for massive processing and computation (Butler, 2025)

Servers

- Computers that serve many users and handle many transactions
- Any computer from a PC to a mainframe can act as a server
 - Growing tendency for “server farms” consisting of large numbers of PCs, especially in area of cloud computing

Personal computers (PCs)

Desktop and laptop “Wintel” and Apple Macintosh computers

- Laptops now vastly outsell desktops

Continue to increase in power, especially when on computer networks

Have essentially become a commodity

Mobile computers (Sim, 2019)

“Computers” are getting smaller

- Concept not new, e.g., (Smith, 1981)

Tablets

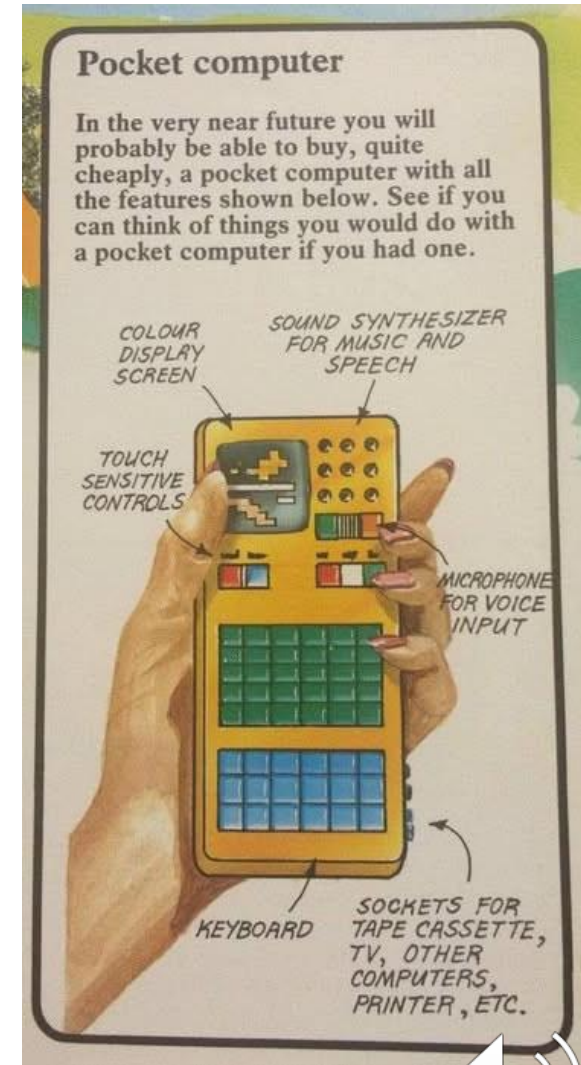
- Evolution to smaller and simpler

Smartphones – evolution from personal digital assistants (PDAs)

- Merger of phone and Internet-enabled devices

Use of these devices for health applications sometimes called mHealth (Cerrato, 2019)

- Also create threats; need policies for “bring your own device” (BYOD) (Evans, 2019)



Tablet computers

Screen and power of laptop computer but even more portable

Motion C5 was designed with healthcare in mind

- Sealed from moisture: could be disinfected
- Rugged: could be dropped
- Had wireless connectivity, barcoding, camera, Bluetooth, etc.

