The 1st Annual Computer Science Event, 2019

Islamic Azad University

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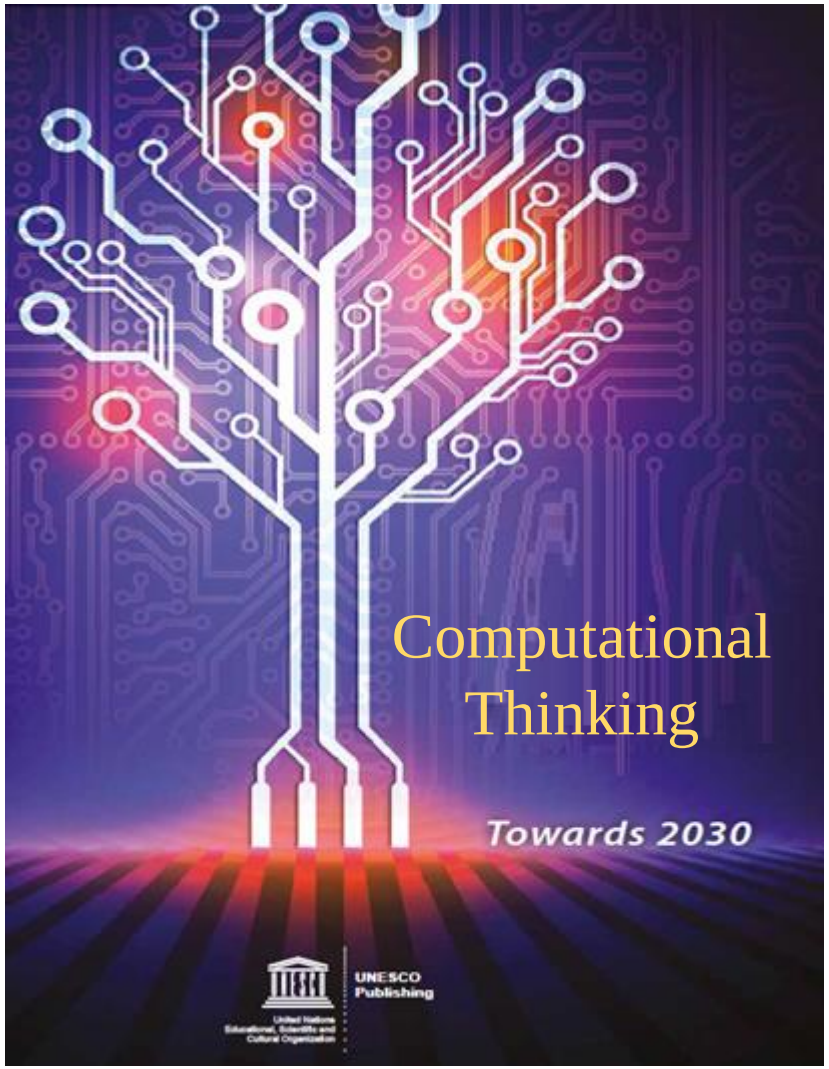


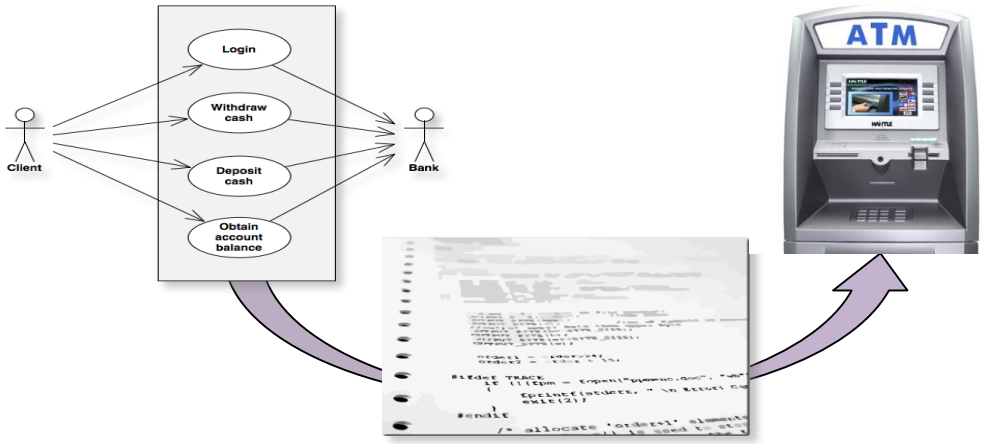
West Tehran Branch, Islamic Azad University, Tehran, Iran

9 November, 2019

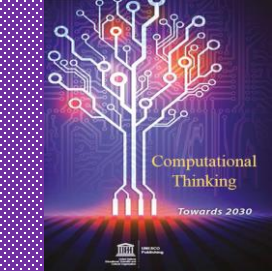
What is Computer Science … not

Computer Science is not Programming

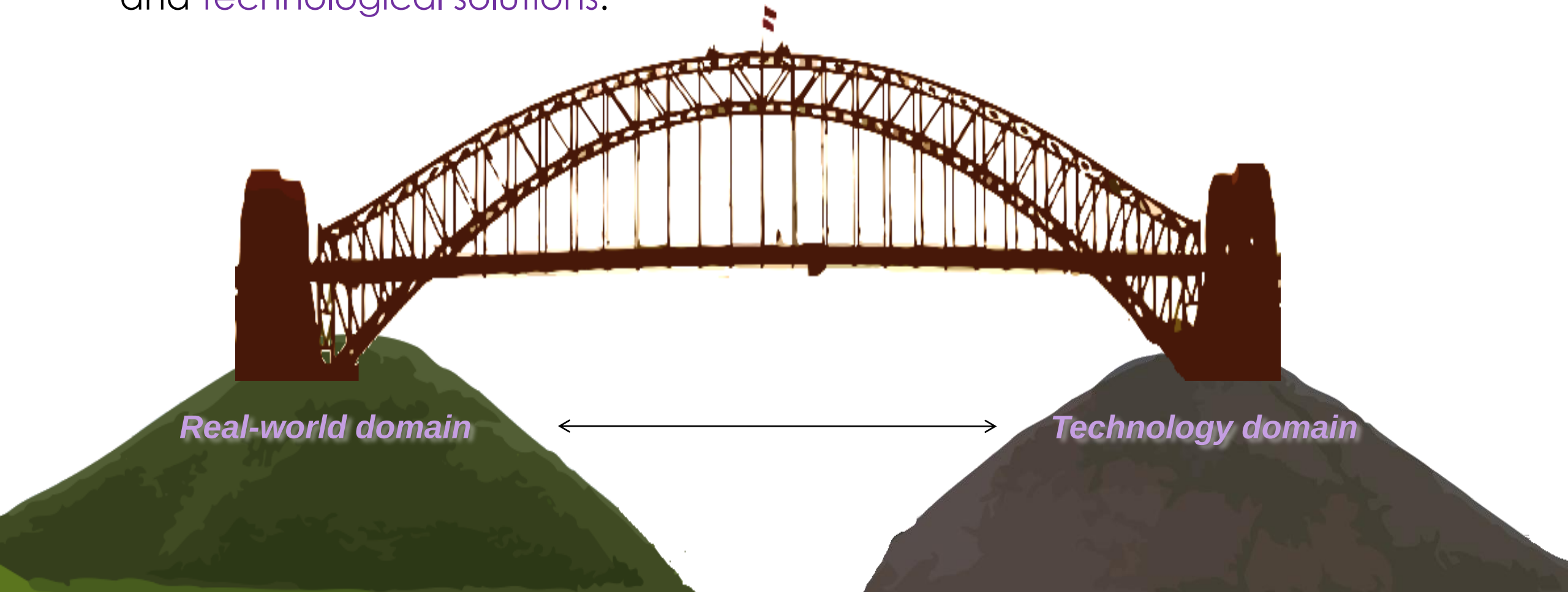
- Programming a key tool in CS
- Programming is **modeling**
  - A model captures certain properties of interest of a subject



What is Computer Science?



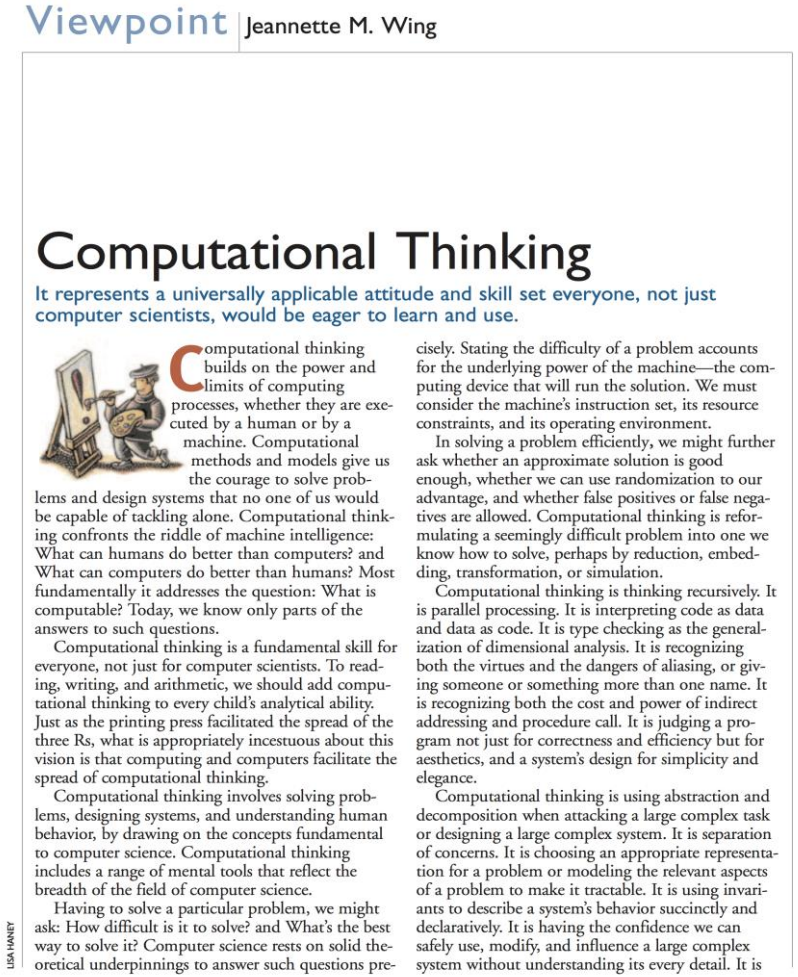
Computer Science is about building bridges between Human problems and technological solutions.



CS is about Computational Thinking

- Dr. Jeannette Wing of Microsoft Research (formerly at Carnegie Mellon) offered an update on her 2006 article introducing the idea of "Computational Thinking."
- In her talk, Dr. Wing predicted that "computational thinking will be a fundamental skill used by everyone in the world by the middle of the 21st century."

Source: Jeannette Wing, slides from August 2016 public workshop.



Viewpoint | Jeannette M. Wing

Computational Thinking

It represents a universally applicable attitude and skill set everyone, not just computer scientists, would be eager to learn and use.

Computational thinking builds on the power and limits of computing processes, whether they are executed by a human or by a machine. Computational methods and models give us the courage to solve problems and design systems that no one of us would be capable of tackling alone. Computational thinking confronts the riddle of machine intelligence: What can humans do better than computers? and What can computers do better than humans? Most fundamentally it addresses the question: What is computable? Today, we know only parts of the answers to such questions.

