State of the School of Computing

Mary Hall, Director

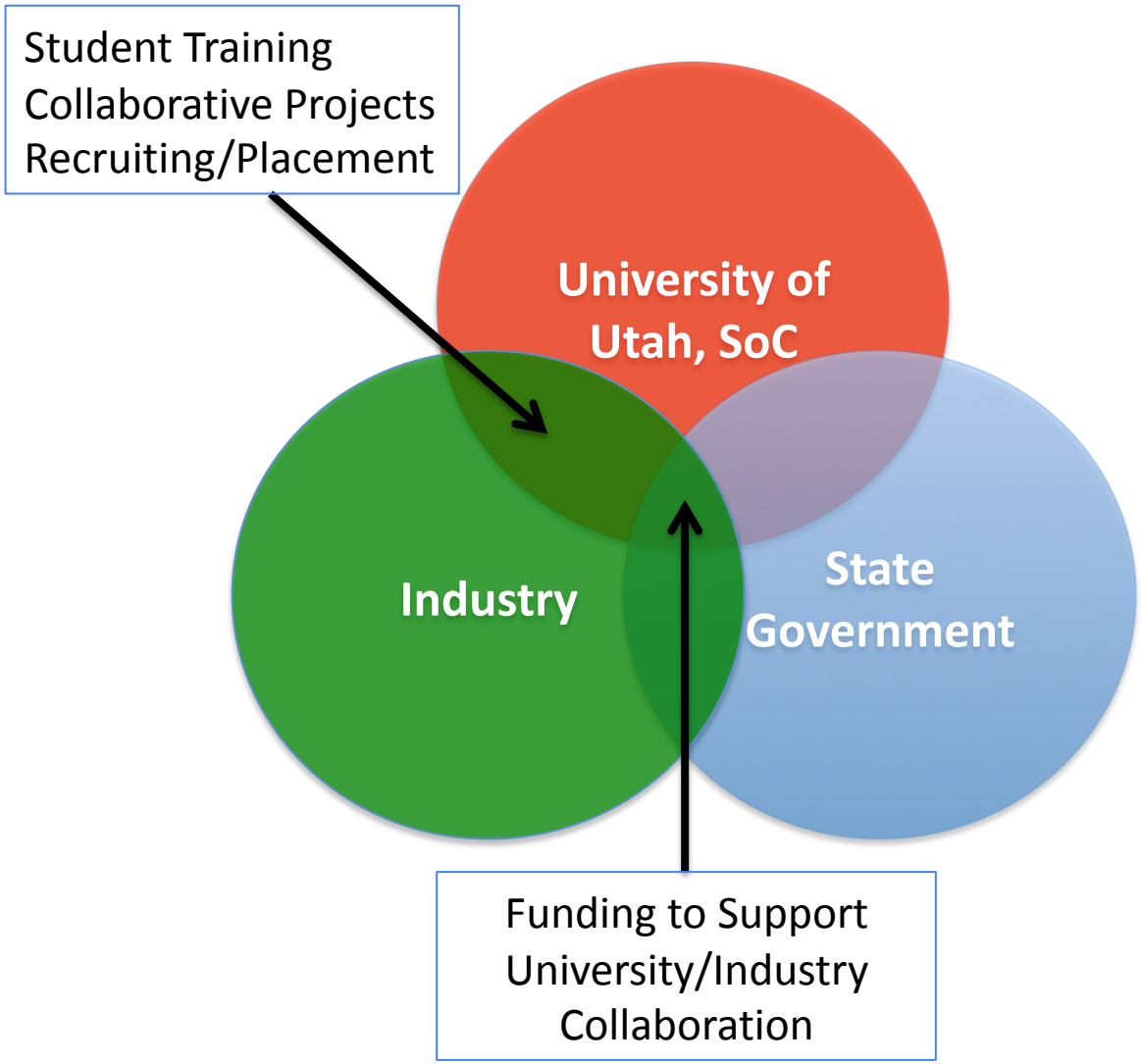
Industrial Advisory Board Meeting

November 8, 2021

Outline

1. Program context
2. Continued growth
3. Utah Center for Inclusive Computing
4. Clinical Capstone Pilot
5. Workforce-Related Masters Programs
6. Agenda Overview

SoC and Tech Economy



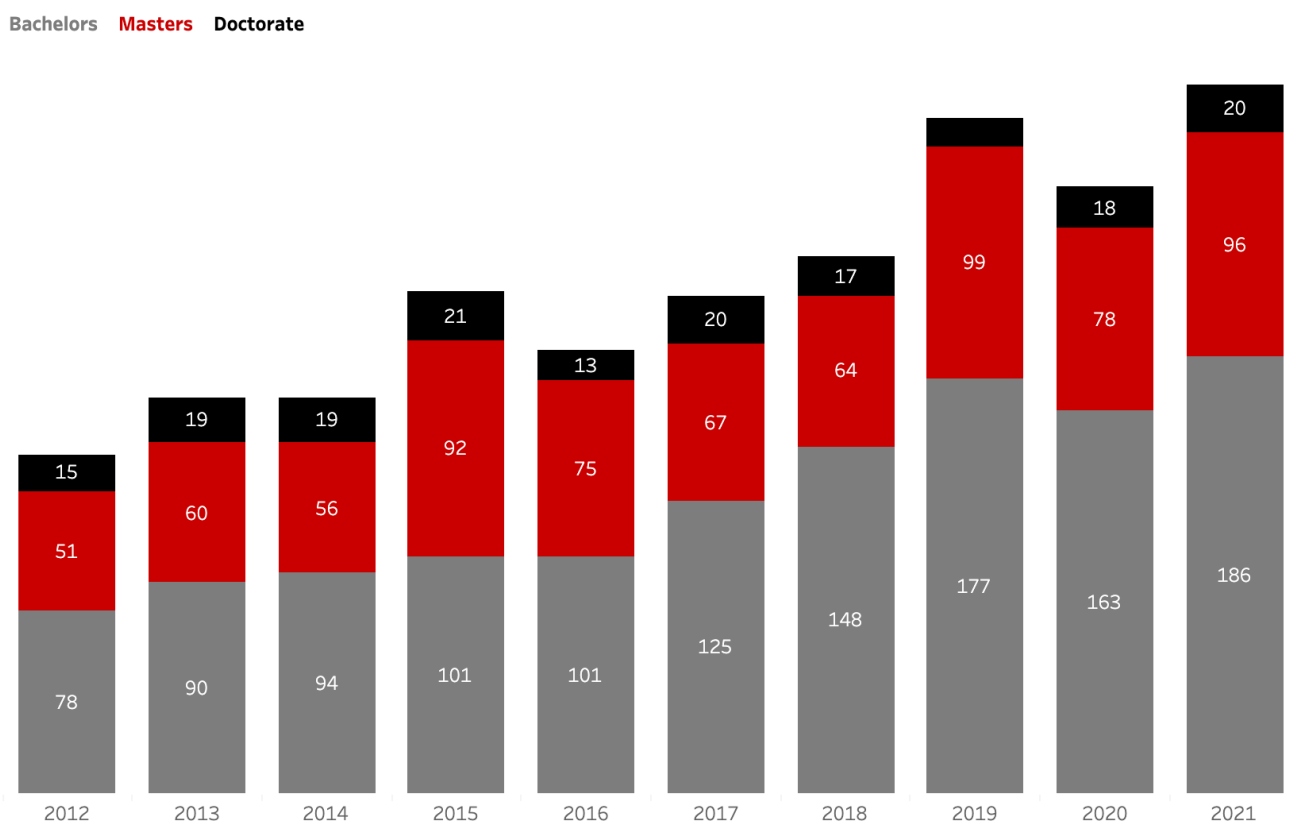
1. Context of Program

- School of Computing
  - Interdisciplinary computing research & education (**CS +** …)
- Undergraduate degrees offered
  - Traditional CS degree
  - Computer Engineering, joint with ECE
  - Data Science (shares CS1, CS2, CS3) +
  - **In 2022: Software Development (shares CS1, CS2, CS3) +**
- Graduate degrees offered
  - BS/MS
  - Masters of Software Development
  - Master of Science in Computer Science
  - Master of Science in Computing w/Tracks
    - Data Mgmt&Analysis, HCC, Robotics, Graphics&Vis, Scientific Computing, Image Analysis, Computer Engineering, …
  - PhD in Computer Science or Computing

+Both Data Science and Software Development require Ethics courses

2. Continued Growth

- CS is the #1 undergraduate major on campus
- U of U delivering **46%** of CS degrees in USHE
- BS CS Median Starting Salary **$80,000**



3. Utah Center for Inclusive Computing

Center Launch, Sept. 1, 2021

Marissa Smith
Diversity & Outreach Coordinator

- **Goal:** 30% women CS/DS/SD graduates by 2025
- **Today:** **16%** of CS students are women, **8%** are Latinx – below national averages for computing field
- $700K from Pivotal Ventures via Northeastern University
- Regular meetings with external consultant, other universities

3. Interventions to Broaden Computing Participation

- Old CS1 pathways
  - **CS 1030:** CS0 course recommended for students with no experience and need for math preparation
  - **CS 1410:** Single CS1 course, Calc1 as co-requisite
- New CS1 pathways
  - **CS 1400+1410:** 2 semesters, no experience required
  - **CS 1420:** 1 semester, advertised as “accelerated”, and for students with prior programming experience
- Retention TAs
  - Spring 2021 pilot in CS2 and CS3
  - Work with at-risk students retaking classes or conditionally in the major, no other responsibilities
  - In Fall 2021, CS 1400 and CS 1420 retention TAs added

