

# Why everyone needs digital literacy

Mark Guzdial

School of Interactive Computing

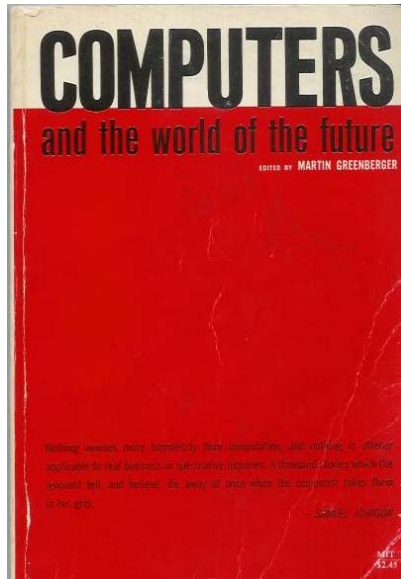
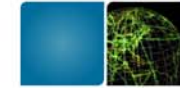




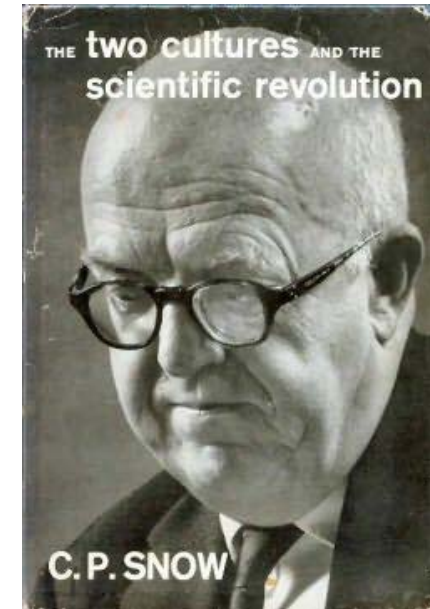
# Three arguments

1. Computing as a way of thinking.
  - Powerful and critical for all.
2. Computing as a tool for thinking.
3. Computing for our modern information economy.
  - Driving force for the US CS10K effort.

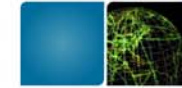
Since 1961:  
CS understanding is needed for all



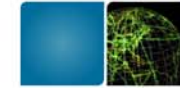
- Alan Perlis
  - The study of process is useful for everyone.
- C.P. Snow
  - Those who don't understand algorithms will be at the mercy of those who do.



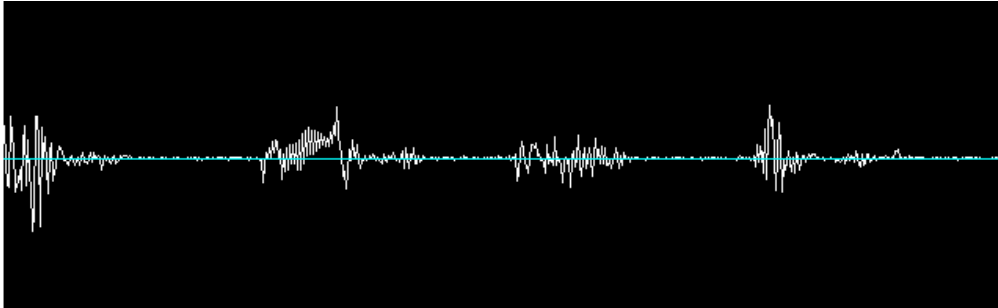
# Richard Dawkins on Biology as Computer Science



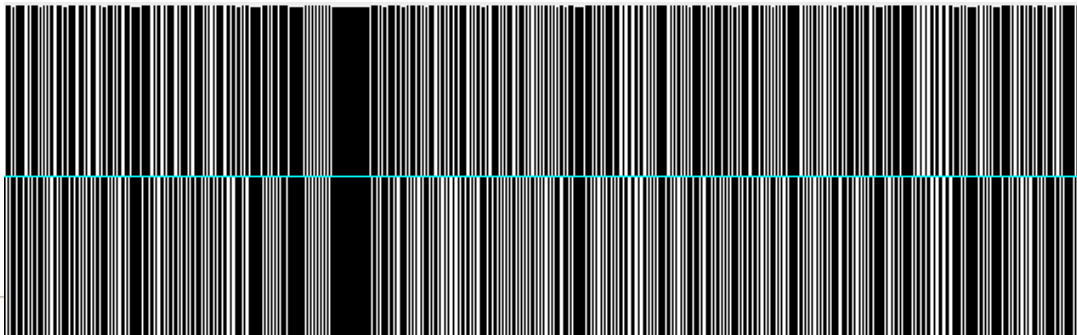
- On *US National Public Radio* in April 2007:
- GROSS: You close your book saying, "I am thrilled to be alive at a time when humanity is pushing against the limits of understanding." How do you think that's happening in your field of evolutionary biology?
- Mr. DAWKINS: Well, it's the most exciting time to be a biologist... **Since Watson and Crick in 1953, biology has become a sort of branch of computer science.** I mean, genes are just long computer tapes, and they use a code which is just another kind of computer code. It's quaternary rather than binary, but it's read in a sequential way just like a computer tape. It's transcribed. It's copied and pasted. **All the familiar metaphors from computer science fit.**