Computational thinking is a fundamental skill for everyone, not just for computer scientists. To reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability. Just as the printing press facilitated the spread of the three Rs, what is appropriately incestuous about this vision is that computing and computers facilitate the spread of computational thinking.

Computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science. Computational thinking includes a range of mental tools that reflect the breadth of the field of computer science.

Having to solve a particular problem, we might ask: How difficult is it to solve? and What's the best way to solve it? Computer science rests on solid theoretical underpinnings to answer such questions precisely. Stating the difficulty of a problem accounts for the underlying power of the machine—the computing device that will run the solution. We must consider the machine's instruction set, its resource constraints, and its operating environment.

In solving a problem efficiently, we might further ask whether an approximate solution is good enough, whether we can use randomization to our advantage, and whether false positives or false negatives are allowed. Computational thinking is reformulating a seemingly difficult problem into one we know how to solve, perhaps by reduction, embedding, transformation, or simulation.

Computational thinking is thinking recursively. It is parallel processing. It is interpreting code as data and data as code. It is type checking as the generalization of dimensional analysis. It is recognizing both the virtues and the dangers of aliasing, or giving someone or something more than one name. It is recognizing both the cost and power of indirect addressing and procedure call. It is judging a program not just for correctness and efficiency but for aesthetics, and a system's design for simplicity and elegance.

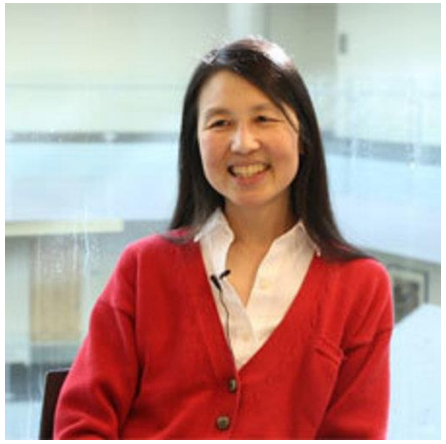
Computational thinking is using abstraction and decomposition when attacking a large complex task or designing a large complex system. It is separation of concerns. It is choosing an appropriate representation for a problem or modeling the relevant aspects of a problem to make it tractable. It is using invariants to describe a system's behavior succinctly and declaratively. It is having the confidence we can safely use, modify, and influence a large complex system without understanding its every detail. It is

LISA HANEY

What Is Computational Thinking?

"Computational thinking is a way of solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to ***computer science****"*

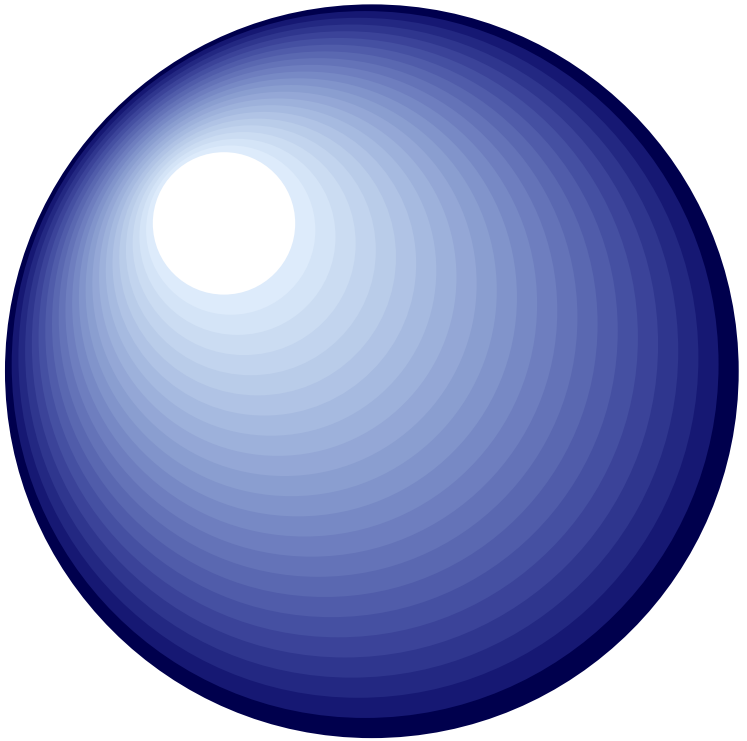
— Jeannette M. Wing, CACM 2006



Critical thinking + Computing power = Making decisions and Innovate solutions

Alfred Spector: Computational Thinking

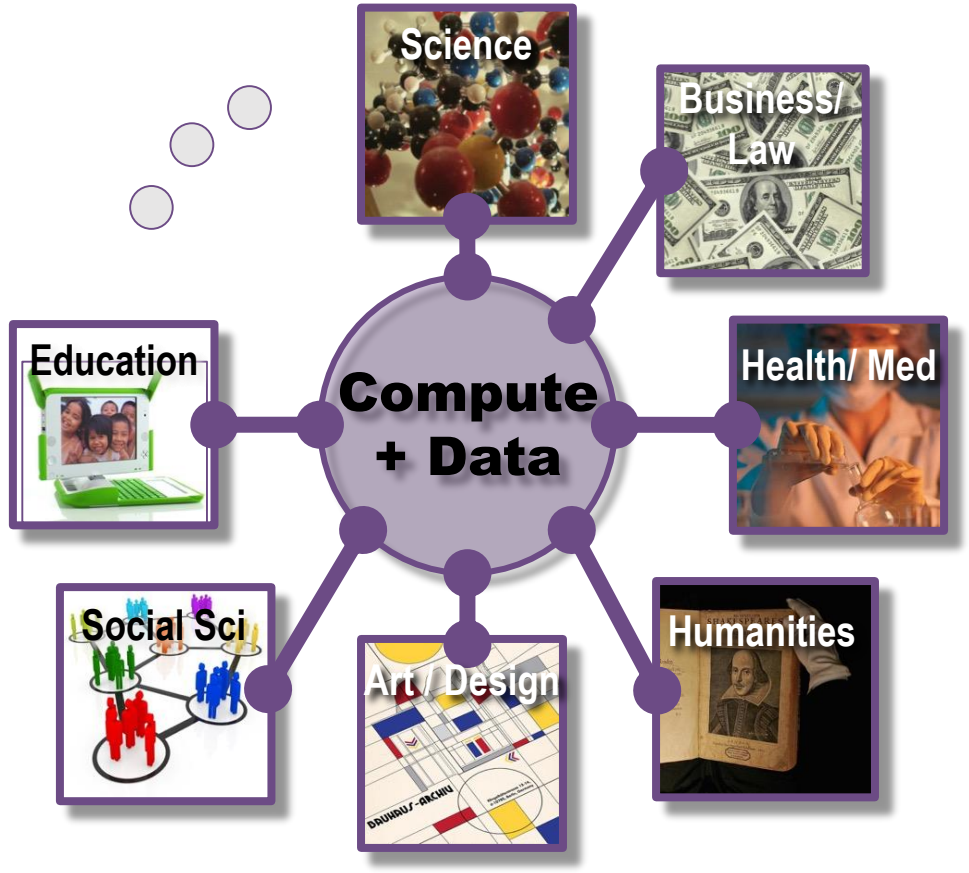
- Dr. Alfred Spector, founder and CEO of Two Sigma Ventures and formerly at Google and Carnegie Mellon, likened computer science today to an expanding sphere that touches every discipline.
- Dr. Spector noted that the growth offers "vast opportunity at the edge as the sphere expands into $\forall X_i$ CS+X_i (CS+X for all X)."
- Prophetically, Dr. Spector initially used this slide in a talk at Harvard in 2004.



Source: Alfred Spector, slides from August 2016 public workshop

Rob Rutenbar: Go Big, Go Wide, Go Deep

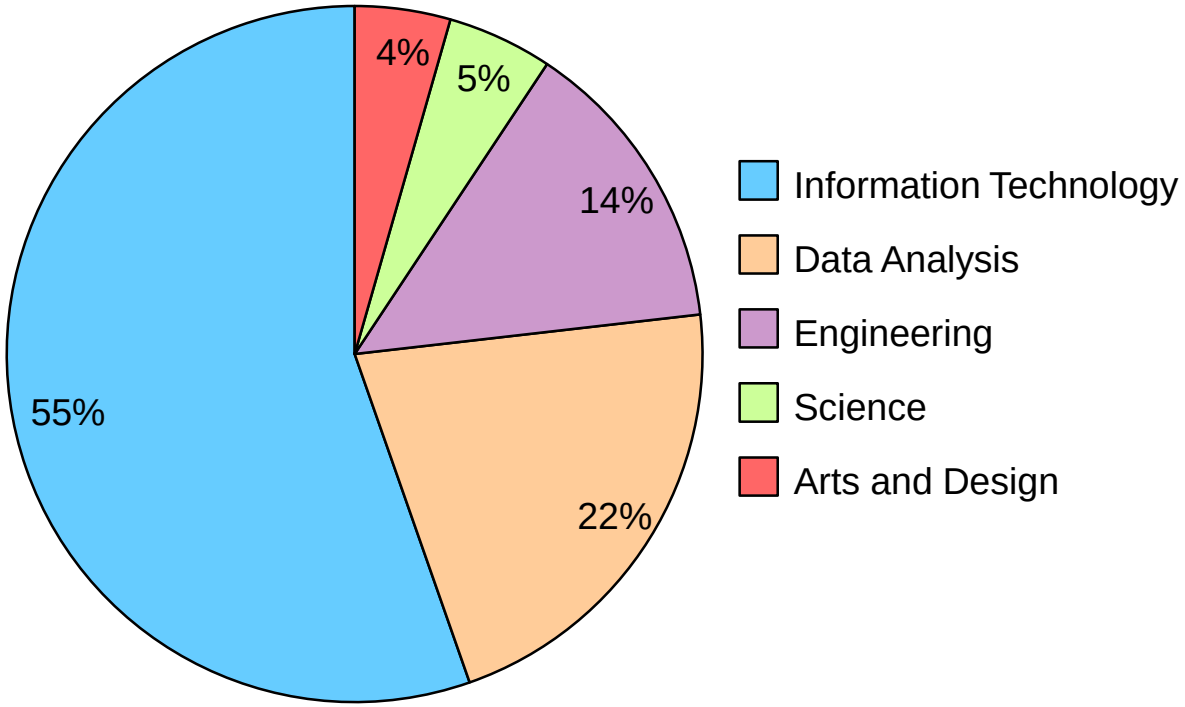
- Dr. Rob Rutenbar of the University of Illinois at Urbana-Champaign noted the variety of connections between computation and other fields.
- These connections form the foundation for the CS+X program at UIUC.



Source: Rob Rutenbar, slides from August 2016 public workshop.

Computing Jobs Exist in Many Areas

- Burning Glass Technologies (BGT) estimates that 45% of all jobs that require advanced computer science training are outside the traditional IT sector.
- The growing importance of computing[1] is reflected in the proliferation of CS+X programs that combine CS with other discipline.