3. Early Results on New Pathways

Course	Enrolled	Women	Freshman	CS	CE	Premajor	Undeclared
F20 1410	465	20%	30%	40%	6%	66%	6%
F21 1400	345	21%	50%	46%	6%	79%	12%
F21 1420	371	17%	42%	48%	11%	68%	6%

- Growth in 2021
  - >50% more CS1 students in Fall 2021 than Fall 2020
- Some differences in demographics
  - Slight improvement in % women, higher rate of freshman and undeclared in CS 1400
  - This year's CS1 students are younger and more committed to CS than in 2020
- Retention TAs reduced withdrawal rate, improved outcomes

4. Clinical Capstone Pilot

- What is it
  - Industry partner works with undergraduate capstone team, typically 3 students
  - Proposes project idea to students, interested students apply, continued engagement
- Structured agreement
  - Organizations sign formal agreement ($15,000) for scholarships, mentor, materials, awards
  - Students sign Intellectual Property agreements
  - Graduate student mentor assigned
  - Regular team meetings over two semesters
  - Primary deliverables are demonstration and written report
  - Senior Capstone Demo Day in April

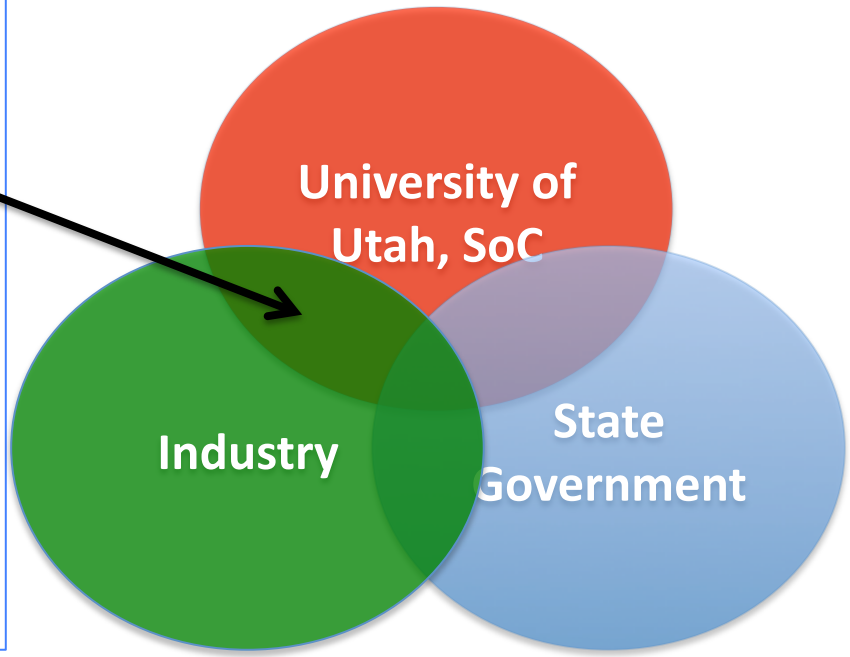
4. 2021 Pilot Projects

L3 Harris Technologies

- Cybersecurity using Knowledge Graphs and Graph Neural Networks

Idaho National Laboratory

- Development of an Interactive Resiliency Index Tool



Interested? Plan to expand to 4 projects in 2022

Also, Masters Capstones for MSD and new Deep Tech Certificates with different structures

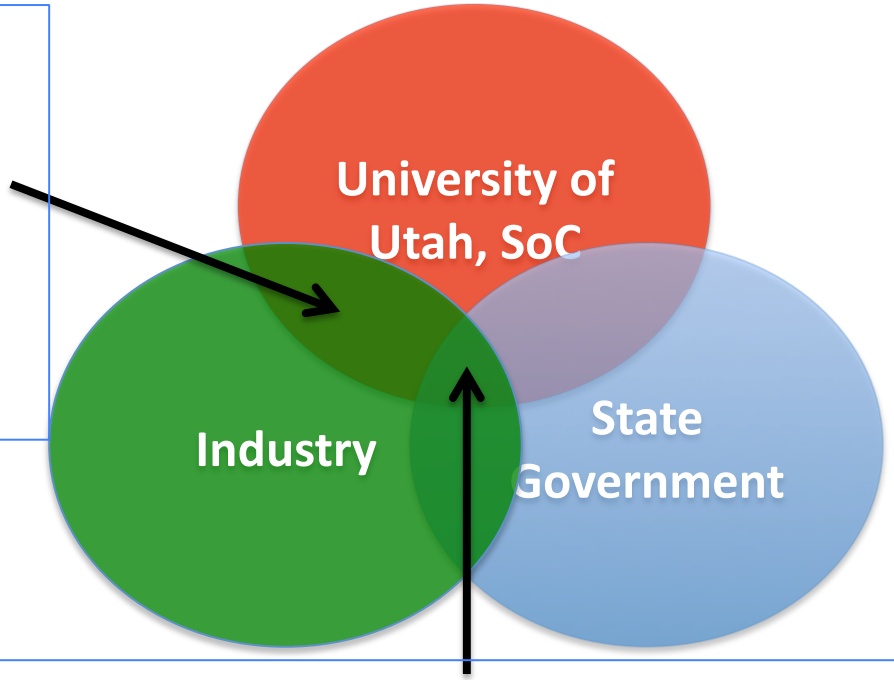
5. Workforce-Related Masters Programs

Areas for Workforce Development

Utah Center for Data Science (Director: Phillips)

Human-Centered Computing (Presenter: Wiese)

Financial Technology (Future)



Deep Tech Initiative, selected by USHE

Bringing Fairness in AI to Forefront of Education (PI: Wang Phillips + Business, $343K)

Deep Learning Certificate in AI and Robotics (PI: Tom Henderson, $416K)

Graduate Certificates in Secure Computing (PI: Sneha Kasera, $671K)

6. Agenda Overview

2021
THE UNIVERSITY OF UTAH
SCHOOL OF COMPUTING
ADVISORY BOARD

12:00 PM **Arrival, pick up lunch**

12:10 PM **Welcome**

Mary Hall
Professor & Director, School of Computing

Introductions: All attendees

12:20 PM **State of the School**

Mary Hall
Professor & Director, School of Computing

Growth, Inclusion, Pathways through Undergraduate Program, Workforce Needs, Senior Clinical Capstone Pilot Program, and Agenda Overview

12:50 PM **Faculty Panel Discussion:**

Skilled Workforce to Meet Utah Needs:

1. Jason Wiese, Human-Centered Computing
2. Bei Wang, AI and Fairness
3. Tom Henderson, Machine Learning
4. Sneha Kasera, Cybersecurity
5. Jeff Phillips, Data Science

1:20 PM **Discussion**

1:40 PM **New School of Computing Building**

Richard Brown
Dean, College of Engineering

Josh Grant
Executive Dir., Development and External Relations

2:10 PM **Discussion**

2:30 PM **Adjourn**

COMPUTE

Questions for Discussion

1. Across all areas of computing, what are the important things an incoming developer should know? Please consider both technical knowledge and practical skills. If you believe that there are gaps in our programs, please help us identify them.
2. Of the different certificates and Masters programs described – Human-Centered Computing, Fairness in AI, Deep Learning in AI & Robotics, Cybersecurity, Data Science – which of these apply to your organization?
3. From the perspective of your organization, what are ways in which you currently interact with the School of Computing? What are future interactions that would be of interest to your organization?
4. What are ways in which the university, industry and government might collaborate to build technology in Utah?

Deep Learning in AI & Robotics

Advisory Group: Tom Henderson (SoC) , Cathy Liu (CEE), Tolga Tasdizen (ECE), Mark Pittman (Blyncsy)

Faculty Associates:

SoC; Ross Whitaker, Shandian Zhe, Vivek Srikumar, Tucker Hermanns, Alan Kuntz

Math: Berton Earnshaw

CEE: Carlos Oroza, Jianli Chen, Gaby Ou, Nikola Markovic

SCHOOL OF COMPUTING

University of Utah
8 November 2021

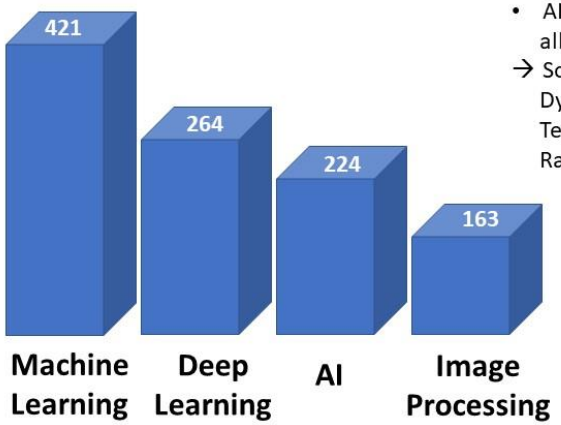
THE UNIVERSITY OF UTAH

SCHOOL OF COMPUTING

The Deep Learning Certificate Program will provide:

* **working knowledge** of the use of state-of-the-art deep learning technology
* **internship projects with industry** partners on image analysis, language translation, autonomous systems, sensor data processing, database analytics, fraud detection, etc., for classification/recognition/decision making

Unmet Utah Workforce Demand
(Jobs per Area – source: Indeed)



- AI employment from 2015-2019 grew 20% vs total employment growth of 5.6%
- AI job postings grew 28% from 2015-2019
- AI occupations projected to grow faster than all other occupations in next 10 years

→ Source: "U.S. AI Workforce, Labor Market Dynamics," Center for Security and Emerging Techologies, Issue Brief, D. Gehlhaus and I. Rahkovsky, Georgetown University, April 2021.

