CS4teachers 2019!
Why Computer Science?

Why UW’s Paul G. Allen School?

Ed Lazowska
Bill & Melinda Gates Chair
Paul G. Allen School of Computer Science & Engineering
Today ...

- The past fifty years
- The changing nature of the field
- The expanding role of the Paul G. Allen School at the University of Washington
- Seattle – then and now
- Workforce demand
- Student demand
- The changing nature of the world we live in
1969 – Fifty years ago ...

Credit: Peter Lee, Microsoft Research
THE ARPA NETWORK
DEC 1969
4 NODES

29 Oct 69 2100
LOADAP CP. PROGRAM CSU
Add BBN BARKER
BBV

22:30 Talked to SRI
Host to host

Leffarp Imp. program CSU
running after sending
a host dead message
to Imp.
With nearly 5 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 …

EXPONENTIAL US

* Commonly — although erroneously — attributed to the space program
Exponentials are rare – we’re not used to them, so they catch us unaware
The exponential improvements that have characterized computing can be exploited in two ways

- Constant capability at exponentially decreasing cost
- Exponentially increasing capability at constant cost
Measuring change ... the 1970s to today

Size: about the same
Speed: about the same
Efficiency (MPG): about the same
Value (cost relative to performance): about the same
Measuring change ... the 1970s to today

1971 Intel 4004  
(2,300 transistors)

2015 Intel Xeon  
(4,300,000,000 transistors)

Size: area occupied by a transistor reduced by $1,000,000x$
Speed: operations per second increased by $100,000x$
Efficiency (operations per watt): improved by $6,750x$
Value (dollars per instruction): improved by $2,700x$
Measuring change ... the 1970s to today

What if cars had improved as rapidly as microprocessors?
Measuring change ... the 1970s to today

Size: A car would be smaller than an ant
(About 1/5\textsuperscript{th} of an inch long)
Measuring change ... the 1970s to today

Speed: A car would go 6,000,000 miles per hour
(San Francisco to New York in 1.7 seconds)
Measuring change ... the 1970s to today

Efficiency: A car would get 100,000 miles per gallon (San Francisco to New York on 1/2 cup of fuel)
Measuring change ... the 1970s to today

Cost: A car would cost less than $10
"The wheel was great. What have you done for me lately?"
The changing nature of the field: From smaller/faster/cheaper to tackling societal challenges

UW has led this modern view of the field – both in concept and in implementation
Mobile, Virtual Reality, and Wearable Interaction

- **EyeContact**: High-accuracy head orientation tracking for virtual reality
- **Finexus**: Lip-tracking sensor for using magnetic sensing
- **MagnifiSense**: Wearable magnetic sensor that monitors daily activity
- **Simblee**: Detects high gestures using ambient light (IR)
- **GripSense**: Using built-in sensors to detect hand pressure and pressure on phones

Health Technologies

- **SpiroSmart**: Monitor your heart from a mobile device
- **BiliCam**: Blood oxygen level detection
- **CoughSense**: Automatic, auditory cough monitoring from a mobile phone
- **OsteoApp**: Scanning for osteoporosis on a smartphone using vibration
- **iPressure**: An app to assess intracranial pressure
- **WiBreathe**: Monitoring blood pressure using a smartphone camera

Sustainability and Low-power Sensing

- **ElectriSense**: Monitor home, single-point sensing of power transferred to the home
- **HydroSense**: Monitor home, single-point sensing of rechargeable water usage
- **SNUPI**: Mobile power wireless sensor network by Microsoft
- **BANDAIDS**: Power transfer through the body, with NFC
- **DOSE**: Sensing various states of home energy by one study in use from 2014
Small Update

We’ve posted a small update today, here’s what’s in it:

- Some stability issues, particularly with crashes when canceling recipes.
- Improvements to scoring of sequence alignment. The scores of your existing alignments will change in the Sequence Alignment Tool due to this, but it won’t affect your actual scores for the puzzles.

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Zoran Popovic
Data Storage on DNA Can Keep It Safe for Centuries

By DANA HUSSEY | JUL 3, 2016

From left, Luis Ceze, one of the designers of the new DNA storage system; Douglas Carmean, a designer of computers at Microsoft; and Karin Strauss, a Microsoft computer architect, at the University of Washington in Seattle. (David Ryder for The New York Times)

SEATTLE — Computer data has been depicted as microscopic magnetic smudges, electric charges and even Lilliputian patterns of dots that reflect laser beams. It may ultimately move into the fabric of life itself — encoded in the organic molecules that are stringed together like pearls to form strands of DNA.