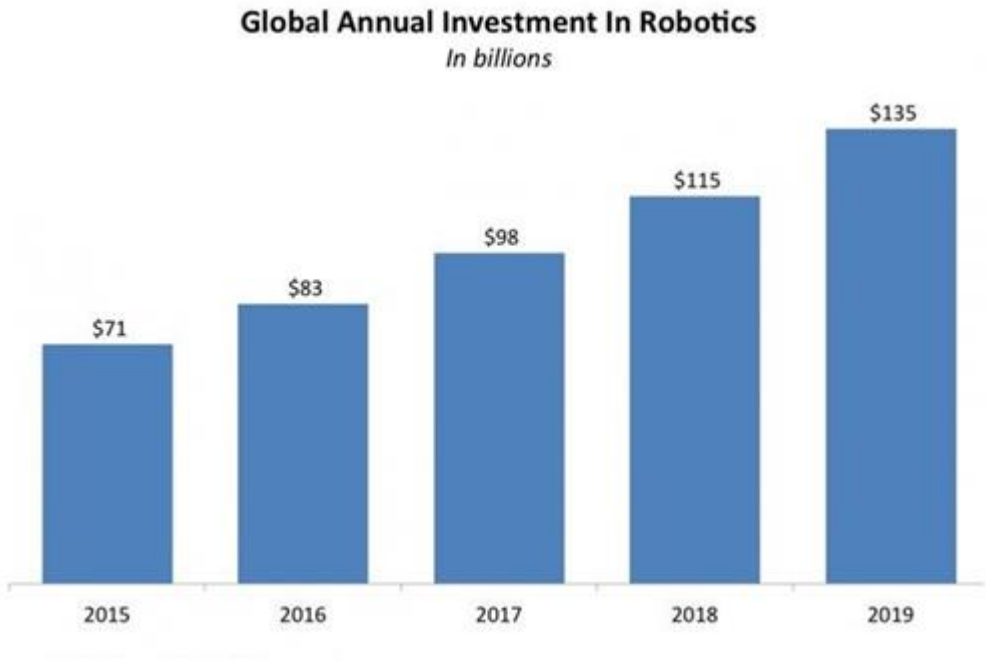
[1] At public meeting for the National Academies report in August 2016

Source: Burning Glass Technologies, Beyond Point and Click.

Growing Trends that will Continue to Expand

M.G. Siegler, general partner at GV (formerly Google Ventures)

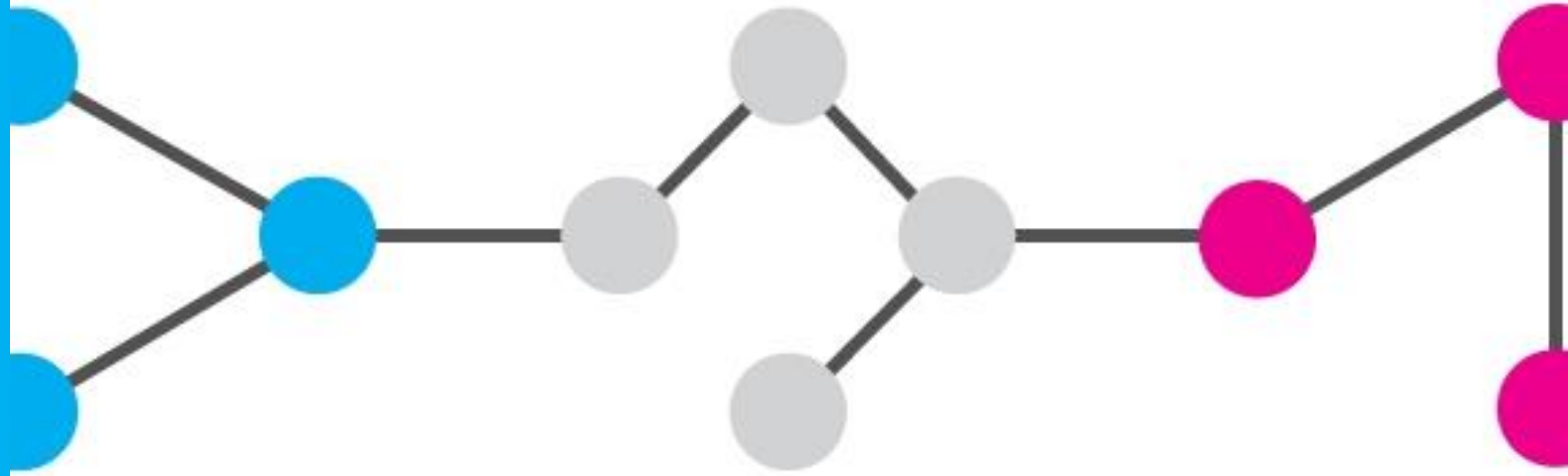
"Artificial intelligence and machine learning are the growing trends to continue gaining speed into next year…Obviously, products like the Amazon Echo, Google Home, Apple's AirPods have planted the seeds.



Source: *IDC, BI Intelligence Estimates, 2016*

What is Artificial Intelligence (AI)?

Artificial intelligence is about making computers able to perform the thinking tasks that humans and animals are capable of.



Problems Solved By AI

We can already program computers to have super-human abilities in solving many problems:

Arithmetic

Multivariate Mathematics Equations

Sorting

Sorting Millions of Data

Searching

Smart Searching

Face Recognition

Facial Muscle Movement Recognition

Natural Language Speaking

Voice Recognition and Natural Language

Decision Making

Risk Analysis

Where AI is used?

Transportations

Traffic Patterns, Pedestrian Safety, Autonomous Vehicles, Improvement of Public Safety, Corporate Decision Making, etc

Medicine

Disease Prediction, Robotic Surgery, Gene Research, Protein Structure Prediction, Drug development, Patient profiling etc.

Banking

Transaction Patterns, Fraud Detection, Money Laundry Recognition, Profiling Customers, Streamlining Processes etc.

Security

Network intrusion detection, Maleware detection, Anti Spam, Cyber terrorism surveillance, Chat mining etc.

Business

Prediction Modeling, Risk Management, Recommender System, Tourism, Education, Manufacturing, Agriculture, Oil and Gas etc.

Marketing

Customer Relation Management, Market Basket Analysis, Smart Insights and Prediction Models etc.

Ai is everywhere!

"DEEP LEARNING HELPS ALPHABET'S GOOGLE IMPROVE ITS SEARCH RESULTS"

"AIRBNB RS USES MACHINE LEARNING TO RECOMMEND THE BEST PLACE TO STAY"

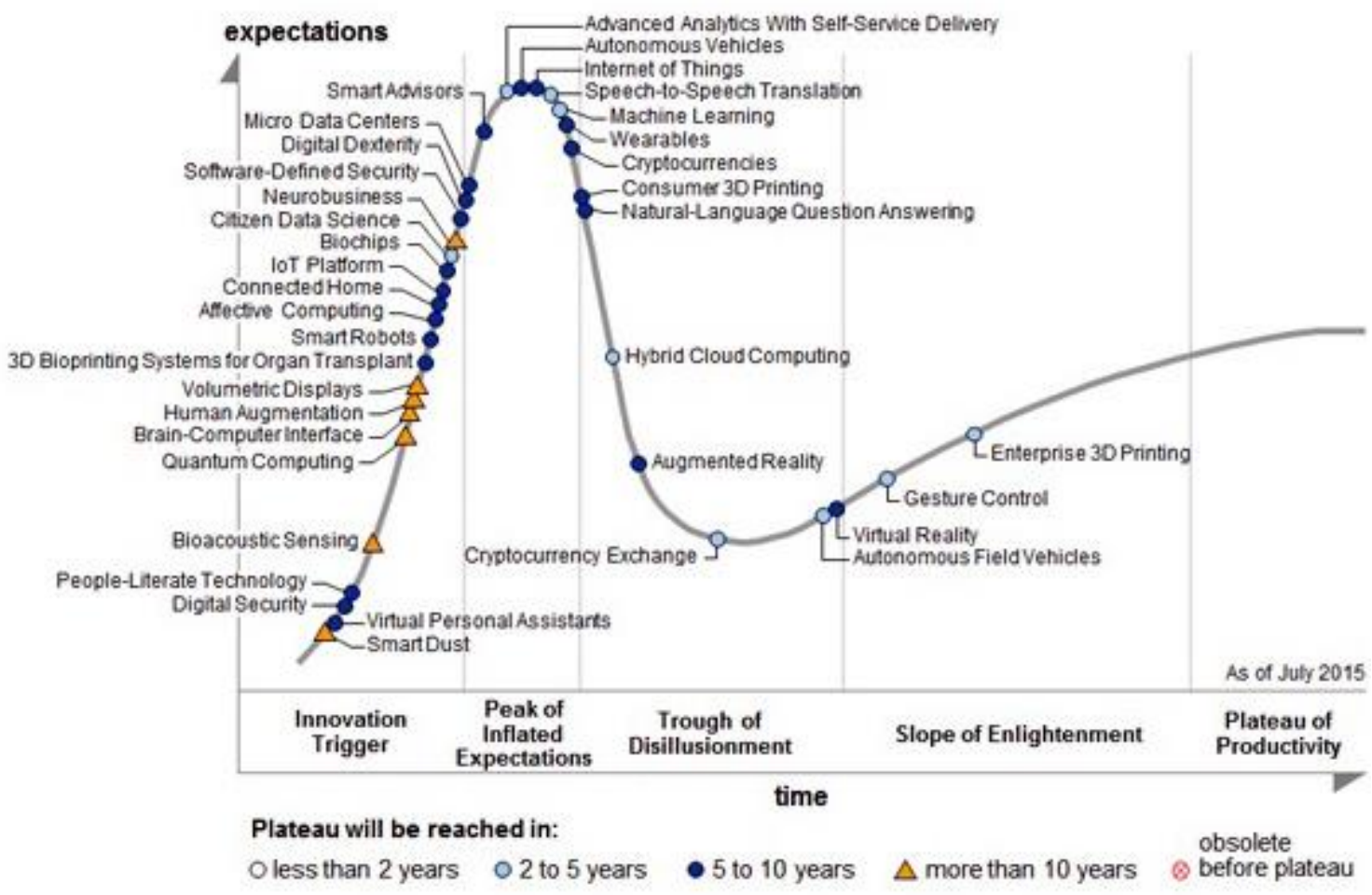
"BIG TECH COMPANIES HAVE DEVELOPED AI-POWERED VIRTUAL ASSISTANTS"

"GENERAL ELECTRIC USES COMPUTER VISION SYSTEMS TO QUICKLY IDENTIFY CRACKS IN JET ENGINE BLADES"

"MASTERCARD USES MACHINE LEARNING TOOLS TO ANALYZE MORE THAN 1.3 BILLION TRANSACTIONS PER DAY AND HELP DETECT FRAUD"

"NASA IS USING ARTIFICIAL INTELLIGENCE TO FIND EXPLANETS, SEARCH FOR OTHER LIFEFORMS IN THE UNIVERSE, AND ANOMALY DETECTION. "

Ai is booming (1/3)



Ai is booming (1/3)