Working Knowledge Courses:

Machine Learning
Artificial Intelligence
Probabilistic Machine Learning

Robotics
Computer Vision
Image Processing
Transportation Operations
Traffic Network Modeling

Deep Learning

Industry Project Internship

THE UNIVERSITY OF UTAH

Industry Partners & the Future

SCHOOL OF COMPUTING

Nvidia

Computer systems design services company

NVIDIA

kairos autonomi

blyncsy

HELPING YOU MAKE DATA-DRIVEN DECISIONS ON YOUR R

Home | Products | Research | Multimedia | New

WHAT'S NEW?

SEP 25 - OCT 10, 2019 KAIROS' PRODUCTS AND PERSONNEL SUPPORT EXERCISE FORGING SABRE AT MOUNTAIN HOME AFB

KAIROS AUTONOMI RECEIVES ISO 9001:2015 RECERTIFICATION

Robotics Appl

The Pronto4 Agnostic Autono

Kairos Autonomi thinks differently about autonomy. produces high-quality, cost-effective solutions that

UDOT

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UDOT udot.utah.gov

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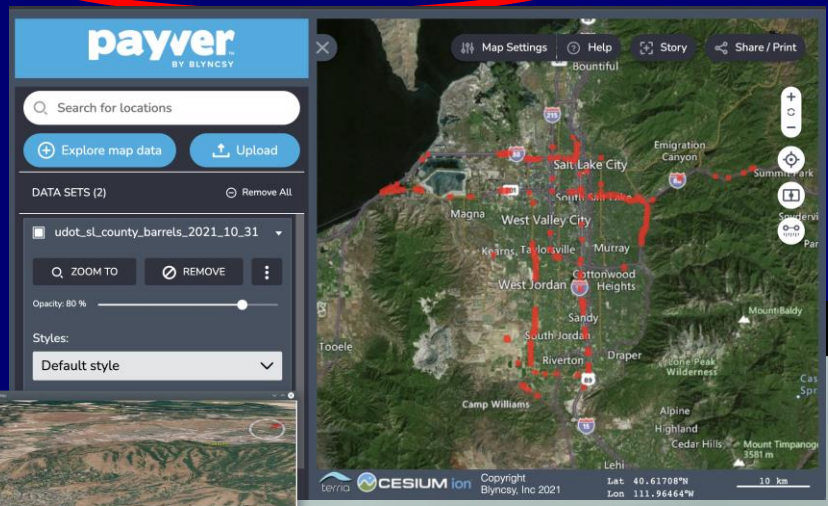
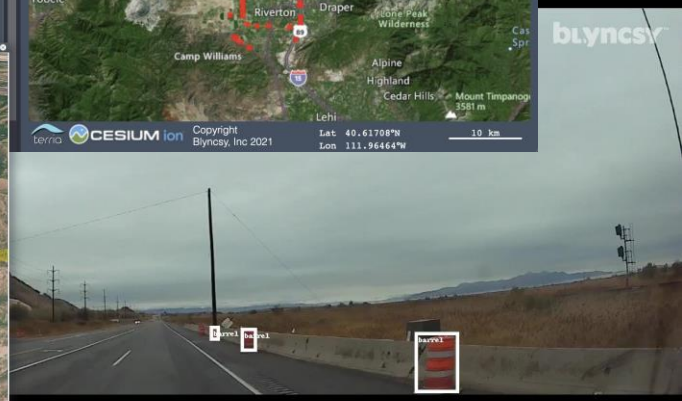
Utah Department of Transportation ... linkedin.com

CogniTech Corporation





Large-Scale UAS Traffic Management

Industry Partners & the Future

Nvidia
Computer systems design services company

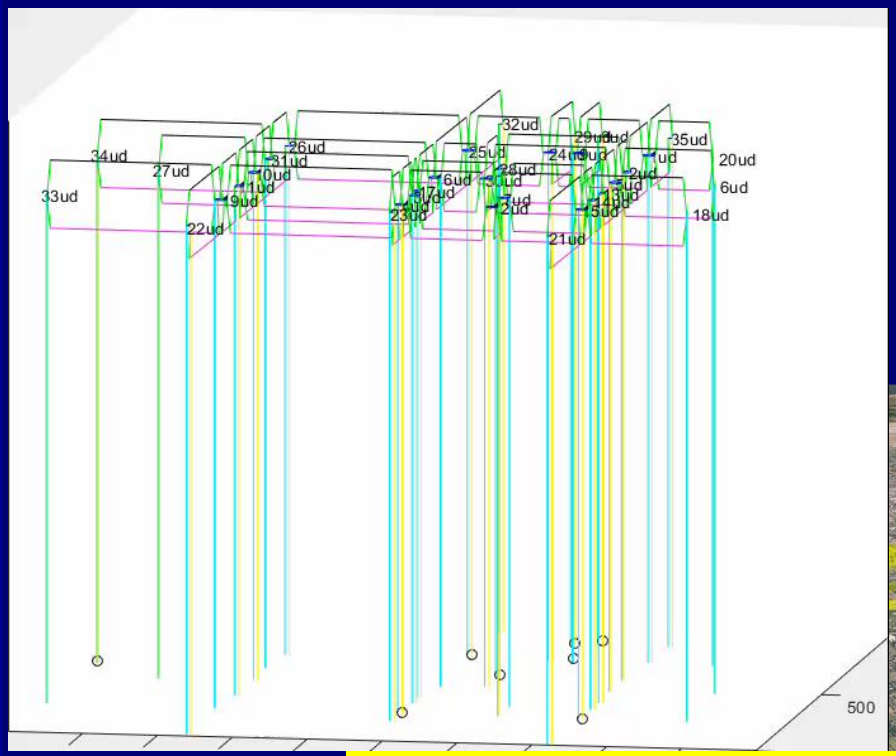
kairos autonomi

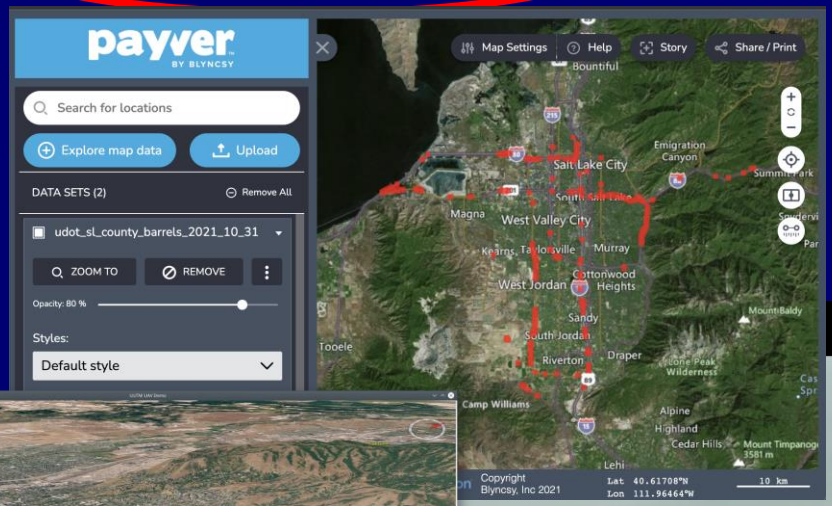
CORP++

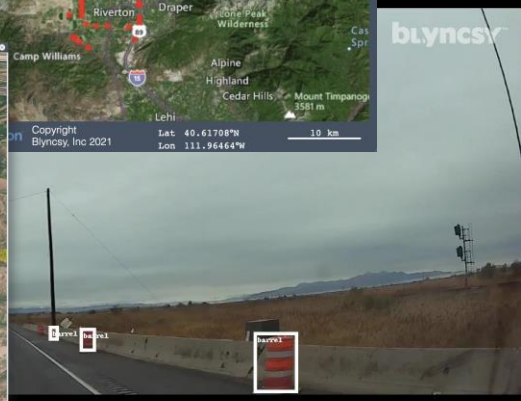
Questions?

HELPING YOU MAKE DATA-DRIVEN DECISIONS ON YOUR R

CogniTech Corporation







Large-Scale UAS Traffic Management

Bring Fairness in AI to the Forefront of Education

Bei Wang Phillips (School of Computing)
Arul Mishra (David Eccles School of Business)
Himanshu Mishra (David Eccles School of Business)

Project Description

- The main focus of AI systems has been to predict risks accurately (financial, business, medical, and legal risks)
- A lack of focus on equity may discriminate against protected groups
- **Develop interdisciplinary courses and educational modules on fair AI within the David Eccles School of Business and the School of Computing at the University of Utah.**

Courses with Fairness Modules

- Considering different types of business and social decisions
- **Two new courses**: the importance of using algorithms that are fair and the different ways of debiasing algorithms
  - Fair Algorithms for Business Decisions (professional grad.)
  - Fair Machine Learning (undergraduate)
- Research collaborations will be used to develop use cases that help describe how fair algorithms can be developed, deployed, and how they improve outcomes in society

Fair Machine Learning Course (SoC)

- Enhance the new **undergraduate B.S. degree in Data Science**.
- Part of two certificate programs: **Undergraduate Certificate in Data Science** and **Undergraduate Certificate in Data Fluency.**
- Complements existing **Ethics in Data Science** course as elective to discuss ethical issues from the adoption of AI technologies.
- **Trains the next generation data scientists for the Utah workforce, who employ, implement, or deploy fairer machine learning tools in the industry.**

Creating Superior Cybersecurity Workforce

Sneha Kumar Kasera
Mu Zhang
Sameer Patil
Jun Xu

Why?