Newer genre less rugged but lighter and more convenient, e.g.,

- iPad
- Android tablets
- Microsoft Surface



Smartphones

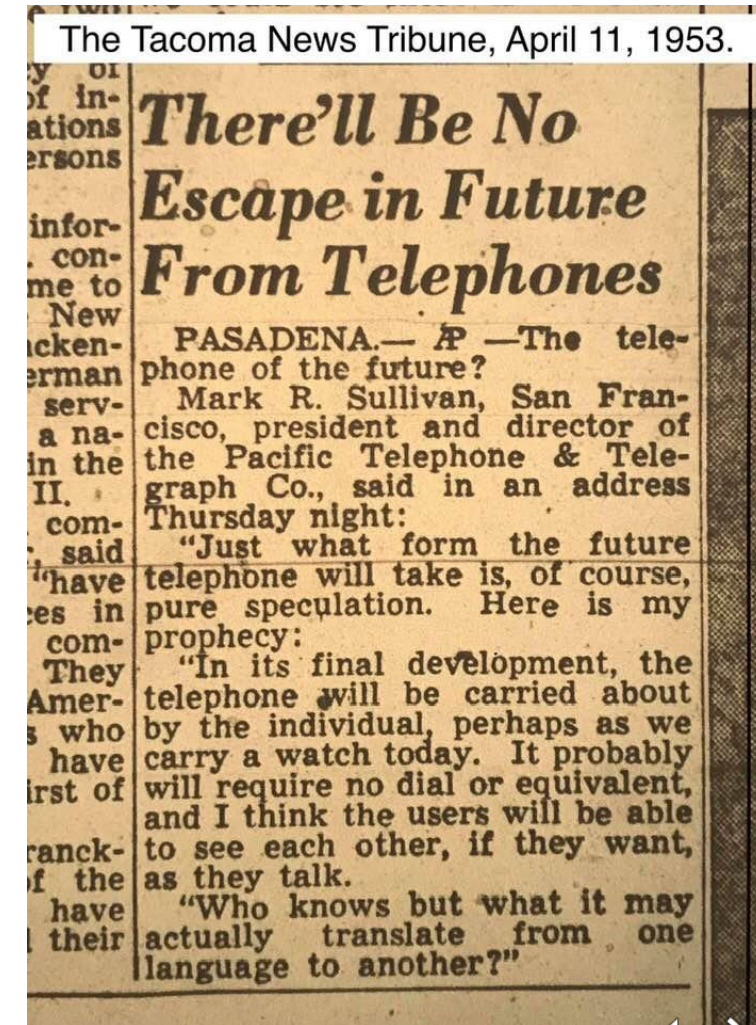
Hand-held computers with high portability, now connected to cell phone and/or wireless networks

- Major platforms are iPhone and Android

Value in healthcare most related to “swappable” apps and shared data store (Mandl, 2012; Mandl, 2015)

Used by

- >90% of US population (Sidoti, Pew, 2024)
- 4.2B (over half) of world population, estimated to exceed 6B by 2029 (Degenhard, Statista, 2024)



Wearable computers

Worn on body generally

- Smartwatches
- Smart rings
- Sensors for remote monitoring of patients

Augmented/virtual reality (AR/VR; Watts, 2023)

- Augmented reality – augment surroundings, e.g., Apple Vision Pro
- Virtual reality – fully immersive, e.g., Meta Quest



How powerful are computers getting?

Moore's Law: Everything from speed to size to cost per unit of power doubles every 18 months (Moore, 1965; Denning, 2016)

Then and now

- [Compare state-of-the-art portable computers from early 1980s Osborne and iPhone 4](#) – Osborne was 100 times slower, 100 times heavier, 10 times more expensive, and 485 times bigger
- Doing more with less – Apollo 11 Moon Landing Guidance Computer (AGC) had lower clock speed and less memory than modern USB chargers (Heller, 2020)



How powerful (cont.)?

Graphical processing units (GPUs)

- Originally designed for parallel computing for image processing but also found to power AI deep learning applications (Garisto, 2024)
- Leading manufacturer has been Nvidia
- Some companies combining CPUs and GPUs into “system on a chip,” e.g., Apple Silicon providing more computing power at lower energy costs

Quantum computing

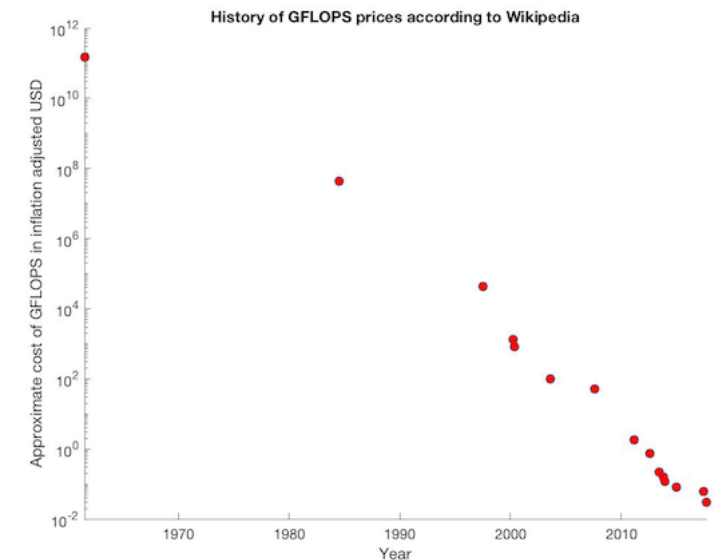
- Potentially many orders of magnitude faster than current computers, e.g., perform in 5 minutes what modern supercomputer would take 10^{25} years (Garfinkel, 2022; Castelvechi, 2024)
- Still not reliable enough for use but getting closer based on recent research from Google (Google, 2024)
- Many possible benefits in biomedical domain, including machine learning for AI, protein folding, drug discovery, network analysis, and cryptography (Durant, 2025)

