Why Computer Science?
Why UW CSE?

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Computer Science & Engineering
University of Washington

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Forty five years ago ...
THE ARPA NETWORK
DEC 1969
4 NODES

29 OCT 69 21:00

LOADED OP. PROGRAM CSK FOR BEN BARKER BBV

22:30 TALKED TO SRC HOST TO HOST

LEFT TOP. IMP. PROGRAM CSK RUNNING AFTER SENDING A HOST DEAD MESSAGE TO IMP.
With 4+ decades of hindsight, which had the greatest impact?

• Unless you’re big into Tang and Velcro (or sex and drugs), the answer is clear ...

• And so is the reason ...
Exponentials are rare – we’re not used to them, so they catch us unaware
Every aspect of computing has experienced exponential improvement

- Processing capacity
- Storage capacity
- Network bandwidth
- Sensors
- Astonishingly, even algorithms in some cases!
You can exploit these improvements in two ways

- Constant capability at exponentially decreasing cost
- Exponentially increasing capability at constant cost

![Graphs showing storage price and microprocessor performance trends.](image-url)
Then and now ...

• 20 years ago, microprocessors had 4 million transistors
  – Today they have 4 billion
• 20 years ago, the Internet had 1 million users
  – Today, it has 1 billion
• 20 years ago, only 15% of households had a computer
  – Today, nearly everyone owns a mobile phone
  – In the past year, more than half of all mobile phones purchased worldwide were smartphones – putting the Internet in the owner’s pocket
Searching for information
Searching for directions
Searching for love
Reading books
Listening to music
Watching movies
During the decade of the 2000’s ...

- Search
- Scalability
- Digital media
- Mobility
- eCommerce
- The Cloud
- Social networking and crowd-sourcing
During the current decade ...

- Smart homes
- Smart cars
- Smart health
- Smart robots
- Smart crowds and human-computer systems
- Smart interaction (virtual and augmented reality)
- Smart discovery (exploiting the data deluge)
Computer science is unique in its societal impact

- Scientific Discovery
- Transportation
- Neural Engineering
- Elder Care
- Medicine and Global Health
- Energy and Sustainability
- Security and Privacy
- Technology for Development
- Interacting with the Physical World

CORE CSE
- mobile
- HCI
- machine learning
- cloud computing
- big data
- sensors
- natural language processing
Computer science is great preparation for anything!

1. Every 21st century citizen needs to have facility with “computational thinking” – problem analysis and decomposition (stepwise refinement), abstraction, algorithmic thinking, algorithmic expression, stepwise fault isolation (we call it “debugging”), modeling
   – Computational thinking is not “this particular operating system” or “that particular programming language.”
   – Computational thinking is not even programming. It’s a mode of thought – a way of approaching the world.
   – Programming is the hands-on, inquiry-based way that we teach computational thinking and the principles of computer science.
2. Fields from anthropology to zoology are becoming information fields. Those who can bend the power of the computer to their will – computational thinking but also computer science in greater depth – will be positioned for greater success than those who can’t.
3. While fluency with computational thinking and with computer science are important to all fields, *the job prospects in the field of computer science itself are extraordinary*, and these jobs are creative, interactive, change-the-world jobs.

– The U.S. Bureau of Labor Statistics recently released its job projections for the decade 2012-2022. Computer occupations will be responsible for 71% of *all* the job growth in *all* fields of STEM (Science, Technology, Engineering, and Mathematics) – the many dozens of fields that comprise the life sciences, the physical sciences, the social sciences, engineering, and the mathematical sciences – and for 57% of all available jobs, whether newly-created or available due to replacement.

– “STEM worker shortage?” *Fuggedaboutit! “It’s all computer science, all the time.”*
Computer Occupations = 71% of all STEM
Job Openings (Growth and Replacement), 2012-22 – U.S. BLS
Computer Occupations = 57% of all STEM
Washington State High Demand Fields at Baccalaureate Level and Above
WSAC, SBCTC, WTECB, October 2013

- Computer Science
- Engineering
- Research, Science, Technical (gap exists at graduate level only)
- Health Professions (gap exists at graduate/professional level only)
UW Computer Science & Engineering

• Ranked among the top 10 programs in the nation (of >200)

• Two undergraduate programs
  – Computer Science (College of Arts & Sciences)
  – Computer Engineering (College of Engineering)

• >300 degrees per year
  – ~200 Bachelors (growing to ~250)
  – ~85 Masters
  – ~25 Ph.D.
• Extraordinary students
  – Fully 1/3 of the UW class medalists since 2000 have been CSE majors
    • Our “fair share” would be 2%
  – 3 of the past 5 Graduate School Medal recipients
    • “Academic expertise and social awareness”
• A deep commitment to providing a top-tier education
  – Winner of 5 UW Distinguished Teaching Awards
  – Winner of the inaugural UW Brotman Award for Instructional Excellence
  – Winner of two UW Distinguished Graduate Mentor Awards
  – In a typical quarter, CSE has 2/3’s of the top-performing instructors in the 10-department UW College of Engineering, according to student course evaluations
    • 9 of the top 10 instructors in the most recent quarter
• We produce students who can *design and build stuff*
  
  – Emphasis on teamwork and design
  
  – 80% of undergraduates do at least one internship
  
  – 50% of undergraduates participate in faculty-guided research
    
    • #1 school in the nation in students recognized in the past 10 years in the Computing Research Association “Outstanding Undergraduate Researchers Award” competition

  – A top-5 supplier of students to Amazon.com, Google, and Microsoft (along with MIT, Stanford, Berkeley, and Carnegie Mellon)

  – The predominate supplier to many leading smaller firms headquartered here
2012-13 UW CSE Student Destinations

- **Amazon.com, Google, Microsoft**, 33%
- **Other large companies**, 17%
- **Small companies or startups**, 27%
- **Graduate school**, 13%
- **Did not report**, 7%
- **Other large companies**, 17%
Tech companies that can be choosy, choose CSE

2011-12 Permanent & Internship Hires from UW by Amazon.com, Facebook, Google, and Microsoft
Why a research-intensive university?
What can we uniquely do?