- Preparing our nation to deal with ever-increasing cyber threats, definitively establish it as world leader in cyber space
- Computing transcending all aspects of our lives, we must secure it
- Global cybersecurity market projected to grow to $270 billion by 2026
- Huge opportunity to meet demands of industry/federal agencies

Key Features of Our New Programs

- Comprehensive understanding of security threats/solutions in systems, code, protocols
- Interdisciplinary curriculum, hands-on projects
- Computer science rigor
- R&D bend – cybersecurity research-active faculty
- **Close partnership with industry**
  - learning outcomes, realism, assessment approaches, compliance
  - informational sessions, internships, mentorships, recruitment

Graduate Certificate in Secure Computing

- Courses (15 credit hours)
  - System and Software Security
  - Network Security
  - Security Operations (collaboration with CISO)
  - Human Aspects of Security and Privacy
  - Business Aspects of Security and Privacy (taught by Business School)
- **Also available online**

MS Degree in Secure Computing

- **Stackable on top of secure computing certificate**
- Required courses – all from certificate
- Additional courses (15 credit hours)
  - 2 from Cryptography and Codes, Advanced Algorithms, ML, AI, Data Mining, NLP, Advanced Operating Systems/Computer Networks, Distributed Systems
  - Thesis/Project/Course-only options

Broadening Cybersecurity

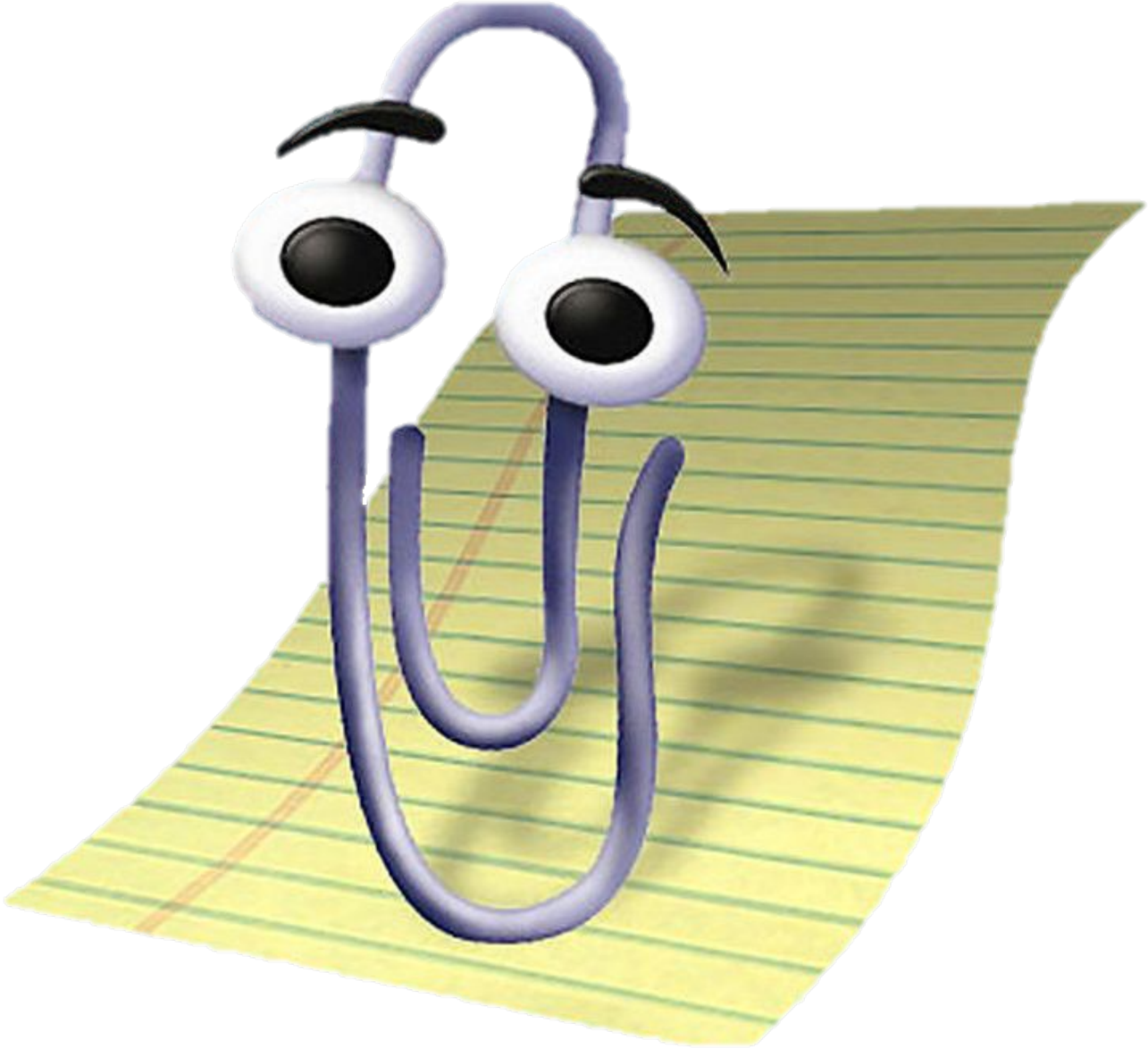
- Develop Cybersecurity ecosystem at University of Utah, beyond
- Center for Cybersecurity, NSA center of excellence

Questions??

Human-Centered Computing

An essential skillset of an elite computing workforce

Jason Wiese
Assistant Professor
School of Computing



If your software solves the wrong problem…

- You waste development
- Applying Human-Centered Computing thinking can prevent this
- alternatives

So…what is Human-Centered Computing (HCC) anyway?

LOG IN

E-mail adress

Password

LOGIN ME

SIGN UP

FORGOT PASSWORD?

LOG IN

E-mail adress

Password

LOGIN ME

SIGN UP

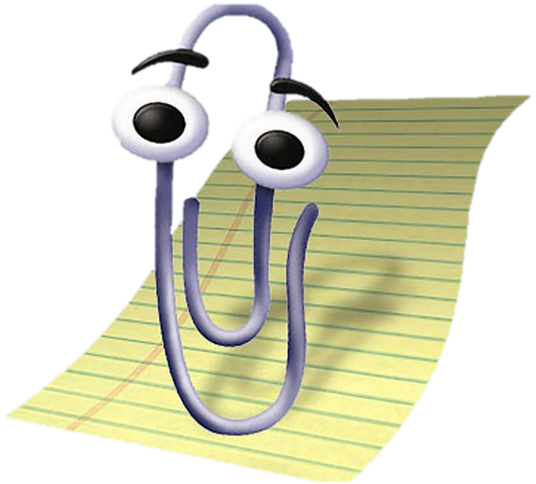
Forgot Password?

A spectrum of HCC

Who are the users?
What are their needs?
What problems might we solve?

What possible solutions are there?
What are the implications of these designs for *all* of the users?
What are the design and implementation trade-offs?

What should we change to make our design usable and aesthetically pleasing?



HCC is a perspective

…and a set of methods to go with it

making technology means making assumptions about how it will be used


I know what
they need

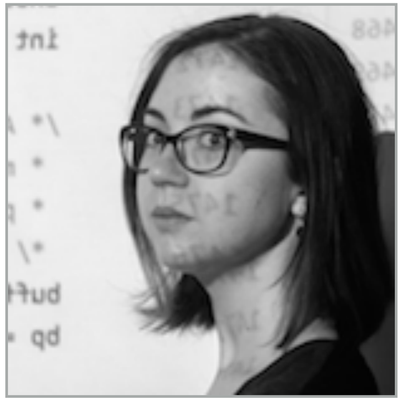
Exposure to a broad HCC perspective is rare for CS students

An employee with CS knowledge and an HCC perspective is valuable

- make the difference between a successful or failed product
- engaged with the big picture and likely a more effective communicator
- Will understand that implementation tradeoffs can impact the end user

HCC courses offered in the SoC

- Designing human-centered experiences
- Ethics in data science
- Social computing
- Human aspects of cybersecurity
- Computer science education
- Personal informatics
- Grad human-computer interaction methods
- Multidisciplinary perspectives of HCI
- Visualization for data science
- Virtual reality

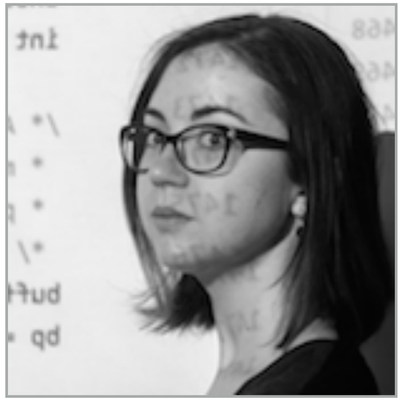


HCC opportunities in the SoC

Undergrads participating in HCC research

- See HCC methods being applied
- Contribute to making something that will really be used (e.g. deployed to users)

Graduate students can complete a Computing MS or PhD in HCC, an opportunity available at only a handful of institutions



Next steps for HCC in the School of Computing

- Spreading an HCC perspective throughout the curriculum
  - Integrate more deeply in the capstone sequence
- BS in Software Development will require HCC courses
- Seeking opportunities to engage industry partners who have or desire an HCC perspective
- Leveraging interdisciplinary perspectives across campus
  - Give students experience listening to and working with people who have deep domain expertise

Data Science is

the methodology and engineering behind

managing, **analyzing**, and **communicating**

ethical and **useful**

decisions informed by data.

Jeff Phillips | jeffp@cs.utah.edu

What is Data Science:

What skills *should** a Data Scientist have?