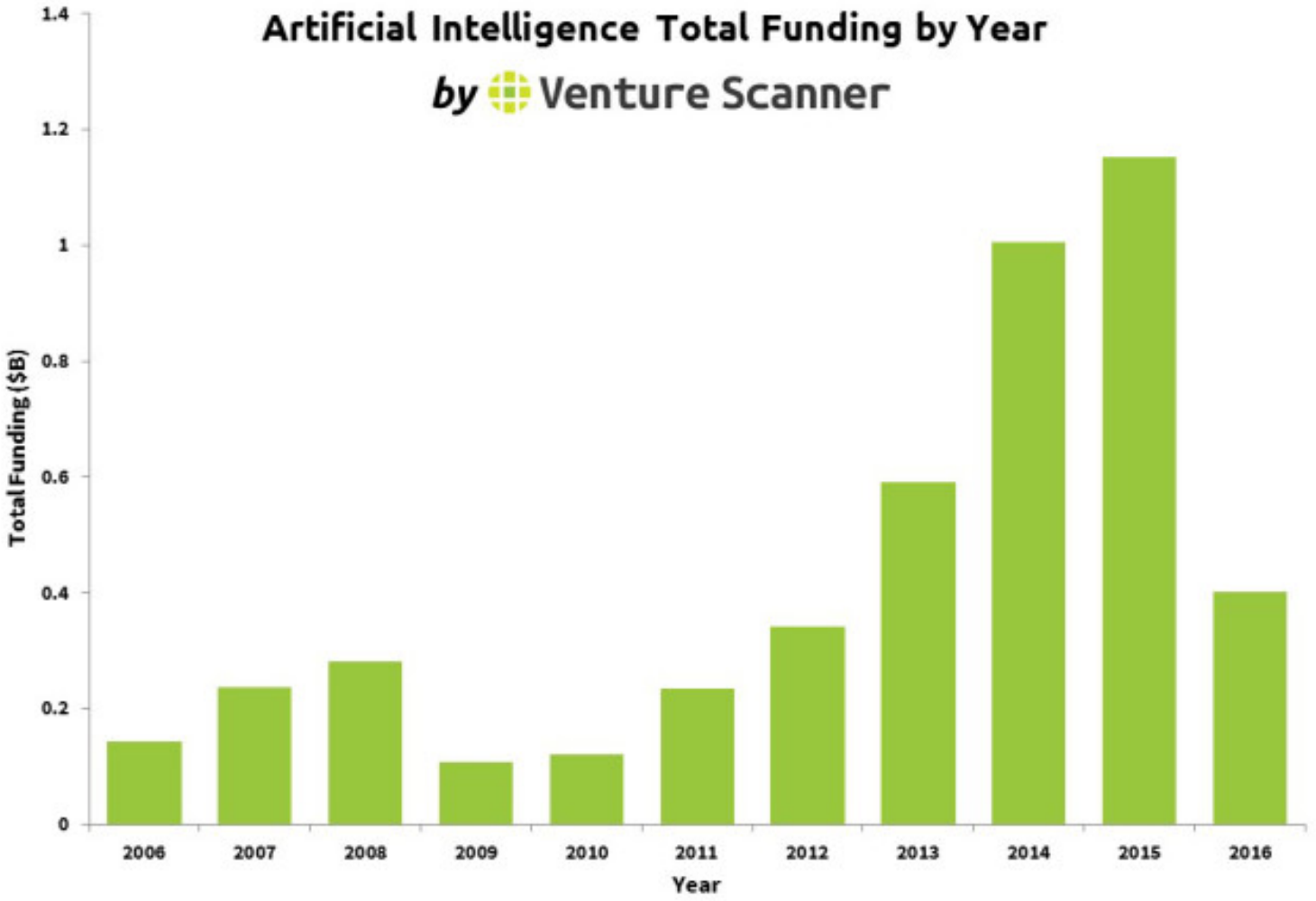
AI IS AT THE PEAK OF HYPE

AI features prominently on analyst firm Gartner's Hype Cycle for Emerging Technologies

Unlikely that all of the technologies flagged up in Gartner's Hype Cycle will make it to the mainstream. But there's enough current interest and activity to ensure that some will -- and when they do, there will be serious implications for businesses.

References: Gartner

Ai is booming (2/3)



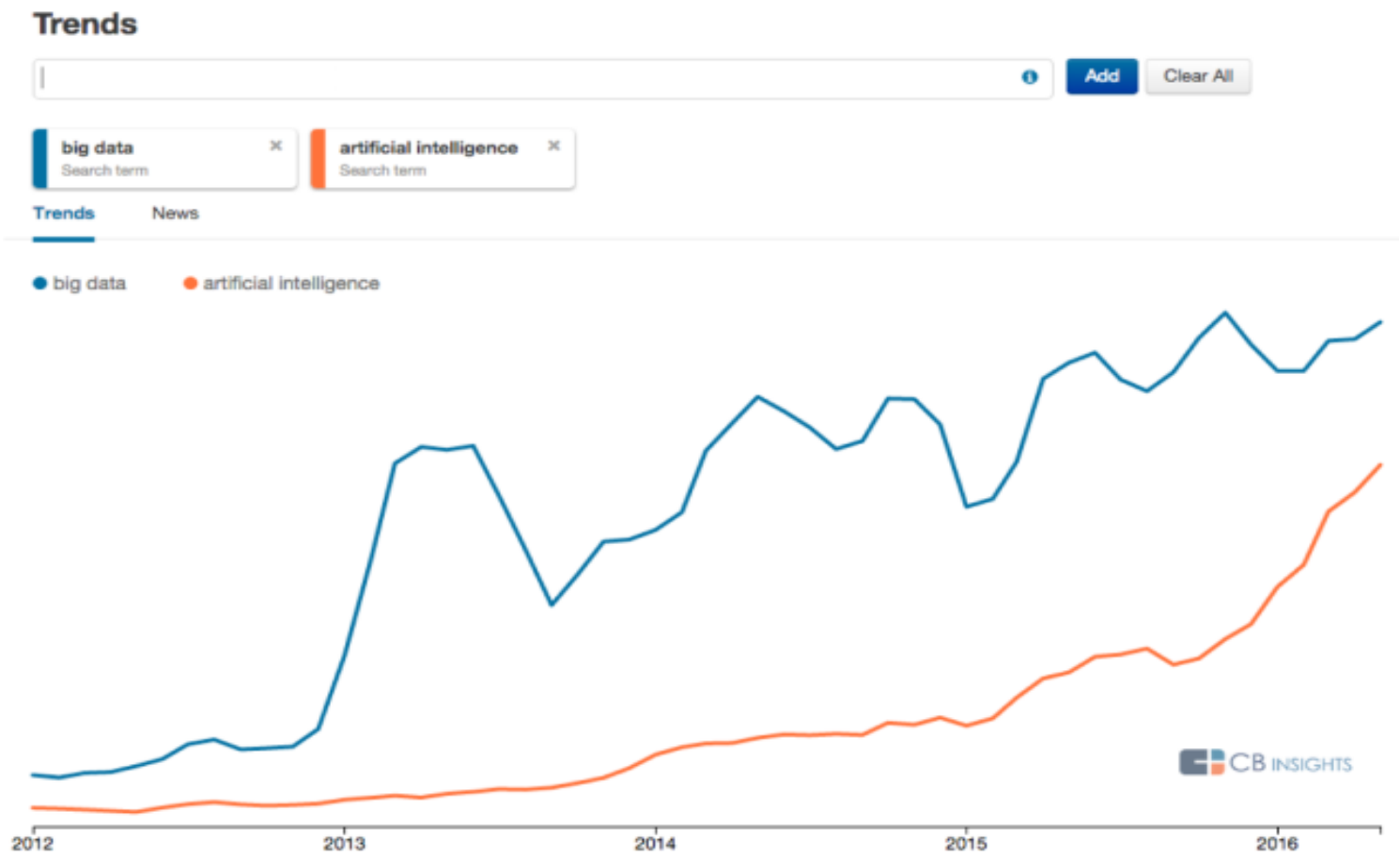
Ai is booming (2/3)

RESURGENCE OF STARTUP FUNDING ACTIVITY

The Machine Learning (Applications) category is leading with over $2B in funding and 263 companies. Natural Language Processing is the runner-up in both stats with $662M in funding and 154 companies.

References: Venture Scanner

Ai is booming (3/3)



CB Insights Trends is software that analyzes millions of media articles to programmatically identify and understand the rate of adoption of emerging technologies and innovations.

References: CB Insights

Ai is booming (3/3)

ARTIFICIAL INTELLIGENCE IS THE NEW BIG DATA

International Data Corp. predicts the worldwide market for cognitive software platforms and applications, which roughly defines the market for AI, to grow to $16.5 billion in 2019 from $1.6 billion in 2015 with a CAGR of 65.2%. The market includes offerings from both established tech giants and AI startups.

Digital Era “2019”

The number of internet users worldwide in 2019 is 4.388 billion, up 9.1 percent year-on-year

The number of social media users worldwide in 2019 is 3.484 billion, up 9 percent year-on-year

The number of mobile phone users in 2019 is 5.112 billion, up 2 percent year-on-year

Our Digital World

Million Users Per Social Media Platform

2,2B Facebook	1,5B YouTube	1,3B WhatApp
980M WeChat	800M Instagram	330M Twitter
300M Skype	260M LinkedIn	200M Pinterest

The Future of AI:
Data Generation – Data Mining

every minute...

YouTube users watch 4.1 million videos.

Google delivers results for 3.6 million searches.

Wikipedia users publish 600 new edits.

2.500.000.000.000.000 Bytes are daily generated

Data Mining

- **The world is data rich but information poor!**
- **How can I analyze these data?**

AI Through Data Mining

Data mining is used to discover interesting patterns and relationships in the massive data in order to help make better decisions.

Data mining is the process of discovering patterns in **large data sets** involving methods at the intersection of **machine learning**, **statistics**, and **database systems**.

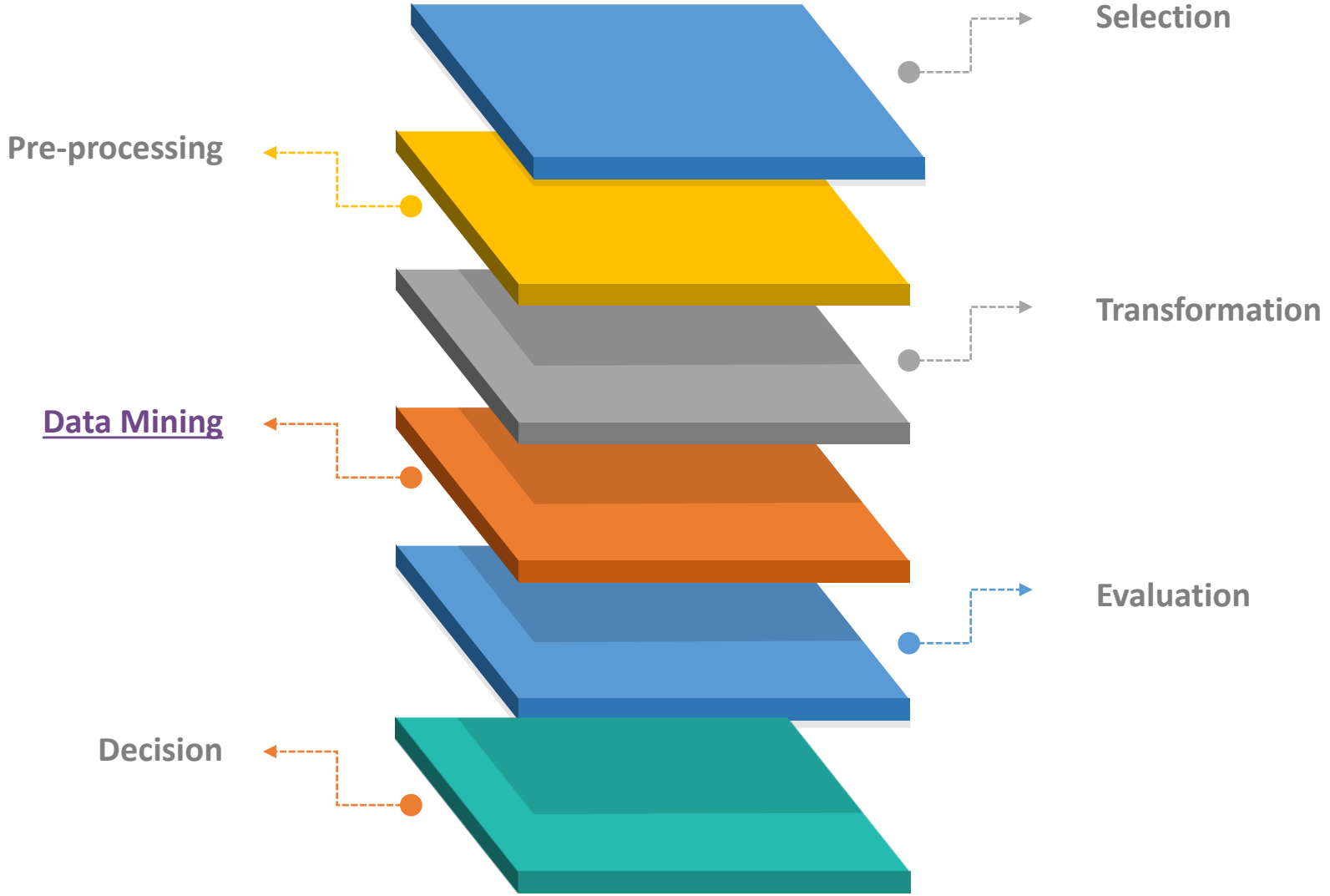
Large Data Sets

Data Base Systems

Machine Learning

Statistics

The Way To AI: Knowledge Discovery from Data (KDD)



Data Mining Projects

Industries/Fields where you applied Analytics, Data Mining, Data Science in 2016?