# Computing as a microscope



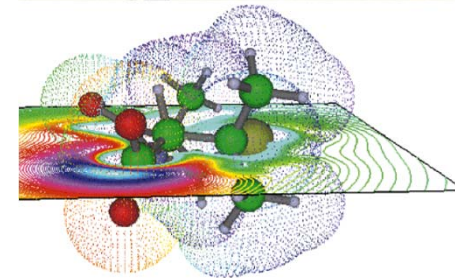
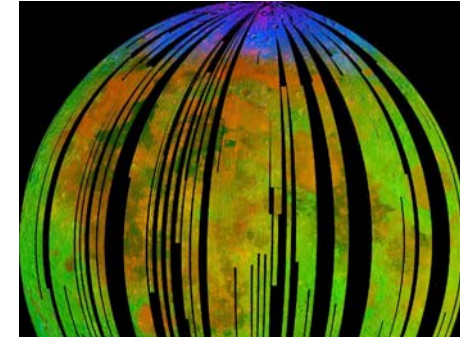
```
def maximize(sound):  
    for sample in getSamples(sound):  
        value = getSampleValue(sample)  
        if value >= 0:  
            setSampleValue(sample, 32767)  
        if value < 0:  
            setSampleValue(sample, -32767)
```



# Goals for an atypical CS student: Future computational scientist or engineer

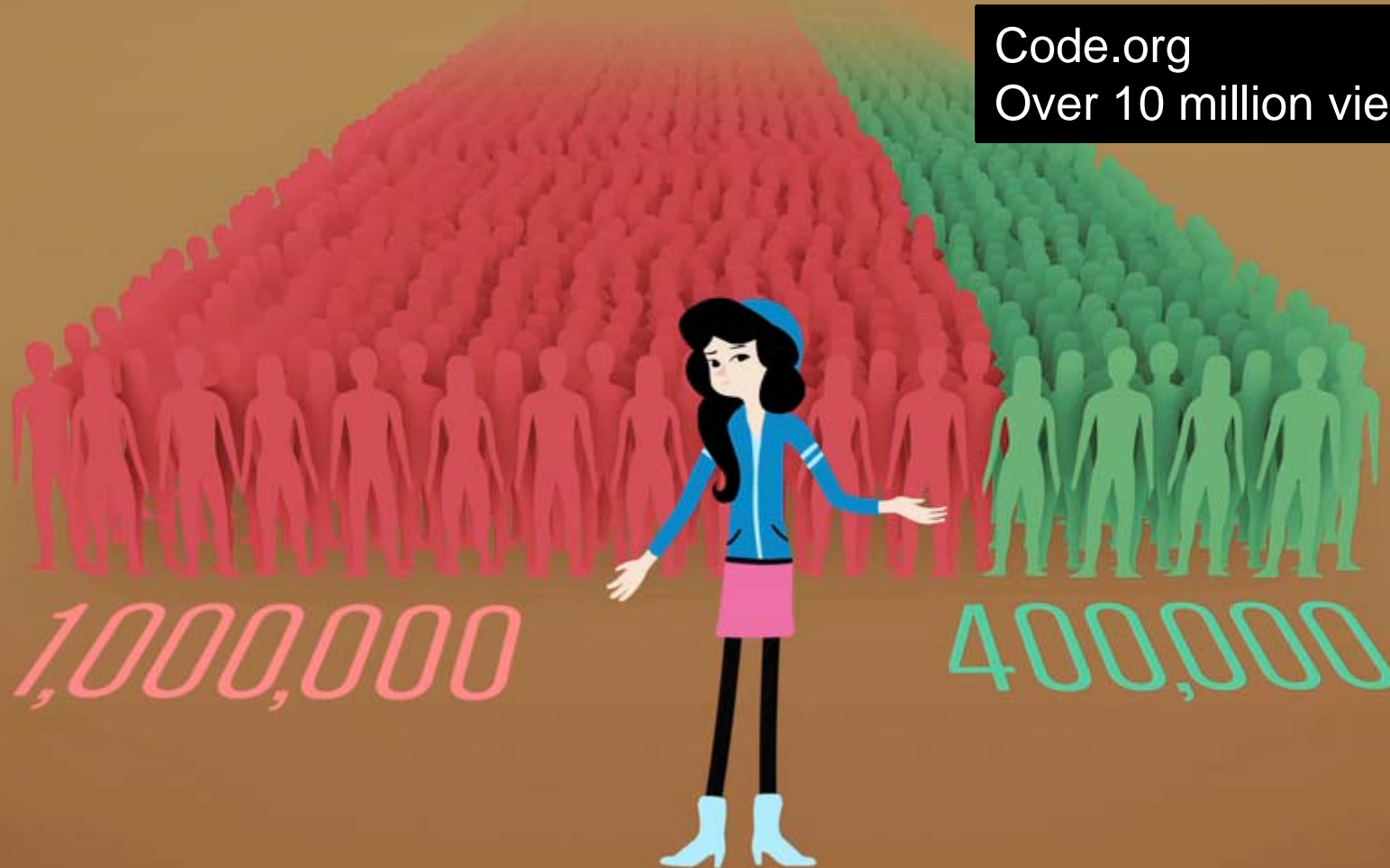


- To use computation as a tool to enhance understanding.
- To write programs of (at most) 100 lines (most often, 10 lines) for themselves.
  - They care about the products of the programs, not the programs.
  - Only to learn programming languages as are needed for their tasks.
- To work in interdisciplinary teams, including software engineers.