(1) To efficiently **manage**, process, and compute on a wide variety of data types.

(2) To apply probabilistic and statistical thinking and **analysis**.

(3) To take an abstract task involving a data set, and perform appropriate and **useful** data analysis.

(4) To **interact** meaningfully with experts in a technical data domain.

Computer Science Fundamentals

Probability, Statistics, Linear Algebra

Data Wrangling, Math Foundation, Data Ethics

Data Domain Interaction

* according to SOC and
"Curriculum Guidelines for Undergraduate Programs in Data Science" - PCMI 2016
"Data Science for Undergraduates: Opportunities and Options (2018)" — NASEM 2018

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2013

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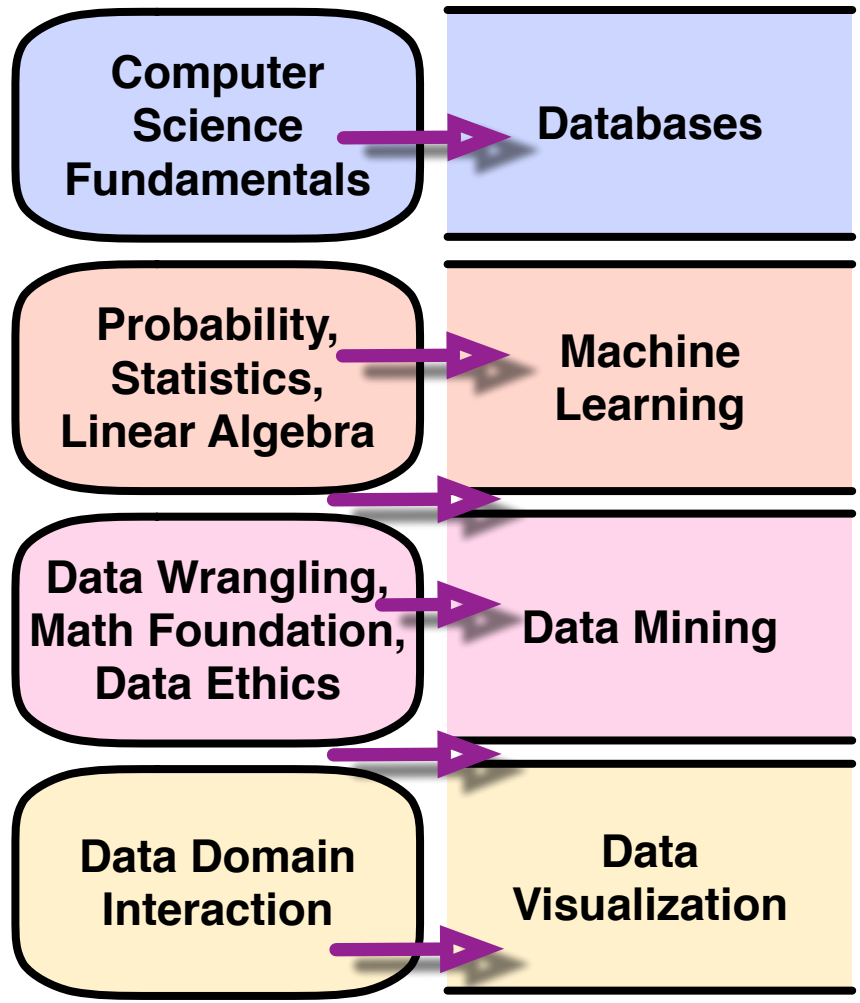

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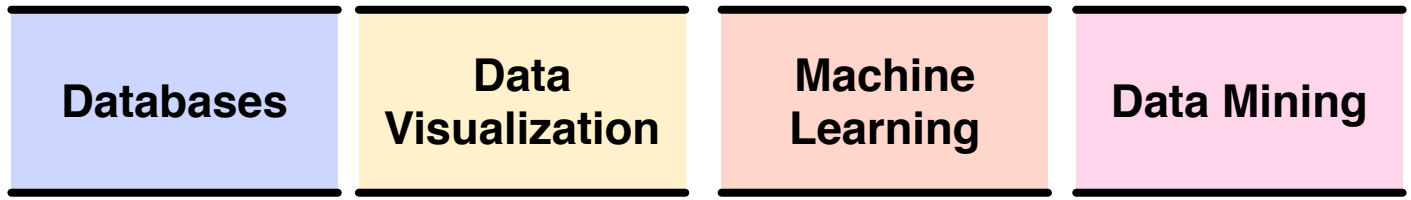
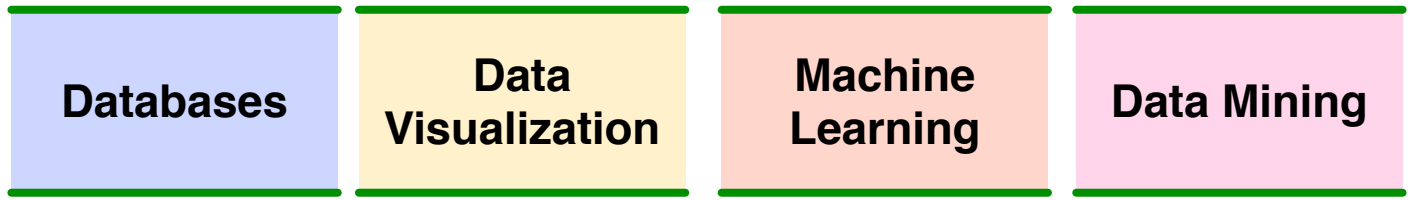
BS in Data Science Flow Chart