CRM/Consumer analytics (90)	16.3% 18.6% 22.2%
Finance (83)	15.0% 15.4% 10.9%
Banking (74)	13.4% 14.3% 16.7%
Advertising (66)	12.0% 8.9% 10.4%
Science (66)	12.0% 11.7% 13.6%
Health care (66)	12.0% 13.4% 16.3%
Fraud Detection (61)	11.1% 10.0% 13.6%
Retail (57)	10.3% 9.1% 13.6%
Insurance (51)	9.2% 7.4% 8.6%
E-commerce (49)	8.9% 10.3% 9.5%
Telecom / Cable (46)	8.3% 7.7% 9.0%

Industries/Fields where you applied Analytics, Data Mining, Data Science in 2016?

Data Mining Projects

	2016 % of voters	2015 % of voters	2014 % of voters
Social Media / Social Networks (46)	8.3%	10.3%	8.6%
Software (40)	7.2%	6.0%	7.2%
IT / Network Infrastructure (40)	7.2%	6.6%	na
Oil / Gas / Energy (39)	7.1%	8.9%	9.5%
Education (39)	7.1%	10.0%	7.7%
Credit Scoring (38)	6.9%	7.1%	8.1%
Supply Chain (36)	6.5%	na	na
Medical/ Pharma (36)	6.5%	6.0%	7.2%
Other (35)	6.3%	8.9%	13.6%
Investment / Stocks (34)	6.2%	4.3%	5.0%
Biotech/Genomics (32)	5.8%	4.9%	6.8%

Industries/Fields where you applied Analytics, Data Mining, Data Science in 2016?

Data Mining Projects

2016 % of voters
2015 % of voters
2014 % of voters

Manufacturing (31)	5.6% 6.9% 9.0%
Government/Military (31)	5.6% 7.1% 6.3%
Search / Web content mining (30)	5.4% 6.0% 6.3%
Automotive/Self-Driving Cars (25)	4.5% 4.3% 5.9%
Direct Marketing/ Fundraising (24)	4.3% 5.1% 7.2%
Mining (23)	4.2% 3.7% na
Travel / Hospitality (22)	4.0% 2.6% 3.2%
Entertainment/ Music/ TV/Movies (22)	4.0% 3.1% 1.8%
HR/workforce analytics (20)	3.6% 6.3% 5.9%
Mobile apps (18)	3.3% 1.4% 2.3%
Agriculture (18)	3.3% 2.9% na

Data Mining Projects

Industries/Fields where you applied Analytics, Data Mining, Data Science in 2016?

	2016 % of voters	2015 % of voters	2014 % of voters
Games (16)	2.9%	4.0%	1.8%
Security / Anti-terrorism (15)	2.7%	2.3%	2.3%
Social Good/Non-profit (11)	2.0%	2.3%	1.4%
Social Policy/Survey analysis (10)	1.8%	1.7%	1.8%
Junk email / Anti-spam (6)	1.1%	0.3%	1.8%

Source: https://www.kdnuggets.com/2016/12/poll-analytics-data-mining-data-science-applied-2016.html

Top Data Mining Tools

rapidminer

TensorFlow

MATLAB

python™

WEKA
The University
of Waikato

hadoop

R

orange
DATA MINING
FRUITFUL&FUN

ORACLE®

Microsoft®
SQL Server®

Excel

IBM
SPSS MODELER
PROFESSIONAL

KNIME

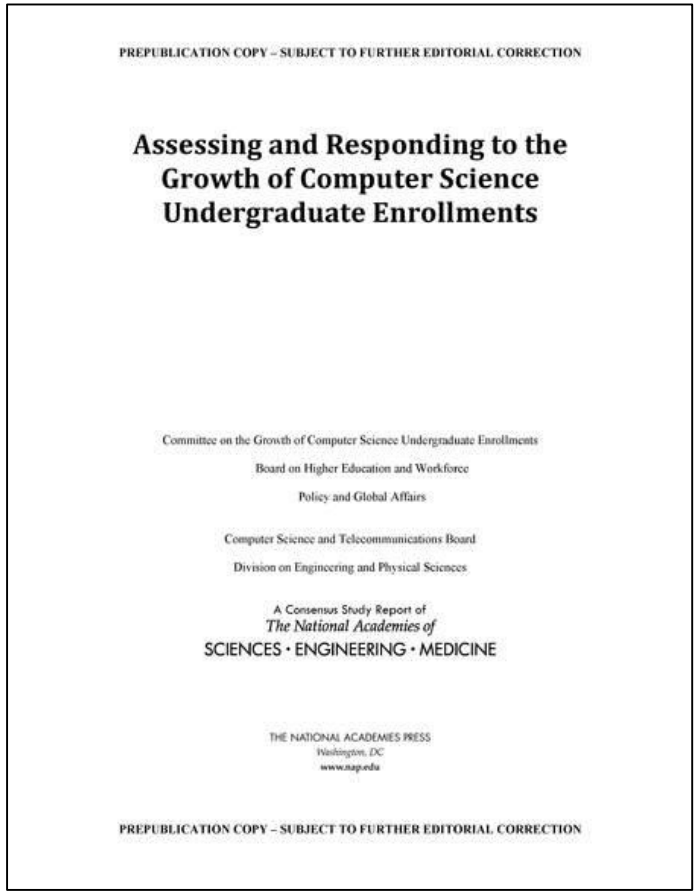
sas
THE POWER TO KNOW®

+ableau

APACHE
Spark™

The National Academies Report

- On October 26, 2017, the **National Academies** released its report (in prepublication form) on the growing enrollments in computer science and the challenges that universities and colleges face in responding to the demand.
- This presentation reproduces these findings along with additional slides outlining the supporting evidence.



PREPUBLICATION COPY – SUBJECT TO FURTHER EDITORIAL CORRECTION

Assessing and Responding to the Growth of Computer Science Undergraduate Enrollments

Committee on the Growth of Computer Science Undergraduate Enrollments

Board on Higher Education and Workforce

Policy and Global Affairs

Computer Science and Telecommunications Board

Division on Engineering and Physical Sciences

A Consensus Study Report of
The National Academies of
SCIENCES • ENGINEERING • MEDICINE

THE NATIONAL ACADEMIES PRESS
Washington, DC
www.nap.edu

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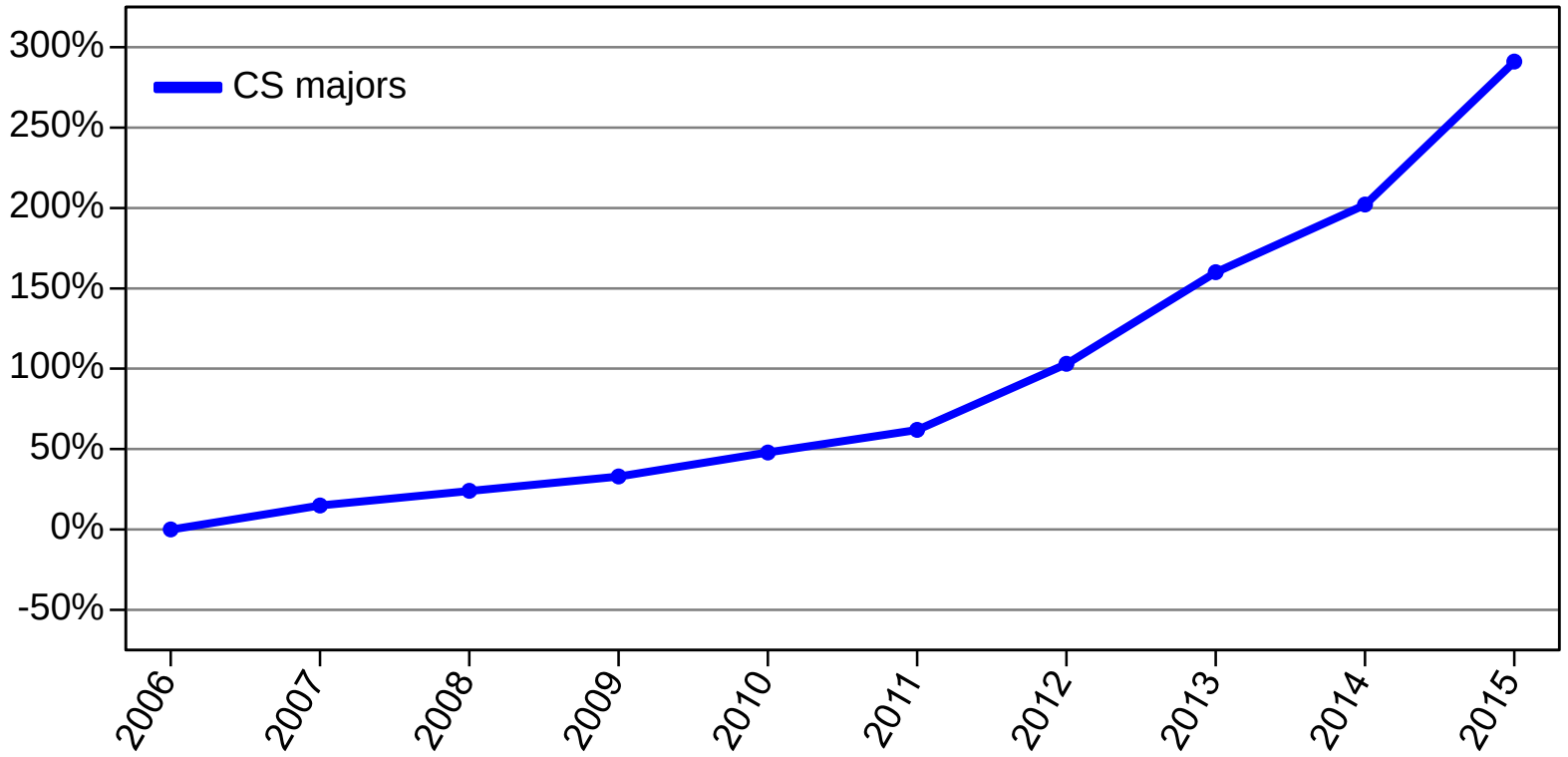
The Growth in Computing Degrees

Finding 1:

National bachelor's degree production in computer science production has increased by 74% between 2009 and 2015, over and above the increase in total degrees (16%).