# 1.4M IT jobs in US 400K graduates

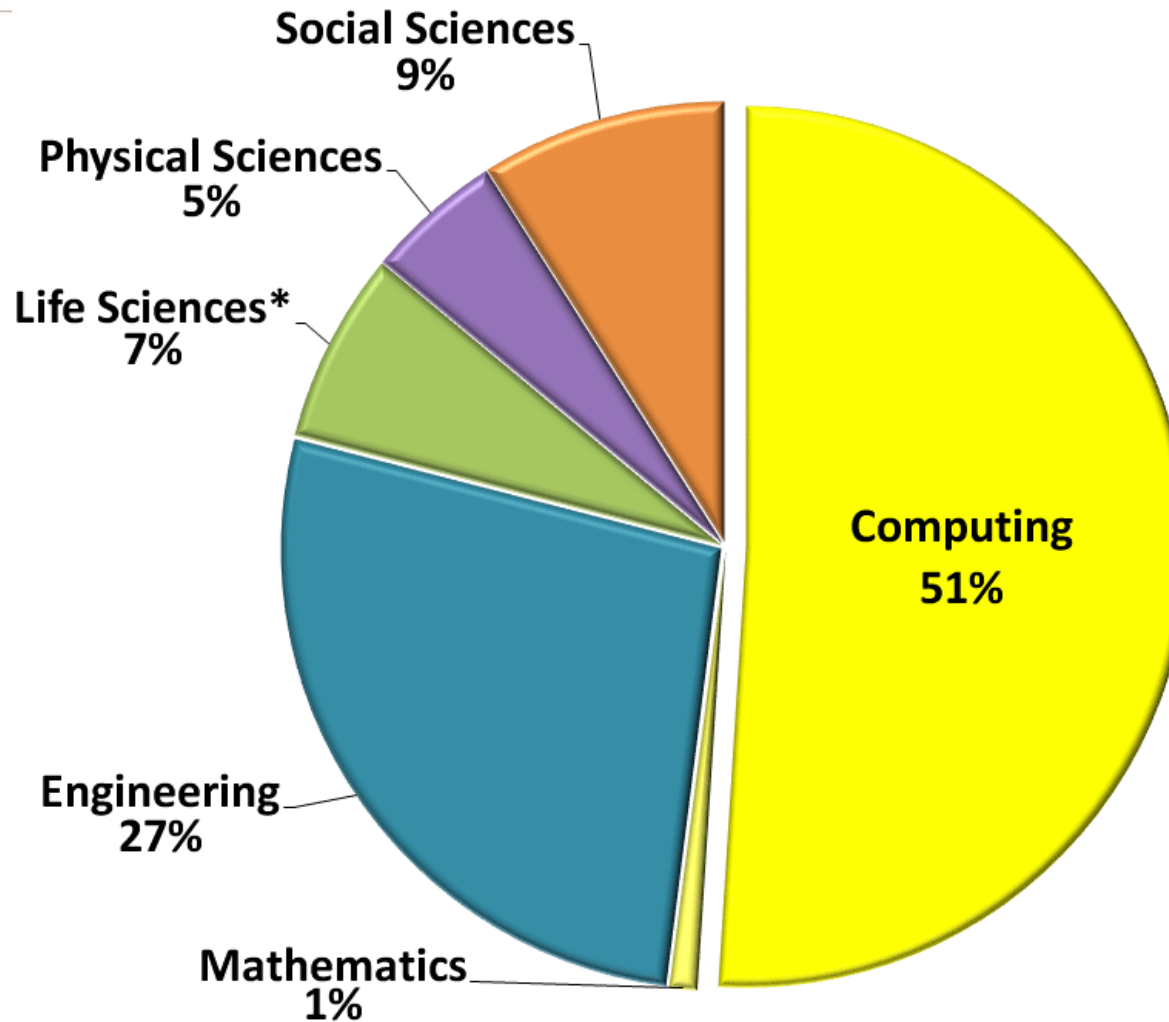
Code.org  
Over 10 million views



# Where US STEM Jobs Will Be



Projected Annual Growth of Total STEM Job Openings 2010-2020



\* STEM is defined here to include non-medical occupations.

Source: Jobs data are calculated from the Bureau of Labor Statistics (BLS), Employment Projections 2010-2020, available at <http://www.bls.gov/emp/>.