2013



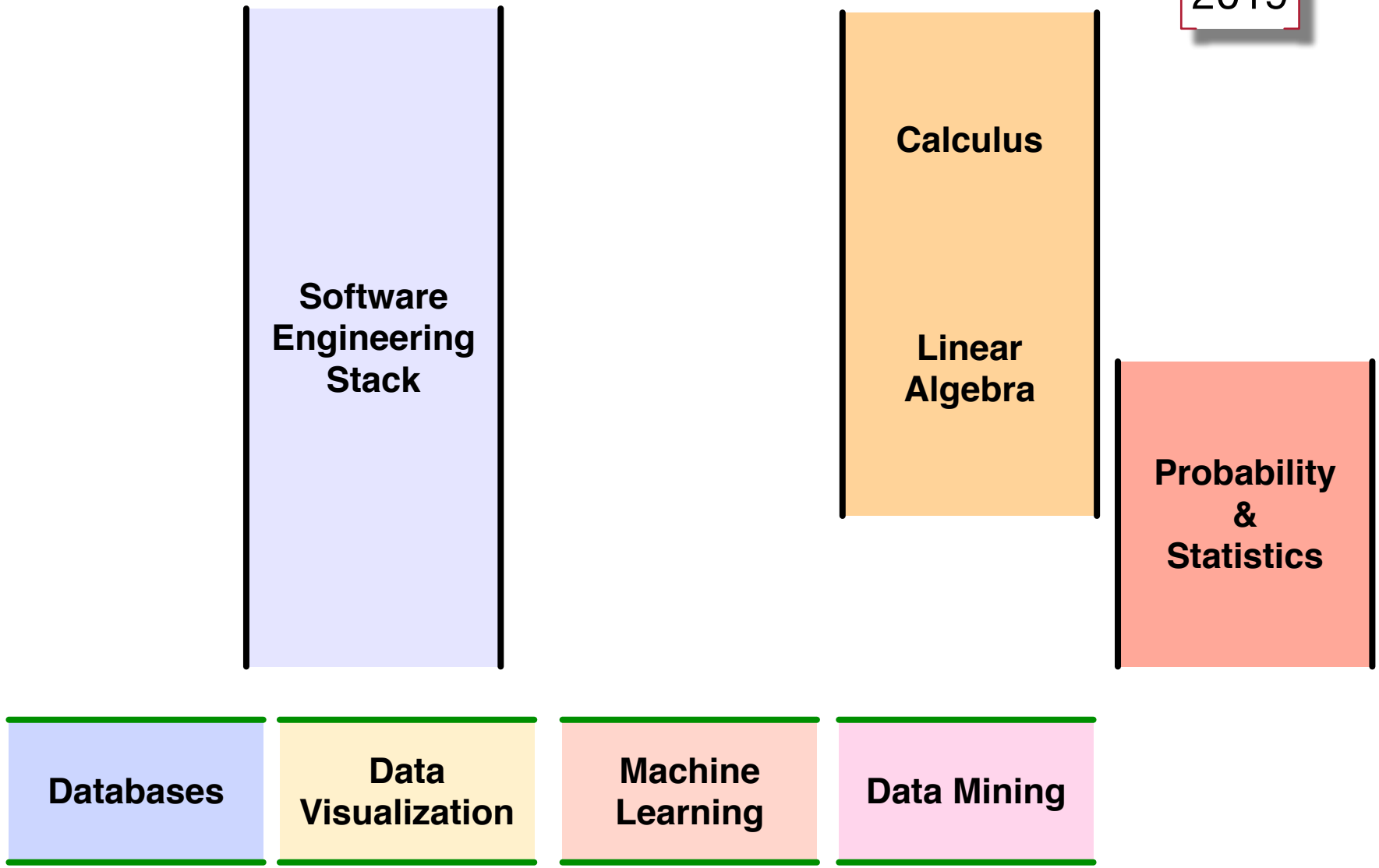
BS in Data Science Flow Chart

2014

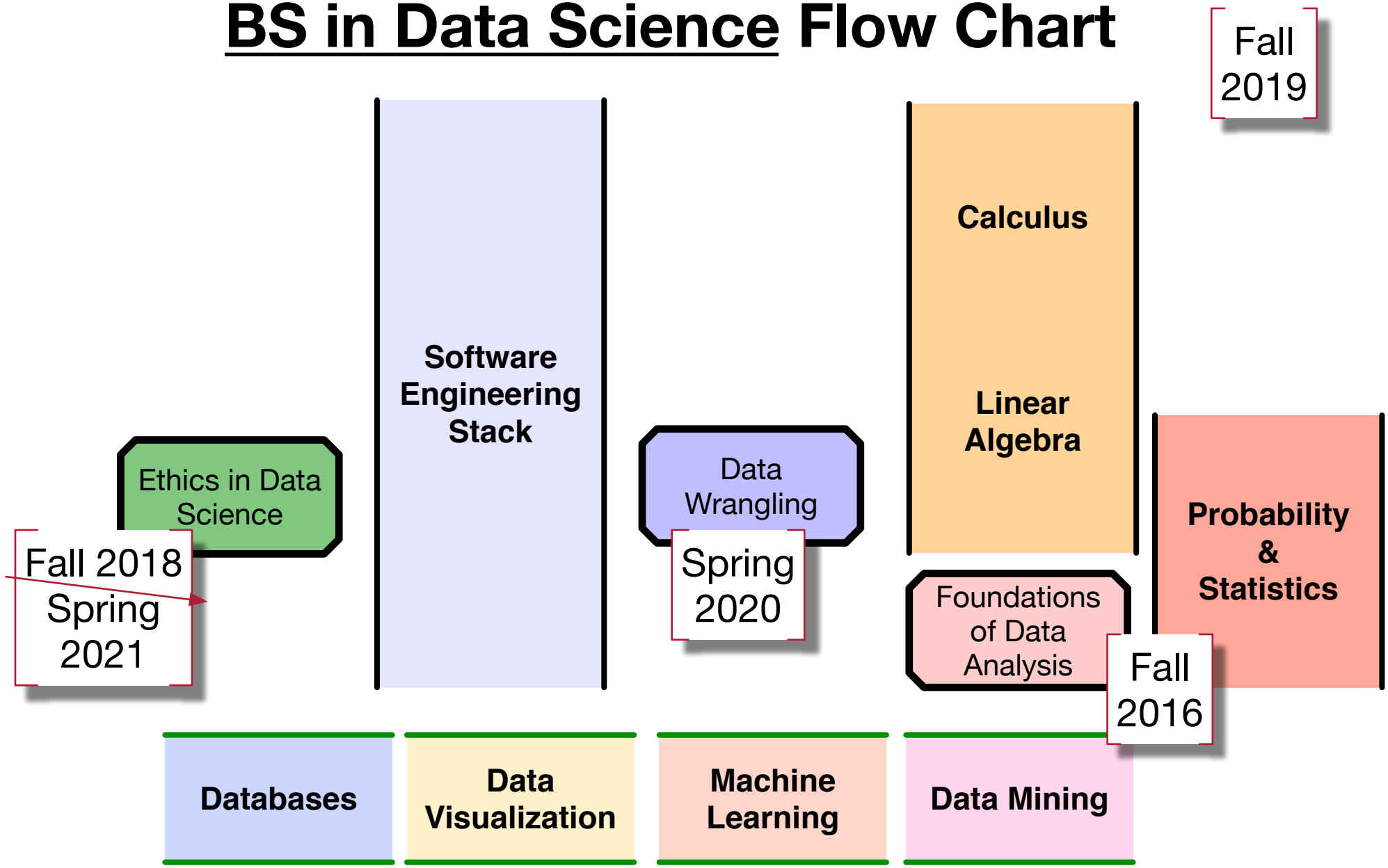


BS in Data Science Flow Chart

Fall 2019

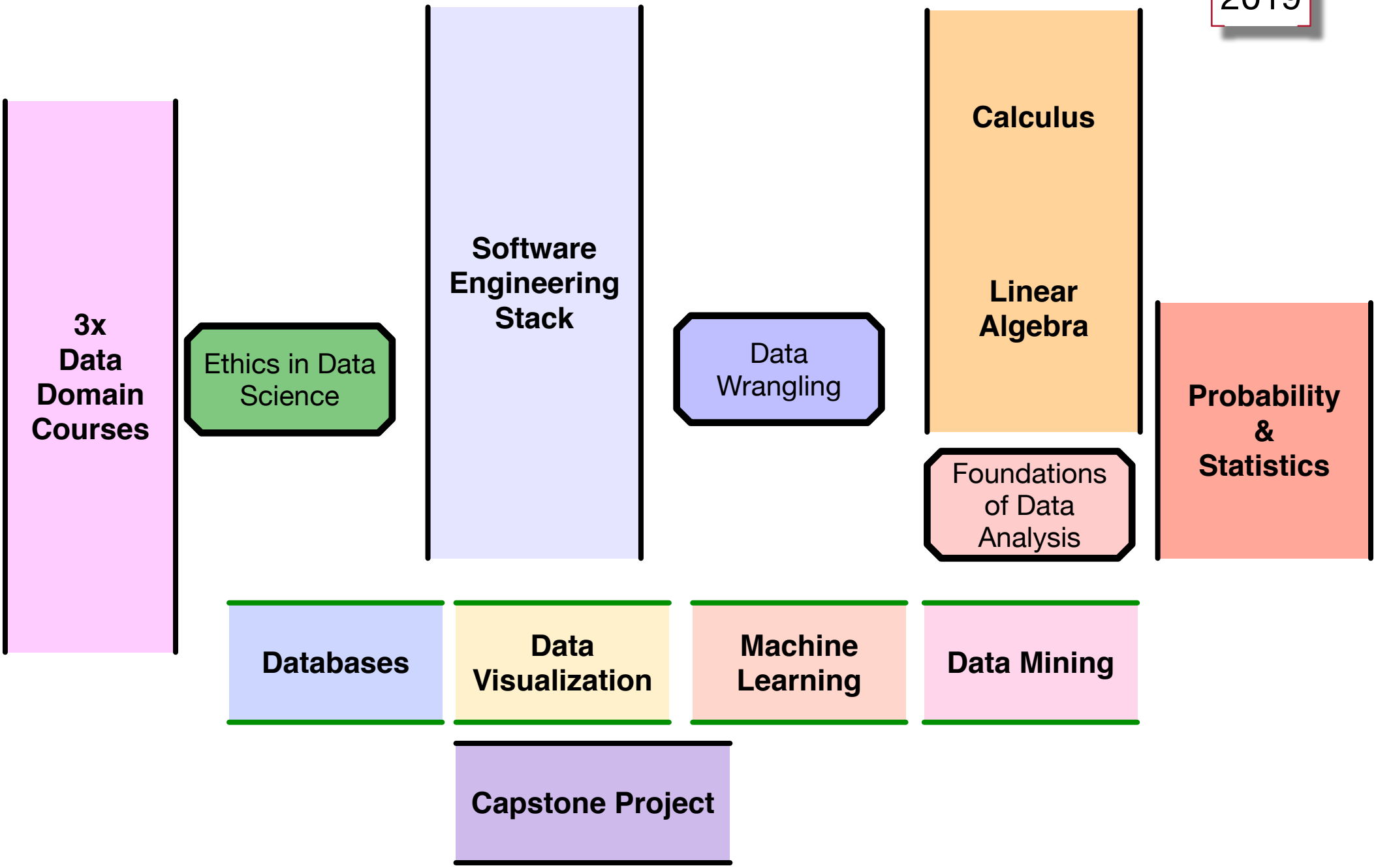


BS in Data Science Flow Chart

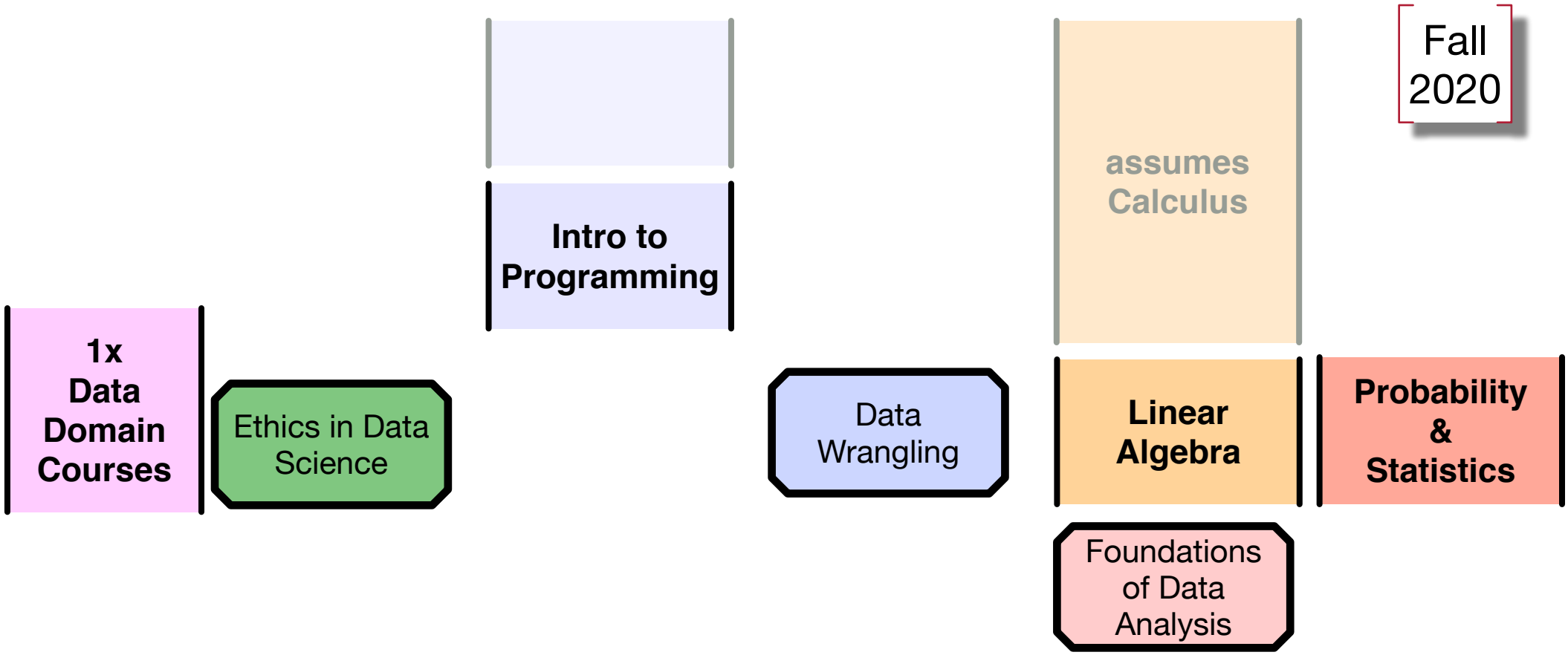


BS in Data Science Flow Chart

Fall 2019