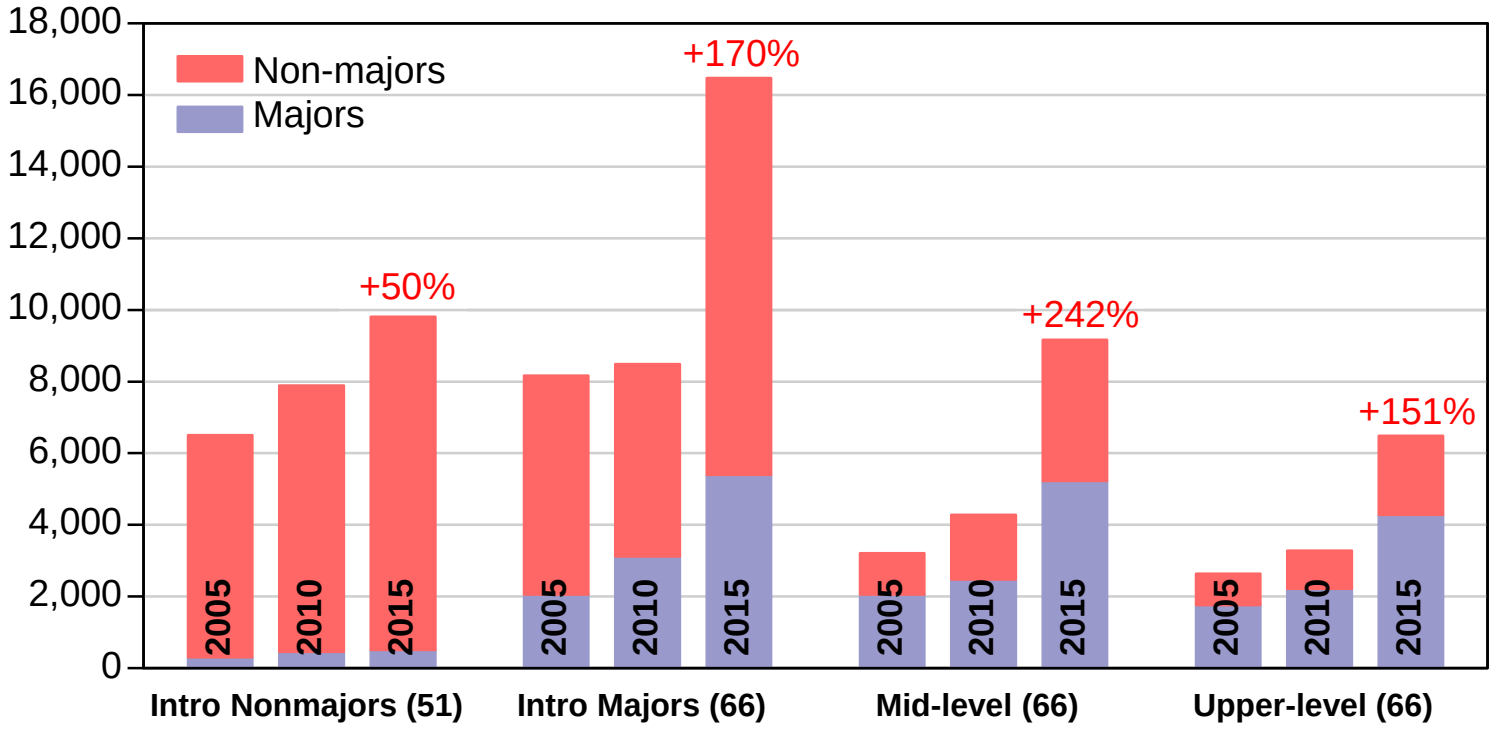


Source: Computing Research Association, *Generation CS*, February 2017

Majors and Non-Majors Are Growing

Finding 2:

Enrollments in CS courses and the number of CS majors have risen markedly since 2005, that shows dramatic growth at all levels of the curriculum for both majors and non-majors.



Source: Computing Research Association, *Generation CS*, February 2017

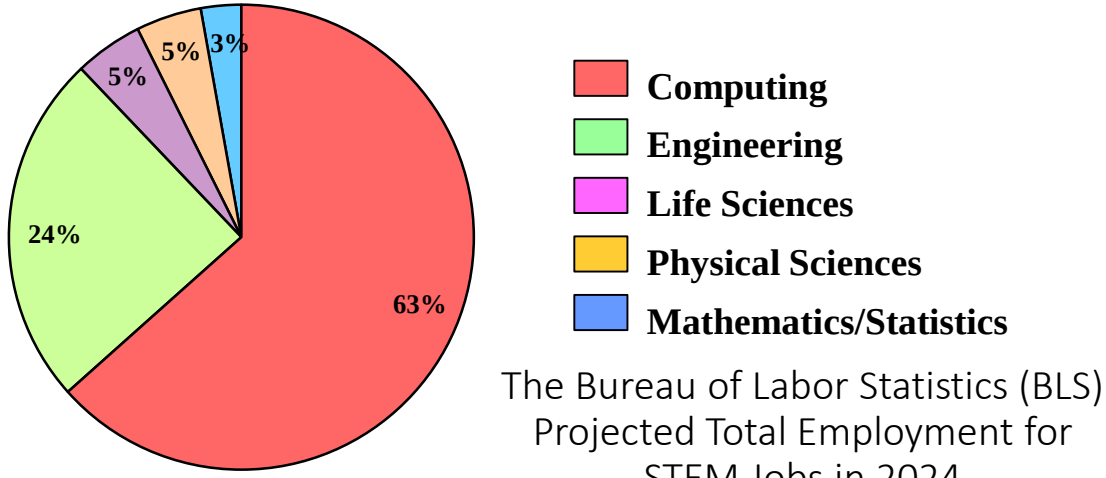
The Strong Growth of Computing Jobs

Finding 3:

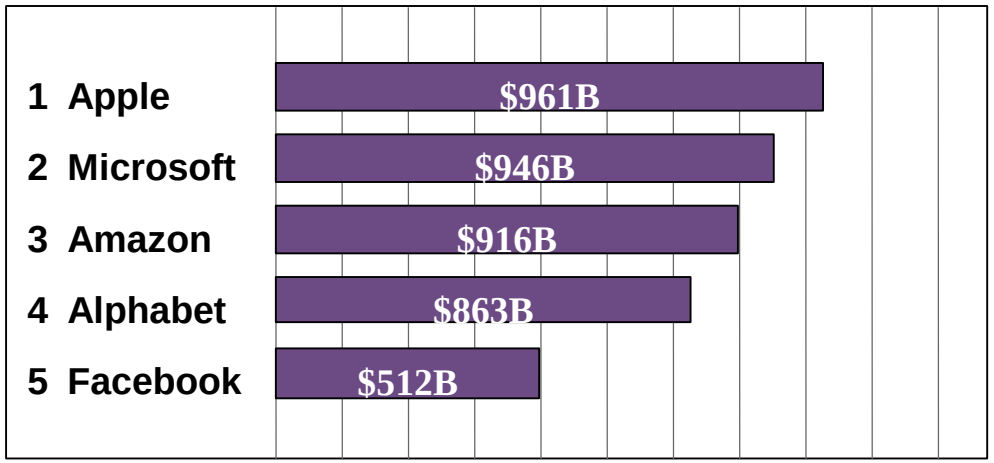
- From 1978 to 2015, employment in the computing sector has risen from 219,000 to 4,106,000, representing an 1800% increase during a time when total employment rose by only 58%.

On Prediction (BLS):

- Computers may replace as many as 75 million jobs by 2025.
- BUT, there will be as many as 133 million new jobs created.

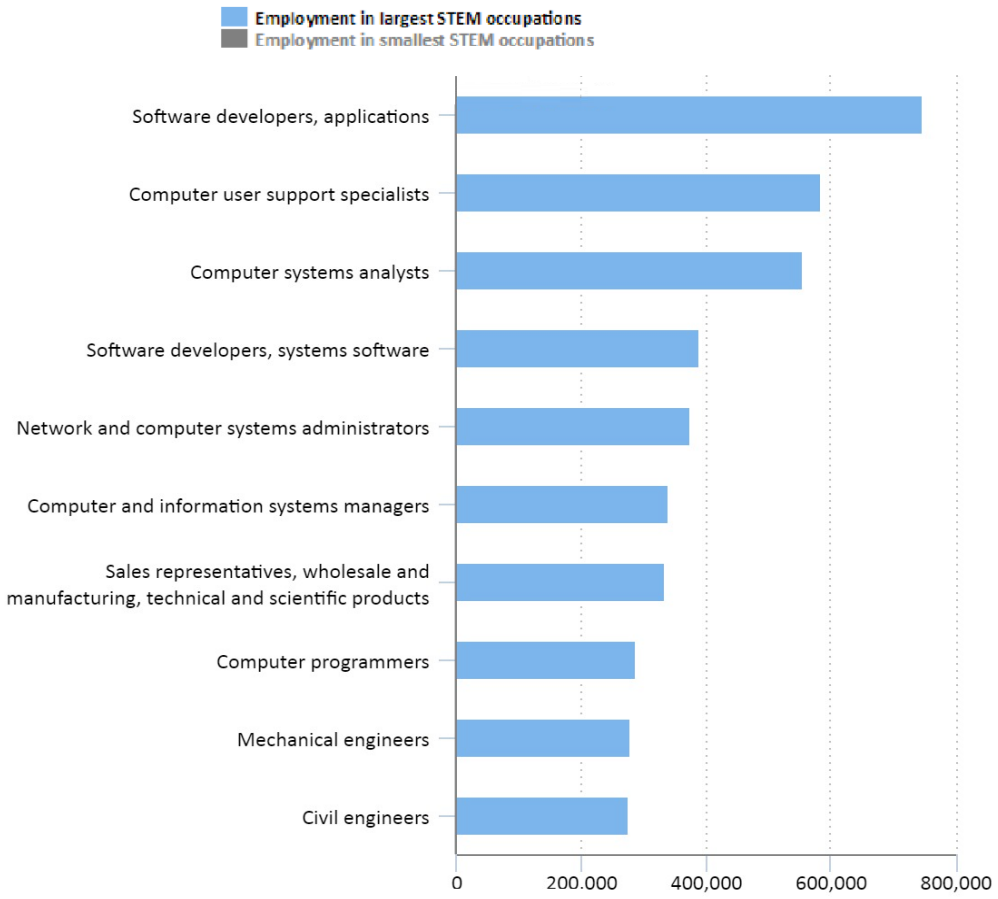


The Bureau of Labor Statistics (BLS) Projected Total Employment for STEM Jobs in 2024