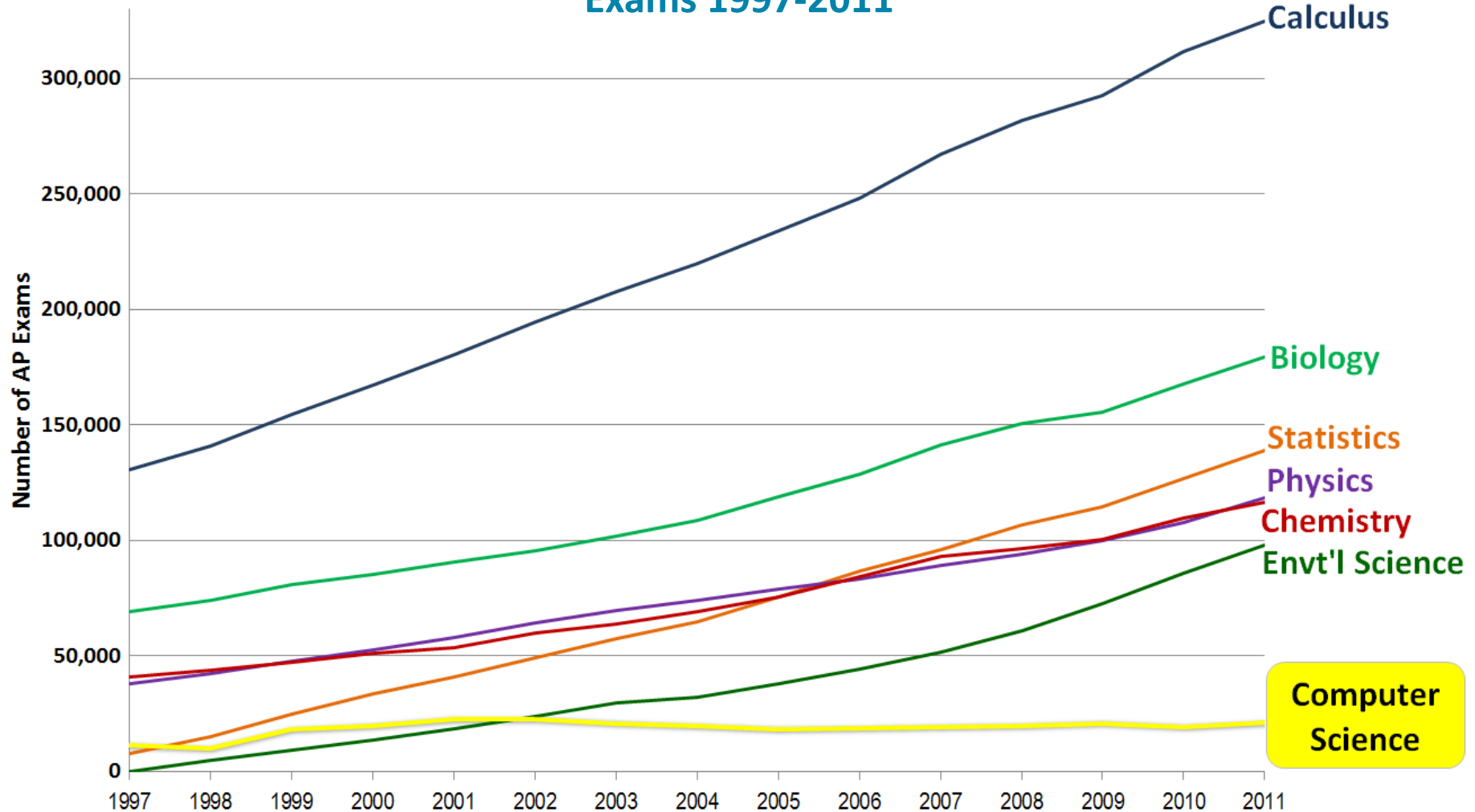
**3 Million** Software Developers

**1:4** Developers to  
End-User  
Programmers

**1:9** Developers to  
(Unknown)  
Programmers

# High School Advanced Placement

Exams 1997-2011



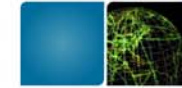
Source: College Board, Advanced Placement (AP) Exam Data 2011, available at <http://professionals.collegeboard.com/data-reports-research/ap/data>. Calculus represents the combined data of Calculus AB and BC. Physics represents the combined data of Physics B, C:Electricity and Magnetism, and C:Mechanics. Computer Science represents combined data of Computer Science A and B.

# Example: Graphic Designers



- Brian Dorn studied graphic designers who program for his dissertation.
- Conducted a series of interviews and assessment activities.
- Found that these subjects want more computer science, but don't find courses (and most other resources) adequate (Dorn & Guzdial, ICER 2010)
- *P10: So, that was a really long way of saying yes, I think that an academic study would make me a better programmer, but not by a whole lot.*

# They think computer science is boring and irrelevant



- P2: You're not going to be front-end anything with computer science. You're going to be back-end everything.
- P4: I think as a front-end developer, you focus more on the design and the usability, and you're focusing more on the audience. And then on the **back-end** I think you're focused on more, these are like the software developers. And they're programming something, and they don't really see what it's gonna look like; they're just making it work.



# They love to use code

- “What interests you about web design?”
- P12: The coding! I don't like to code. But the things that the code can do is amazing, like you can come up with this and voila, you know, it's there. Javascript for one. The plugins and stuff. I think that's very interesting, intriguing and stuff. Because I mean like the code is just, there's so much you can do with code and stuff. It's just like wow.