Moore's Law demonstrated by reducing cost of computing

Common measure of computer speed is floating point instructions per second (FLOPS)

- Modern computers tend to be measured in teraFLOPS – my MacBook Air 15" M2 is 3.6 TFLOPS

Cost per gigaFLOP reduce from (2013 dollars) \$145 billion in 1961 to \$0.03 in 2017 (AI Impacts, 2017)



Storage media getting smaller while increasing in capacity too

5 megabyte storage device disk from IBM 305 RAMAC in 1956, first computer with hard disk



4.5 megabytes of data in 62,500 punched cards, 1955

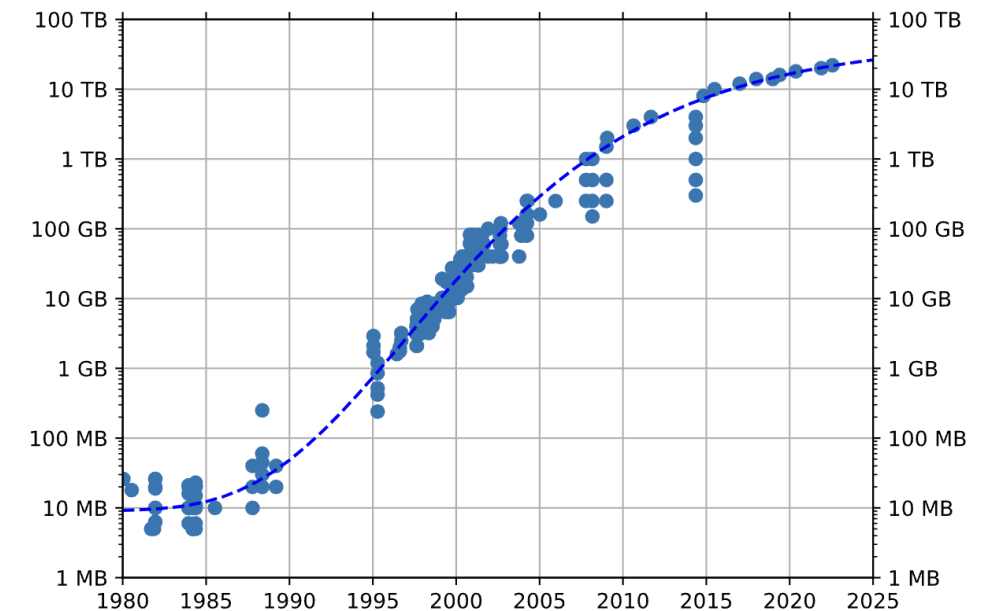
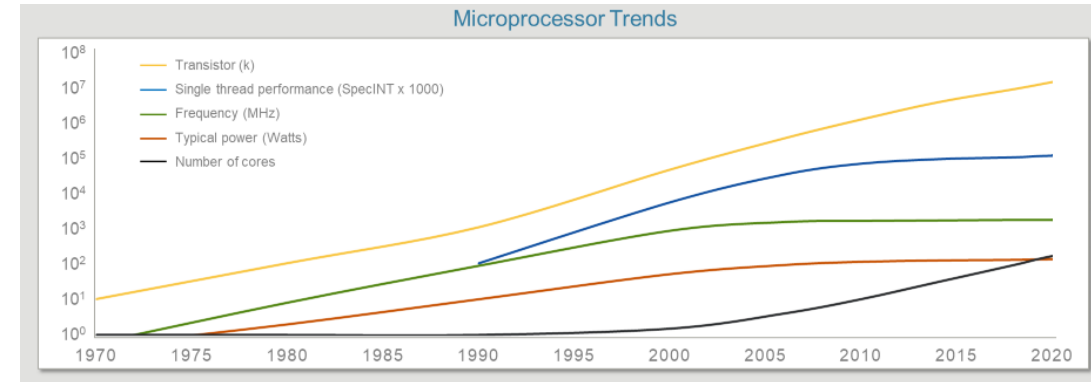


Moore's Law abating over time?

Death knell for Moore's Law predicted for last decade (Denning, 2016)

Some aspects slowing (e.g., clock speed) but others not (e.g., chip cores) (Moraes, 2022)

Hard drive capacity over time continues to grow (Wikipedia, 2023)



Though we find ways to assimilate the power delivered by Moore's Law

Graphical user interfaces – enhanced usability but require more computer power

Code bloat – programmers have more power so less incentive to be efficient

Feature creep – software producers want to have more features than rivals, even if features are minimally used

Other factors – Faster and faster local hardware may wait for slower networks