UG Certificate in Data Science Flow Chart



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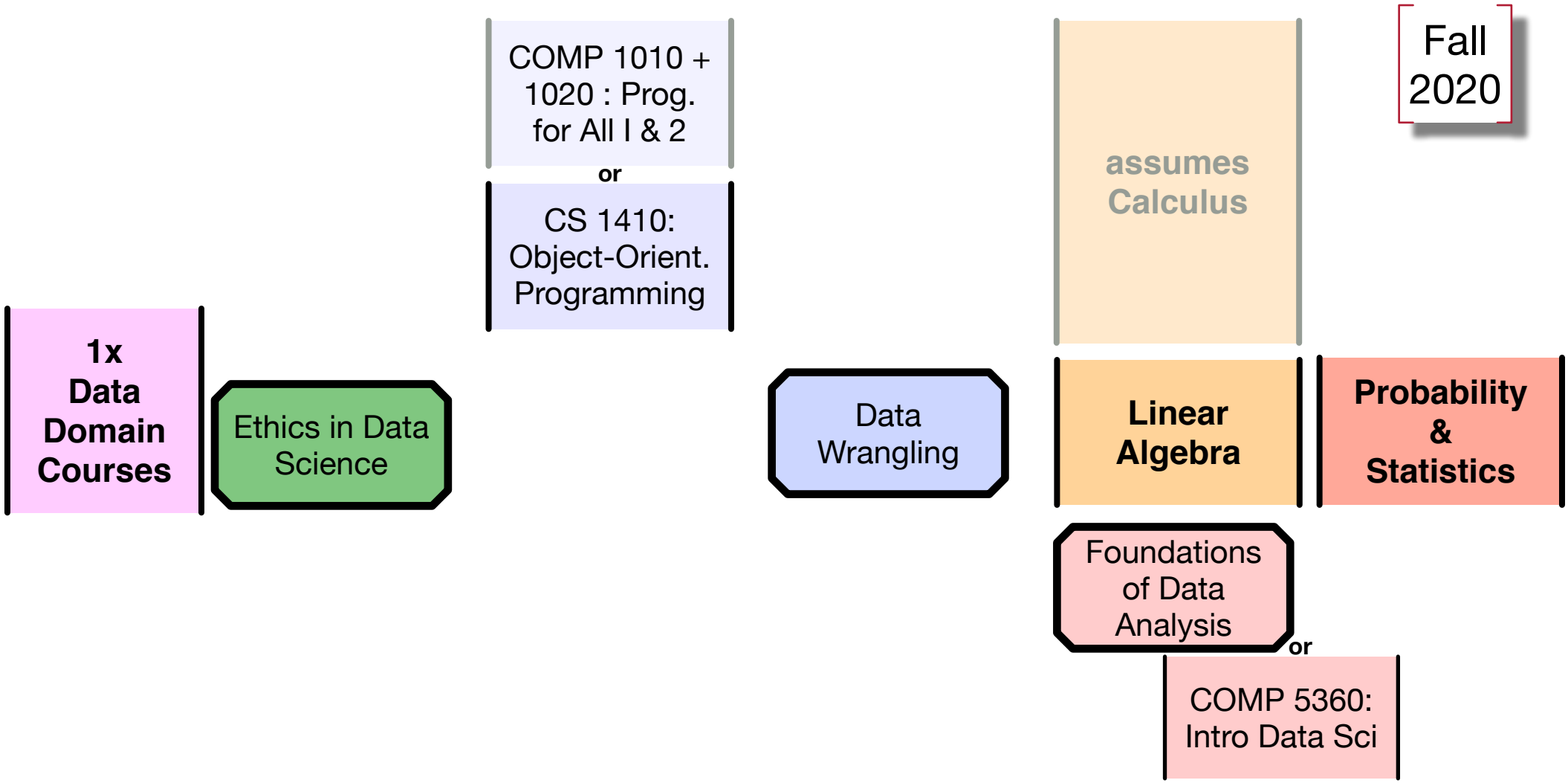
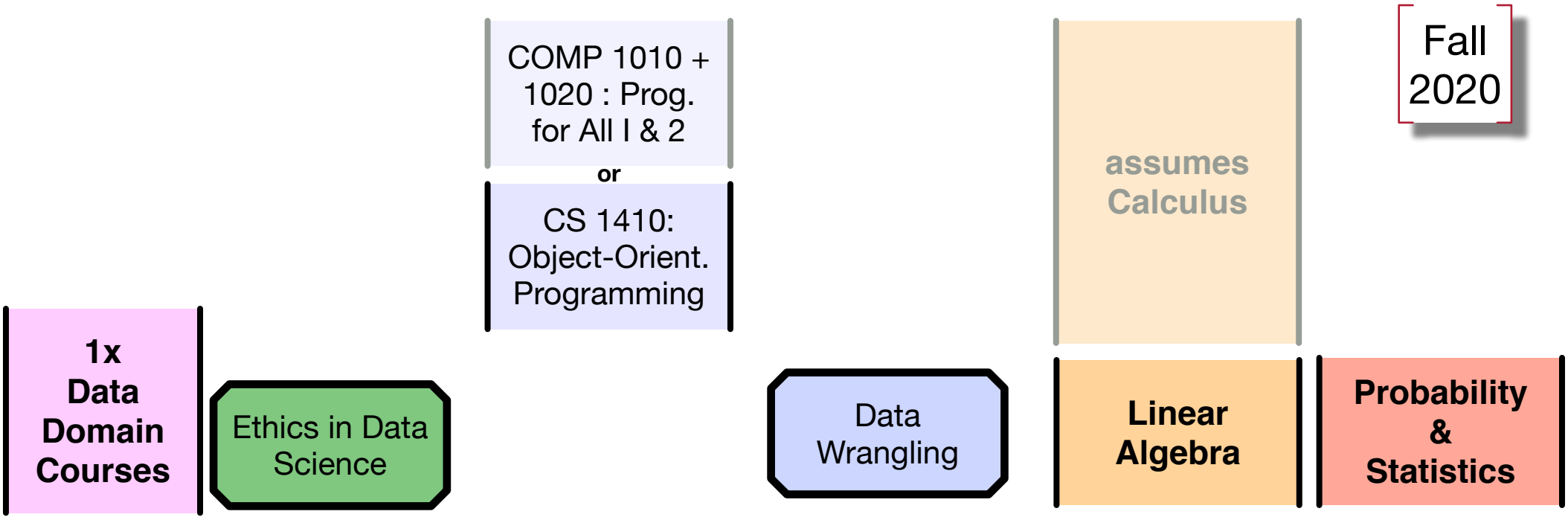


UG Certificate in Data Science Flow Chart



Targeted Majors

* Computer Science
* Engineering (Mechanical, Electrical, Biomedical, …)
* Sciences (Math, Physics&Astronomy, …)