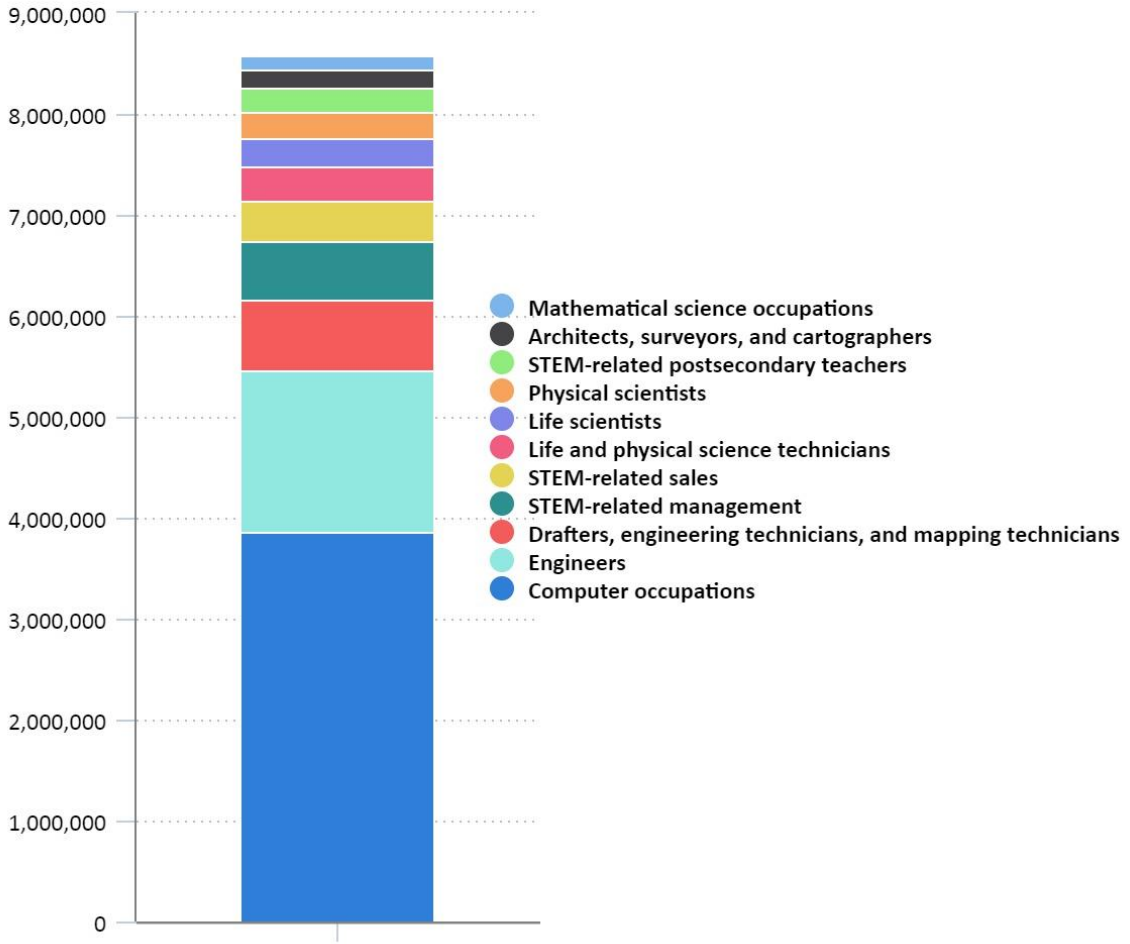
The Five Largest Industrial Corporations in 2019

Top 10 STEM Occupations by Total Employment in 2020



Employment for the largest and smallest STEM occupations, May 2015

Source: U.S. Bureau of Labor Statistics.

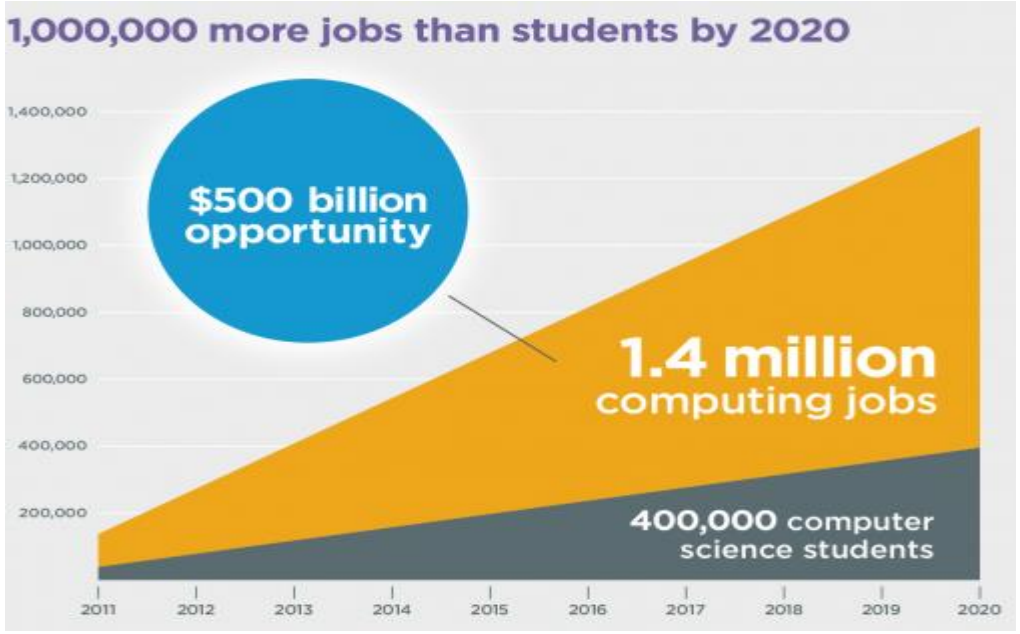


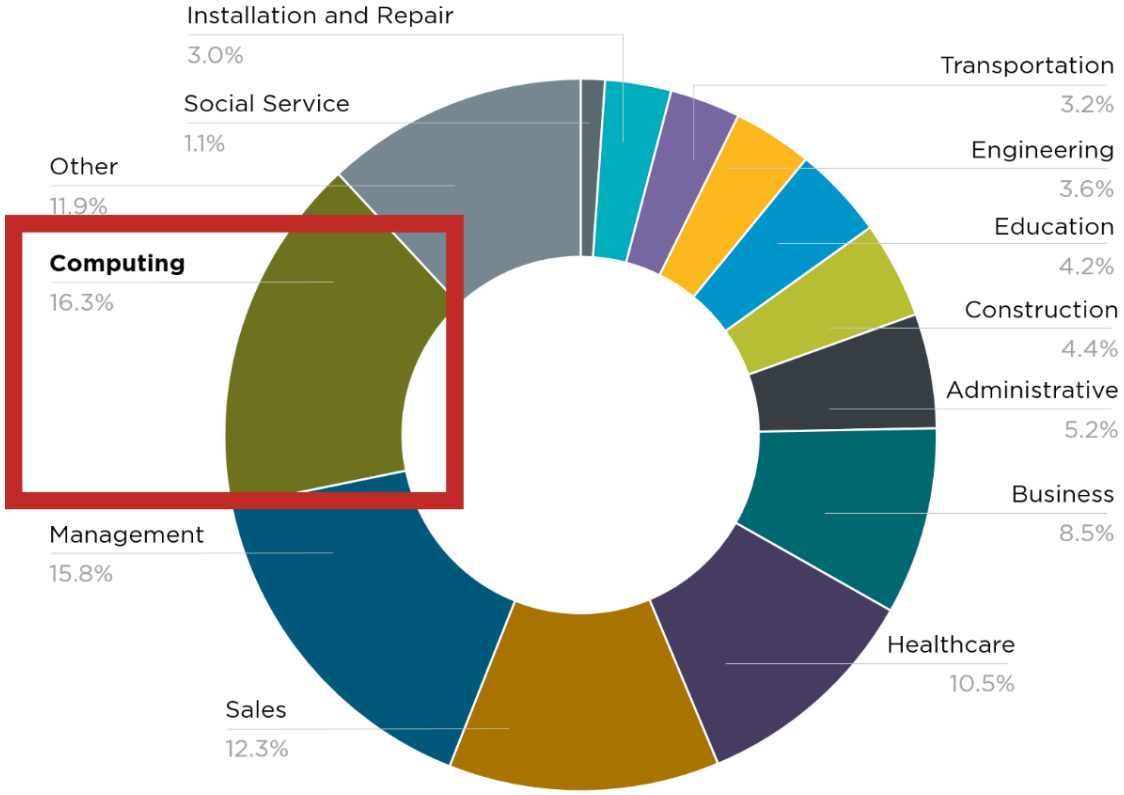
STEM employment by type of STEM occupation, May 2015

Source: U.S. Bureau of Labor Statistics.

Computing jobs are the #1 source of new wages in the United States

Computer science is a top paying college degree and computer programming jobs are growing at 2X the national average.





500,000 current openings: These jobs are in every industry and every state, 2017

Innovative Undergraduate Programs Salary

Engineering
Avg Salary:56,854

Computer science
Avg Salary: 67,393

Biology
Avg Salary: 52,000

Chemistry
Avg Salary: 55,000

Information Systems
Avg Salary: 69,660

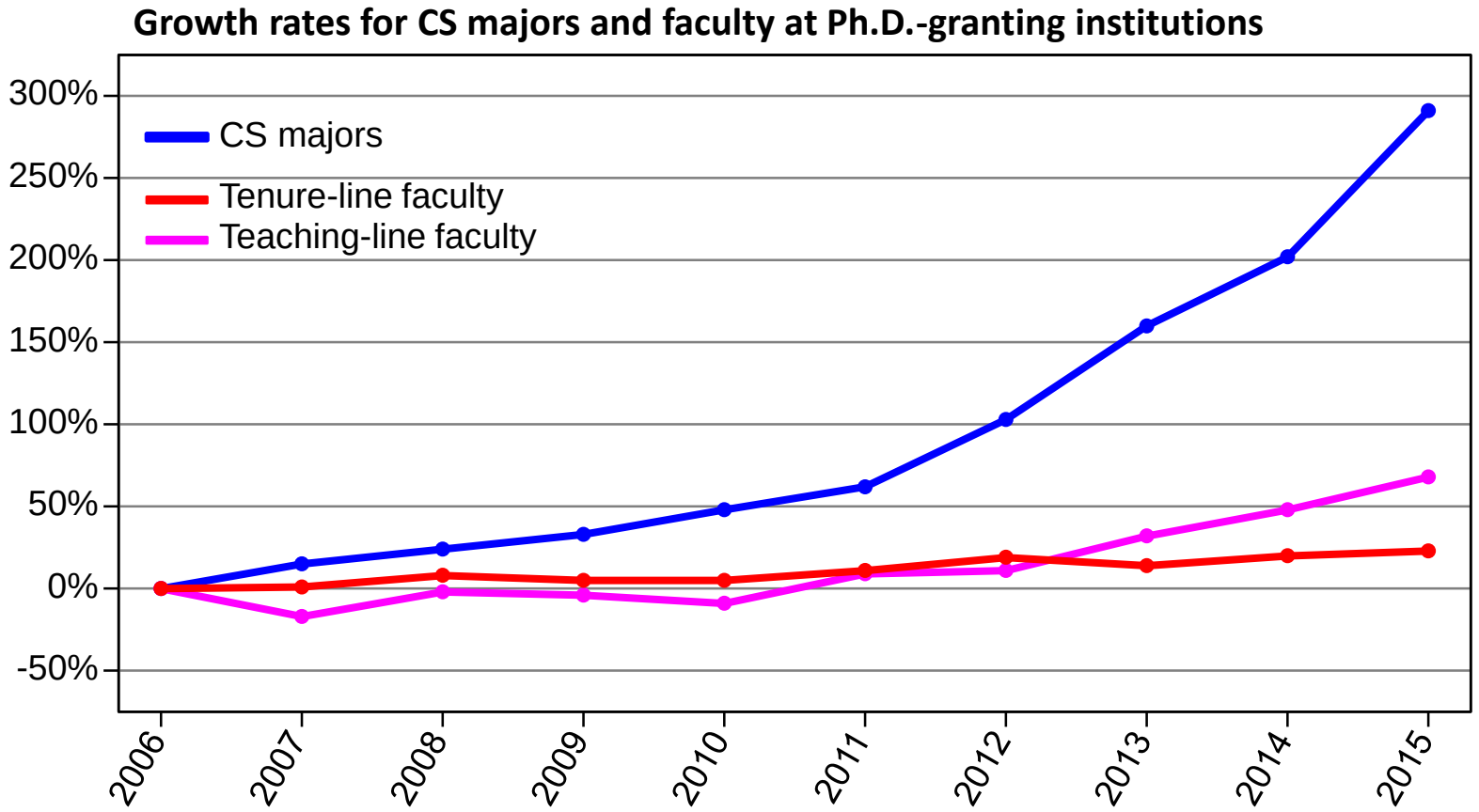
Business
Avg Salary: 53,122

Architecture
Avg Salary: 44,885

Faculty Hiring Lags Behind Demand

Finding 4:

Although institutions have started to hire more faculty in dedicated teaching lines, faculty numbers have not kept pace.

