

# OVERVIEW OF RESEARCH

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# Steps to conducting research

1. Read relevant literature, to get necessary background and to learn what else has been done
2. Identify a concrete investigative question
3. Identify an appropriate methodology for answering the question
4. Carry out the actual research project
5. Disseminate results through oral and written communication

## Example #1:

1. Question: Do CS majors at Eastern prefer Google or Bing?
2. Methodology: design page that displays Google and Bing results side-by-side. Appropriate sampling of students and an experimental study.

## Example #2:

1. Question: Is GD-sort better than quicksort? (Note: better would have to be defined; e.g., better = faster on random data)
2. Methodology:
  - Theoretical running time and memory, big O notation
  - Comparison of GD-sort and quicksort using real data

# How to read scientific research

- See **Tips for Reading Journal** articles, on page 3 of [www.colby.edu/biology/bi319/GuideReadJour.doc](http://www.colby.edu/biology/bi319/GuideReadJour.doc)
  - If the document contains symbols, you will need to change the font
- Example:
  - **Empirical Performance of Internal Sorting Algorithm**
  - Silas, F., Musa, Y., & Joyce, S. A. (2016). *Journal of Advances in Mathematics and Computer Science*, 20(1), 1-9.  
<https://doi.org/10.9734/BJMCS/2017/29238>
  - <https://www.journaljamcs.com/index.php/JAMCS/article/view/23579/44006>
- What does the abstract tell us?
- What does Figure 1 tell us?
- What does Figure 2 tell us?

# Computer Science is a broad discipline

- Association for Computing Machinery (ACM) knowledge areas
  - Algorithms and Complexity
  - Architecture and Organization
  - Discrete Structures
  - Graphics and Visualization
  - Human-Computer Interaction
  - Information Management
  - Intelligent Systems
  - Network and Communication
  - Operating Systems
  - Programming
  - Software Development
  - Software Engineering
  - Social Issues

For full list see: <http://www.acm.org/education/CS2013-final-report.pdf>, page 14

# Choosing a Research Topic

1. What aspects of computer science interest you?
2. Explore what others have done by reading the literature
  - Media and review articles can be a good place to start, but you will need to find *research* articles
3. Trending topics
  - Facial recognition
  - Self-driving cars
  - 3D printers
  - Quantum computing
  - Targeted advertising
  - Social media

# Computer Science

- Computer Science is the systematic study of the **feasibility, structure, expression**, and mechanization of the methodical processes (or **algorithms**) that underlie the **acquisition, representation, processing, storage, communication of, and access to information...**
- Computer Science is not *just* about building computers or writing computer programs!...**Computer science is** not about the tools we use to carry out computation. It is about **how we use such tools, and what we find out when we do.**
- More: <http://www.cs.bu.edu/AboutCS/WhatIsCS.pdf>

Computer science has applications in:

Computer Engineering

Information Technology and Information Systems

Bioinformatics and Computational Biology

Computational Statistics

Mathematical Modeling

# What is a computer (part 1)?

- A computer is a *platform* that implements varying algorithms and methodologies for storing, retrieving, and analyzing information
  - Ex: Quicksort is a sorting method that exists and can be analyzed independently of any computer.
  - Ex: The properties of a relational database do not depend on the computer used to store the data
- There is a theoretical component to computer science, but these theories can be tested in practice
- Project ideas:
  - Develop a new method and compare with existing methods
  - Evaluate how altering a method changes the behavior / performance of the method

# What is a computer (part 2)?

- A computer is a *tool* that can be used to
  - Analyze (large amounts of) data
    - Example: analyzing IMDB data: <https://www.r-bloggers.com/imdb-movie-analysis/>
    - Example: Can Twitter be used to predict crimes? (Answer – yes, to some extent: <http://www.citylab.com/tech/2014/03/how-twitter-could-help-police-departments-predict-crime/8651/>)
  - Simulate physical or biological system and analyze it
    - Cellular automata models
      - <http://mathworld.wolfram.com/CellularAutomaton.html>
      - A cellular automata model of traffic flow
        - [http://www.ajuronline.org/uploads/Volume%2012/Issue\\_1/AJURVol12Issue1Aug2014pp39to48.pdf](http://www.ajuronline.org/uploads/Volume%2012/Issue_1/AJURVol12Issue1Aug2014pp39to48.pdf)
    - Agent-based models
      - Agents move and interact according to rules executed at discrete time steps
      - In some cases this approach has identified emergent behavior that may be counter-intuitive. Ex: should we put a pillar by the front door of the classroom?  
Ex: "The Game": <http://www.icosystem.com/labsdemos/the-game/>
  - Write a program to download and analyze a large dataset, such as tweets, to answer a specific question
  - Develop a simulation (or modify an existing one) to answer a specific question



# Where to find published research

- Library Databases: <http://easternct.libguides.com/az.php?s=126319>  
(if off-campus, log in with your Eastern userID and password)
  - ABI Inform Complete: The database features thousands of full-text journals, dissertations, working papers, etc. Includes IEEE journals.
  - ACM digital library: <http://dl.acm.org>
  - ACM surveys (CSUR) <http://dl.acm.org/citation.cfm?id=J204>
    - Provides comprehensive tutorials and survey papers
  - Academic Search Premier: Multidisciplinary database with full text articles
- Undergraduate research:
  - American Journal of Undergrad Research:
    - <http://www.ajuronline.org>
  - Student Pulse
    - <http://www.studentpulse.com/topics/15/computer-science>
- Google Scholar (<http://scholar.google.com>)