and maybe

* Social Sciences (Economics, Geography, …)
* Business

UG Certificate in Data Fluency Flow Chart

Fall 2020

3x Data Domain Courses

Ethics in Data Science

COMP 1010: Prog. for All I

or

CS 1410: Object-Orient. Programming

does **NOT** assumes Calculus

Math 1070: Intro to Stat Inference

Data Wrangling

or

COMP 5360: Intro Data Sci

UG Certificate in Data Fluency Flow Chart

Fall 2020

3x Data Domain Courses

Ethics in Data Science

COMP 1010: Prog. for All I

or

CS 1410: Object-Orient. Programming

Data Wrangling

or

COMP 5360: Intro Data Sci

does **NOT** assumes Calculus

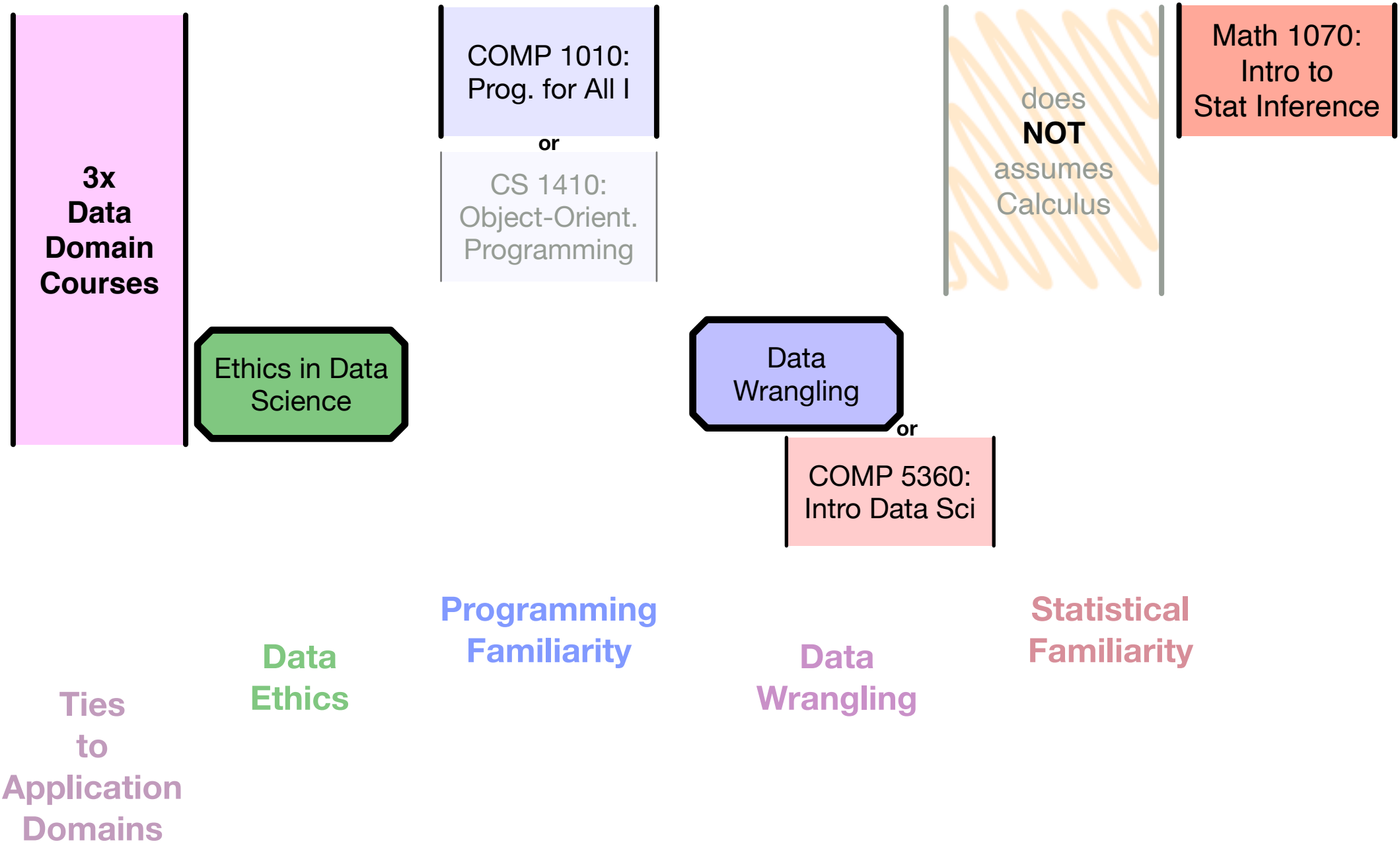
Math 1070: Intro to Stat Inference

Programming Familiarity

Statistical Familiarity

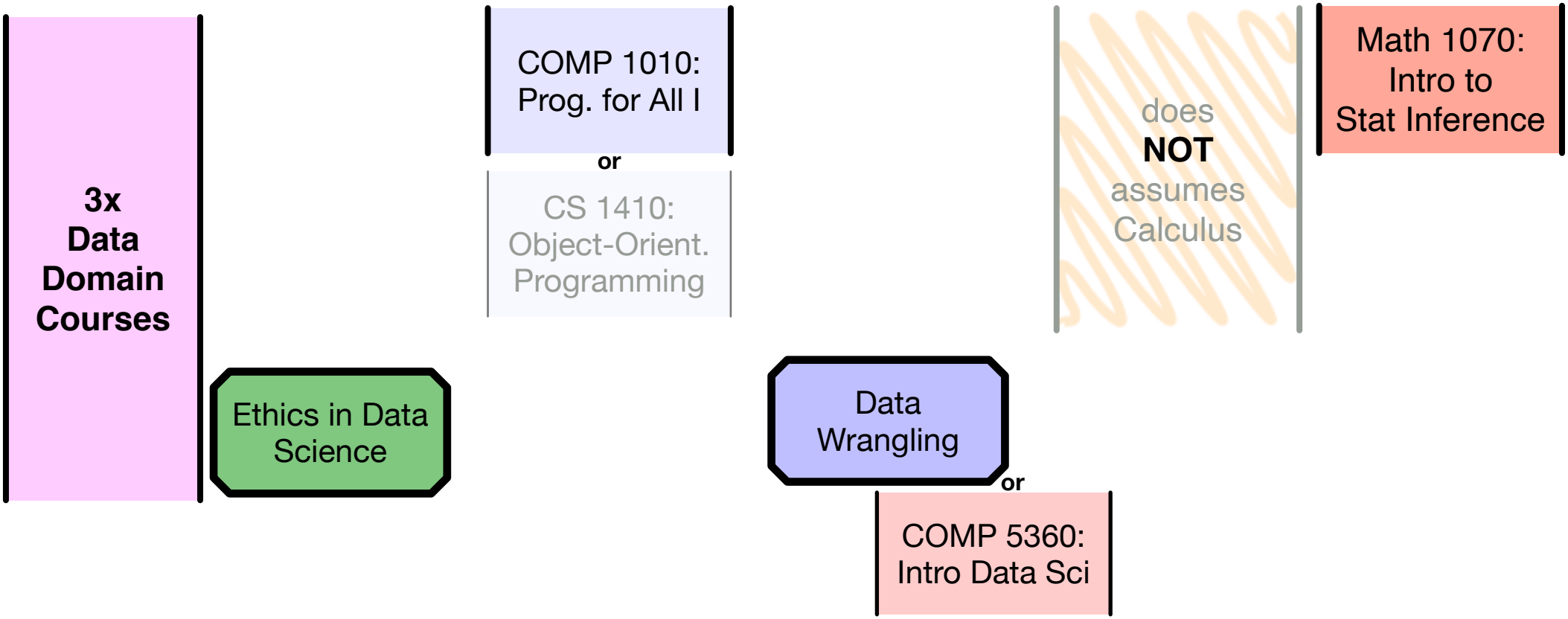
UG Certificate in Data Fluency Flow Chart

Fall 2020



UG Certificate in Data Fluency Flow Chart

Fall 2020



Most undergraduates do not take calculus!

Targeted Majors

* Social Sciences (Economics, Geography, Psychology, Sociology, …)
* Business (Information Systems, Finance, QAMO, …)
* Humanities (Linguistics, Philosophy, …)

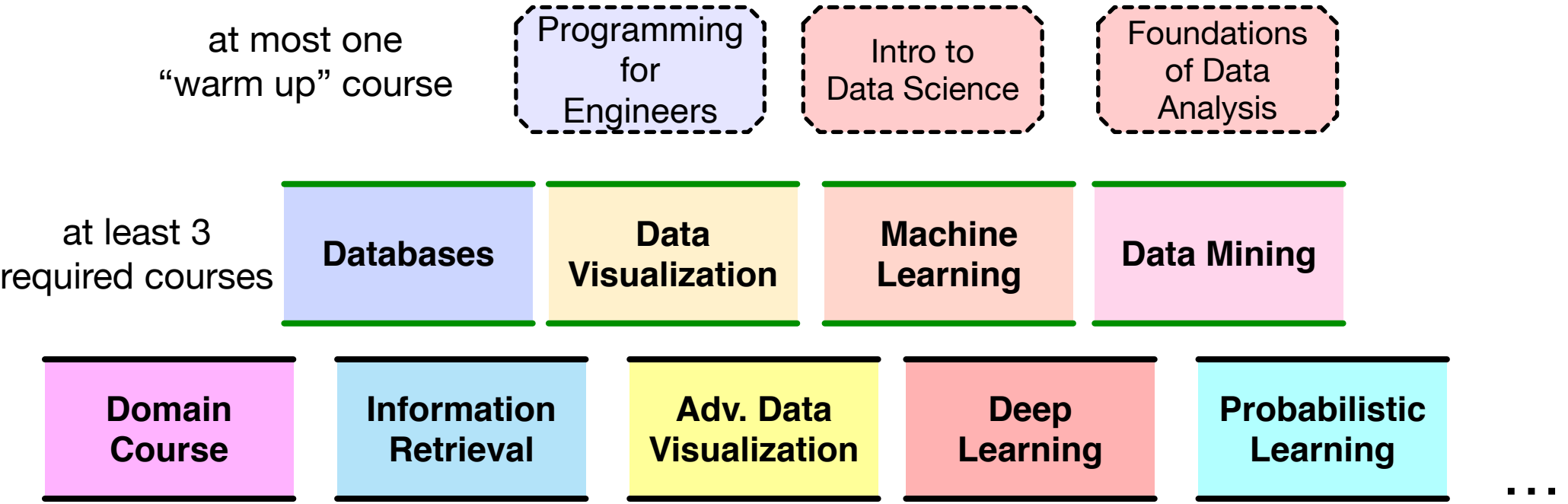
and some

* Engineering, Science, CS, …

Grad Certificate in Data Science Flow Chart

Fall
~~2014~~
2020

5 Grad-Level Courses



Grad Certificate in Data Science Flow Chart

Fall 2020

5 Grad-Level Courses