UW, Microsoft claim big breakthrough with data storage using DNA

Originally published: Jul 2, 2016 at 5:30 AM | Updated: Jul 2, 2016 at 5:55 AM

Luis Ceze, UW Computer Science & Engineering professor; and research scientist Karin Strauss, UW Computer Science & Engineering postdoctoral researcher, store digital data in DNA. (David Ryder for The New York Times)
All aspects of Artificial Intelligence

- Computer Vision
- Machine Learning
- Natural Language Processing
- Robotics

In partnership with ...

- Allen Institute for Artificial Intelligence
- Amazon
- Apple
- Google
- NVIDIA
- Facebook
- Microsoft
The expanding role of the Allen School at the University of Washington

- The **Center for Sensorimotor Neural Engineering**, an NSF Engineering Research Center

- The **Center for Game Science**, funded by the Gates Foundation and DARPA to create revolutionary games for scientific discovery and for learning

- The **eScience Institute**, funded by the Moore, Sloan, Washington Research, and National Science Foundations to bring advances in data-intensive discovery to researchers campus-wide

- **dub** – “design-use-build” – a campus-wide collaboration that has made UW one of the top institutions in the world in human-computer interaction

- **Urban@UW**, a campus-wide urban science collaboration
- The **Taskar Center for Accessible Technology** develops and deploys technologies that increase independence and improve quality of life for individuals with motor and speech impairments.

- **Change**, a campus-wide collaboration exploring how technology can improve the lives of underserved populations in low-income regions.

- The **Tech Policy Lab**, a joint effort of the Allen School, the School of Law, and the Information School, funded by Microsoft.

- **GIX** — the Global Innovation Exchange — a new kind of education that is global, project-based, and integrates technology, design, and entrepreneurship.
Seattle – then and now

1977
Since that time ...

- Starbucks Coffee
- Microsoft
- McCaw Cellular, Inc.
- Adobe
- Amazon
- Nirvana
- $5 coffee
- Craft beer
- Streaming media
- Electronic commerce
- Desktop publishing
- Commercial cloud computing

Grunge
And we’re not done yet!

Seattle's nation-leading crane count is growing again

Jan 20, 2017, 1:42pm PST

INDUSTRIES & TAGS Commercial Real Estate, Technology, Construction
Many hundreds of home-grown tech companies spawned from the University of Washington, Amazon, Real Networks, McCaw Cellular, Microsoft, aQuantive, and Expedia.
More than 100 engineering offices of companies headquartered elsewhere
The gap in Computing is 3x the gap in all other fields of Engineering combined.

STEM Job Growth, 2016-26
U.S. Bureau of Labor Statistics

- Computer occupations (15-1100)
- Engineers (17-2000)
- Life scientists (19-1000)
- Physical scientists (19-2000)
- Social scientists and related workers (19-3000)
- Mathematical science occupations (15-2000)

Nationally, just as in Washington, “it’s all about computer science”

Data from the spreadsheet at http://www.bls.gov/emp/ind-occ-matrix/occupation.xlsx
UW-Seattle offers 112 majors, and 87 specializations within various majors. These are just the top ten!
It’s bigger than the software industry: Digital jobs are expanding, non-digital jobs are contracting

<table>
<thead>
<tr>
<th>Employment by levels of job digitization</th>
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<tbody>
<tr>
<td>High</td>
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<table>
<thead>
<tr>
<th>Occupation</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software developers</td>
<td>5</td>
</tr>
<tr>
<td>Financial managers</td>
<td>40</td>
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<tr>
<td>Lawyers</td>
<td>56</td>
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<tr>
<td>Nurses</td>
<td></td>
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<tr>
<td>Auto mechanics</td>
<td></td>
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<tr>
<td>Cooks</td>
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<td>Construction</td>
<td></td>
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<tr>
<td>Assembly line workers</td>
<td></td>
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</tbody>
</table>
It’s bigger than the software industry: Digital jobs are expanding, non-digital jobs are contracting

Employment by levels of job digitization

- High
- Medium
- Low

Example occupations:
- Software developers
- Financial managers
- Lawyers
- Nurses
- Auto mechanics
- Cooks
- Construction
- Assembly line workers

2002
- 56

2016
- 5
- 23
- 48
- 30

Also, the digital component of non-digital jobs is increasing.
Every K-12 should offer computer science, and every student should take it!

- *Not* because these students are eventually going to work in the software industry (although they might)
- *Not* because programming is a valuable skill (although it certainly is)
- Rather, *because every field is becoming an information field*
- And *because “computational thinking” is an essential 21st century capability*
The bottom line

- Computer science is a field with unmatched “change the world” potential
- An education in computer science is great preparation for pretty much anything

Computer Science: The ever-expanding sphere

Credit: Alfred Spector, Google