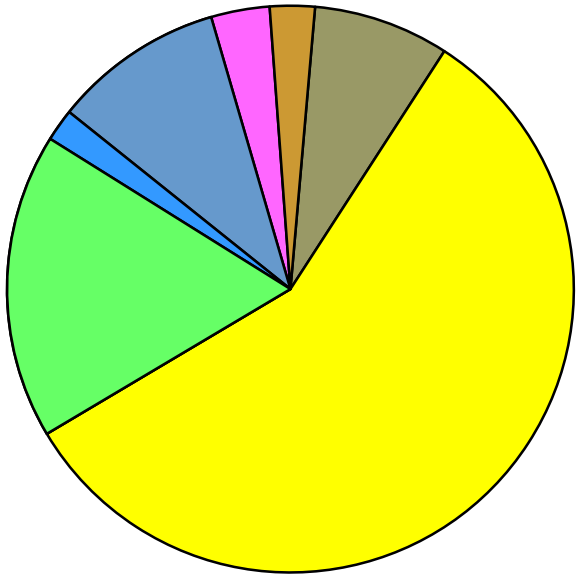


Source: Computing Research Association, *Generation CS*, February 2017

The Challenge of Faculty Recruitment

- The CRA Taulbee survey tracks where North American Ph.D. graduates take jobs. In 2015, the distribution looks like this·

Outside North America (8%)
Industry (57%)
Academia (29%)
Government (3%)
Other (3%)



- Some academic jobs, however, do not involve teaching:

Postdoctoral positions (10%)
Research positions (2%)

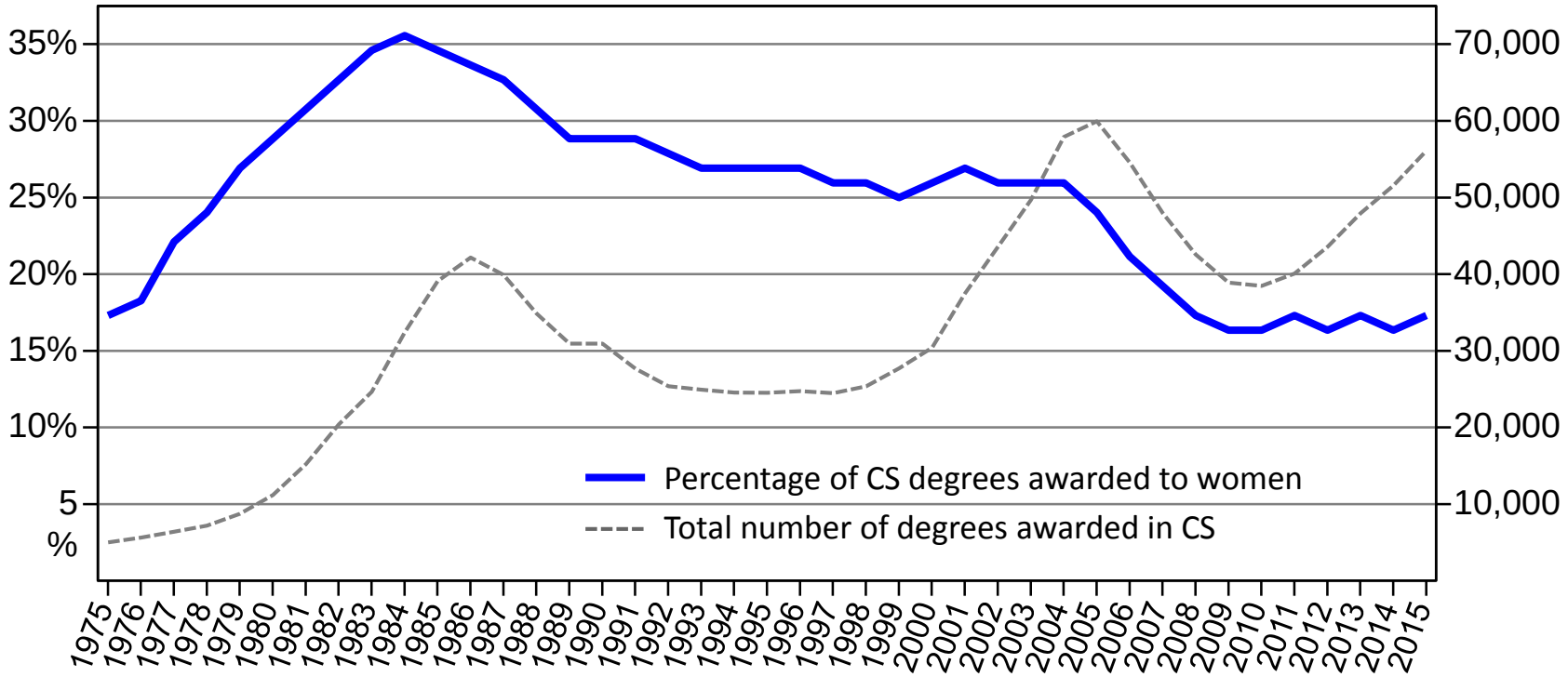
- Even among those few Ph.D.s taking faculty positions, some will be gobbled up by a voracious industry.

Gender Diversity

Finding 5:

CS have had low representation of women and minorities.

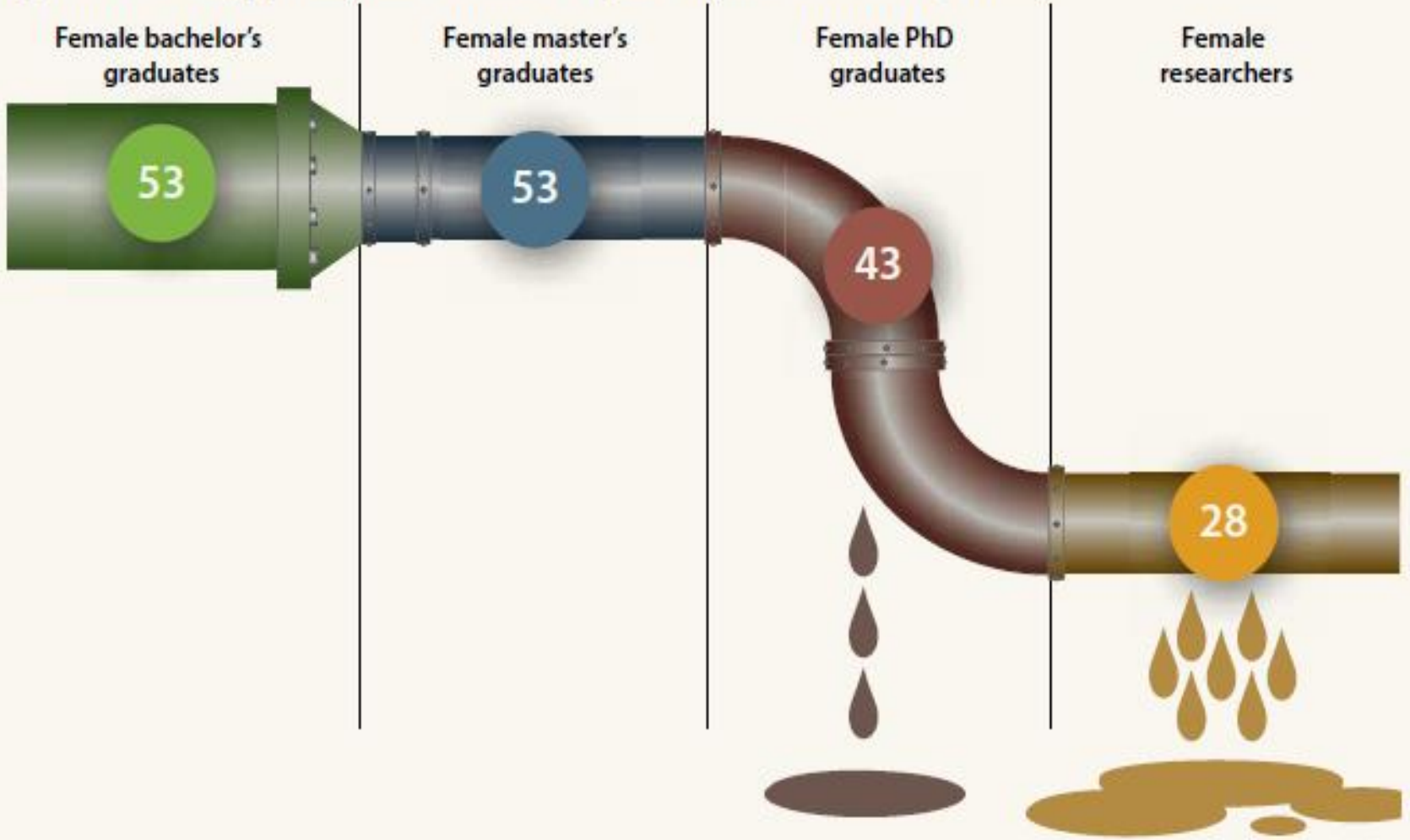
This trend of underrepresentation in bachelor's degree completions had not improved significantly as of 2015.



Source: National Center for Education Statistics, IPEDS database

Women in Science: Pipeline Starts Leaking at Doctoral Level

Figure 3.1: **The leaky pipeline: share of women in higher education and research, 2013 (%)**



Source: UNESCO Institute for Statistics estimates based on data from its database, July 2015

Research fields:

Parity achieved in life sciences

Women a minority in engineering and **computer science**

Women Closest to Parity in Former Soviet States and Latin America

Southeast Europe	48.5
Caribbean	44.4
Central Asia	44.3
Latin America	44.3
Other Europe	40.2
Arab States	36.8
European Free Trade Association	34.2
European Union	33.1
Sub-Saharan Africa	30.0
West Asia	27.2
Southeast Asia	22.5
South Asia	16.9

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Share of female researchers by country, 2013 or closest year (%)

28.4%
Share of women researchers worldwide

48.5%
Share of women researchers in Southeast Europe, the top region for this indicator

Data source: UNESCO Institute for Statistics estimates, July 2015

Note: Data for the most recent year available since 2007. For China, data cover R&D personnel rather than researchers. For Congo, India and Israel, data are FTE rather than head counts.

Women have obtained gender parity in Southeast Europe and are on the verge of doing so in the Caribbean, Latin America and Central Asia

Thank you for your patience!

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