## The cost of digital illiteracy

- Learning less than they might because of a lack of domain knowledge.
  - For example: Exploring code by searching Google for function and variable names.
  - Learning about Java when programming in JavaScript



# Conclusions

- Computing is a powerful and critical way of thinking.
- Computing lets us see things we might not otherwise.
- There is an enormous need for more IT workers.
  - There is an even greater need for people to know IT who aren't computing professionals.



## Example: Secondary school teachers

- *[Becky]: “I struggle with giving everyone the material and being able to explain it to everyone... I struggle with how to be creative with the programming. I have a problem with trying to make the programs have meaning to them... It is hard to teach. It’s hard knowing how to teach it, how to give it to them... It’s hard to explain. When I look at kid’s codes, they think I should know it... They think that I should know it as soon as I look at it. For the longest time I thought I should, but I don’t have to. I have to study it just like they do. So, I would like some training.”*

From Lijun Ni’s 2011 thesis on  
CS teacher identity



# Challenges in traditional computer science classes



- Trying to train teachers while they are in classrooms leads to conflict with other priorities.
  - “I had my few afternoon hours that I could work on the stuff, but it all just boiled down to me not having time for my family when I was taking the courses.”
- They may not have the academic background for CS.
  - “I couldn’t get this mathematical problem to work. His response was, ‘I’m not going to teach you algebra.’”
- They get caught in minor syntactic problems
  - “There were times that it would take me hours to find one comma out of place, or find that one something that was wrong.”