• Get students into the lab
• Make them our partners in discovery
• Prepare them for life-long learning at the forefront of knowledge and society
  • *There is no field in which this is more important!*
• Erin Earl
  – Overlake School -> Robinson Center Transition School -> Robinson Center Early Entrance Program
  – Triple major in Music, Piano Performance, Computer Science
  – UW Dean’s Medal for the Arts
  – Indiana University Conservatory (3 months)
  – Google (5 years)
  – Harvard Law School
  – Clerkship in the United States District Court for the Eastern District of Virginia
  – Clerkship in the United States Court of Appeals for the Ninth Circuit
  – Law practice in Washington DC
• Raymond Zhang
  – Robinson Center Transition School -> Robinson Center Early Entrance Program
  – Double major in Biology, Computer Science
    • Undergraduate research in computational biology
  – Goldwater Scholar
  – Piano performances at Carnegie Hall, Lincoln Center, Benaroya Hall
  – 2013 UW Dean’s Medal in Engineering
  – Google
• Christophe Bisciglia
  – Gig Harbor High School
  – UW CSE
  – Google (5 years)
  – Cloudera, Inc. (Founder) (2.5 years)
  – WibiData (Founder and CEO)
• Emma (Lynch) Nixon
  – Ballard High School ‘07
  – UW CSE ‘11
    • Undergraduate research on Games for Learning – Refraction
    • SDE intern at Microsoft
  – SDE at Microsoft
Community: Undergraduate TAs
Community: Grace Hopper Celebration of Women in Computing
Community: Spring picnic
Community: Summer Day Camps for Middle School Girls
Preparing for CSE

• Not necessarily a high school computer science course!

• Deep comfort with algebra
• Scientific reasoning
• Reading comprehension

• Attention span
• Resilience when faced with challenges
However, **every high school should offer computer science**, and **every student should take it**!

• **Not** because programming is a valuable skill (although it certainly is that)

• **Because every field is becoming an information field**

• **Because “computational thinking” is an essential 21st century capability**
Computer Science in K-12, 1983

A Nation At Risk

Our Nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world. This report is concerned with only one of the many causes and dimensions of the problem, but it is the one that undergirds American prosperity, security, and civility.

If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. As it stands, we have allowed this to happen to ourselves.

Recommendation A: Content

We recommend that State and local high school graduation requirements be strengthened and that, at a minimum, all students seeking a diploma be required to lay the foundations in the Five New Basics by taking the following curriculum during their 4 years of high school: (a) 4 years of English; (b) 3 years of mathematics; (c) 3 years of science; (d) 3 years of social studies; and (e) one-half year of computer science.

IBM PC XT
4.77 MHz 8088
128 KB RAM
PC DOS 2.0
Computer Science in K-12, 2013

Energy (see also Forces and motion)
  - Binding energy in molecules, 109, 110, 111, 112, 239-240
  - Cause-and-effect mechanisms, 125-126, 237
  - Chemical energy, 111, 122, 123, 148, 223
  - In chemical processes and everyday life, 128-130
  - Conservation of, 110, 120-121, 123, 124-126, 128, 148, 153, 154, 175, 223, 238
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  - Definitions of, 120-124
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  - Electrical energy, 123, 125, 128
  - And forces, 126-127
  - Grade band endpoints, 122-124, 125-126, 127, 129-130
  - Kinetic (motion) energy, 110, 111, 121, 122, 123, 124, 126
  - Mechanical energy, 122-123
  - Modeling and mathematical expressions, 123-124, 126
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  - Photosynthesis, 104, 128, 129, 130, 146, 147, 148, 153, 154, 180, 187, 189, 223
  - “Producing” or “using” in everyday life, 128-130
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  - In systems, 120-121, 123, 124-126, 128

  - Terminology, 96, 122
  - Thermal energy, 121, 122, 123, 125, 130, 136, 180, 181
  - (see also Heat)
  - Transfer between objects or systems, 93, 110, 120, 121-122, 124-126
  - Stored (potential) energy, 96, 121-122, 123, 124, 126, 127, 128, 129, 130, 221

Forces and motion
  - Cause-and-effect mechanisms, 113, 114, 115-116, 127
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  - Electromagnetism, 88, 109, 111, 113, 116, 117-118, 121, 123, 126, 127, 239
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  - Patterns in, 115, 116-117, 118, 119, 121, 127, 130
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    - 137, 173, 174, 175, 178, 181, 185
  - Scale and, 114, 116-117, 118, 175
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Computer science, 10, 14-15, 299, 334, 336
## NEXT GENERATION SCIENCE STANDARDS

### Elementary (K-5)

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<td>5-8. Engineering Design</td>
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### PS: Physical Sciences

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### LS: Life Sciences

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<td>MS. Natural Selection and Adaptations</td>
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### ESS: Earth and Space Sciences

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<td>MS. Human Impacts</td>
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### ETS: Engineering, Technology, and Applications of Science

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• In 9 out of 10 high schools nationwide, computer science is not offered

• In 31 of the 50 states, computer science does not count towards the math or science graduation requirement

Yet computer science – “computational thinking” – is a key capability for just about every 21st century endeavor
Hadi Partovi
Code.org
Is this a great time or what?