Dismantling Math, Stats, and CS Silos: PCMI Guidelines for Undergraduate Majors in Data Science

Albert Y. Kim @rudeboybert
Smith College - Statistical & Data Sciences
@SmithCollegeSDS

Thursday August 2nd, 2018

2016 PCMI Undergraduate Faculty Program

Goal: Forming an early set of guidelines for undergraduate majors in data science

About the proposal

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- Math, computer science, and statistics *à-la-carte*.

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- Among the first proposals with interdisciplinary representation

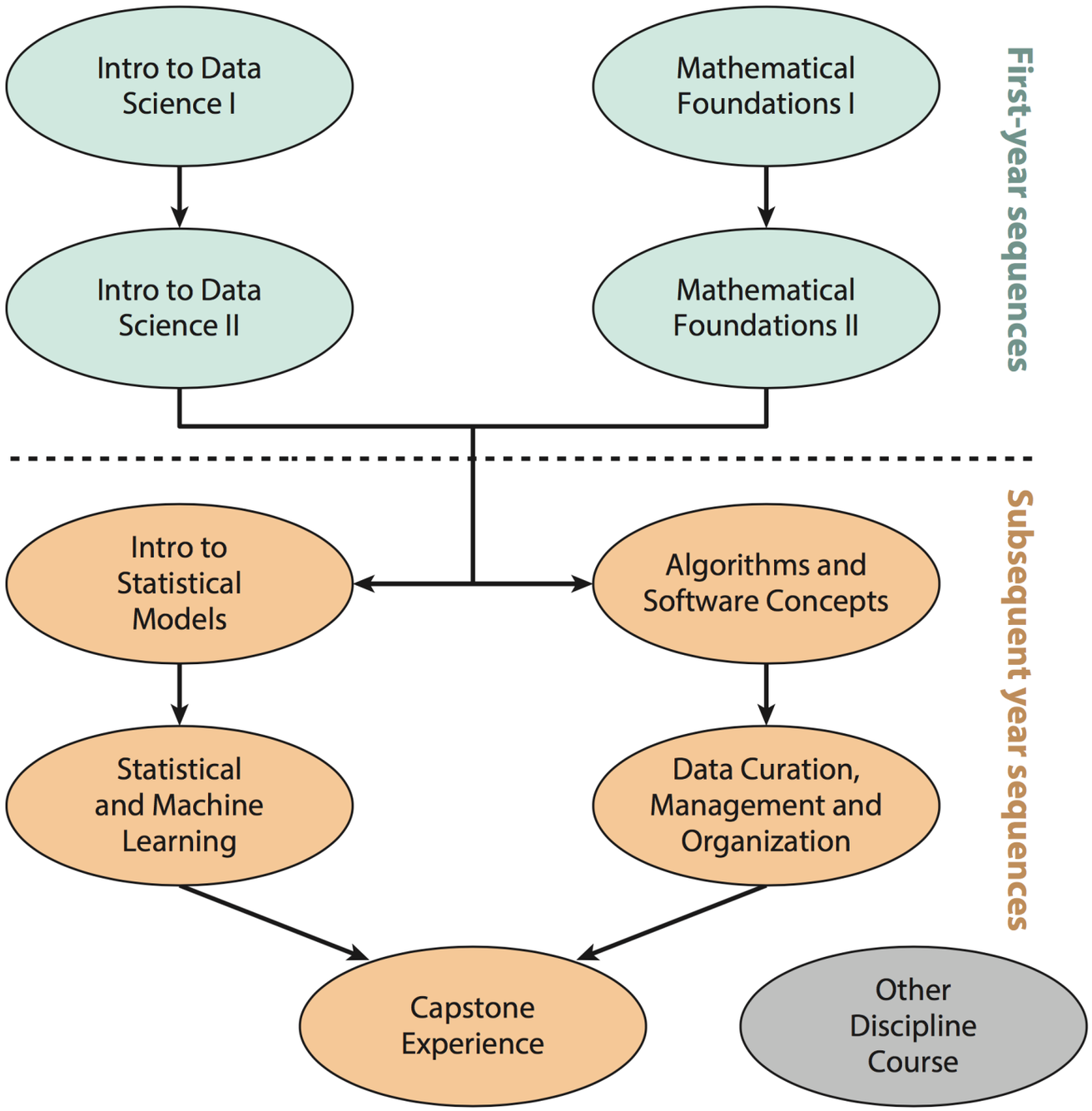
- Ben Baumer asked: *“What if we blew up math, stats, CS, and all their legacies and started over? What would this field look like?”*

Key Competencies for an Undergraduate Data Science Major

1. Computational and statistical thinking
2. Mathematical foundations
3. Model building and assessment
4. Algorithms and software foundation
5. Data curation
6. Knowledge transference, communication, and responsibility

Result: PCMI Guidelines

Curriculum Guidelines for Undergraduate Programs in Data Science (link)



Intro to Data Science I

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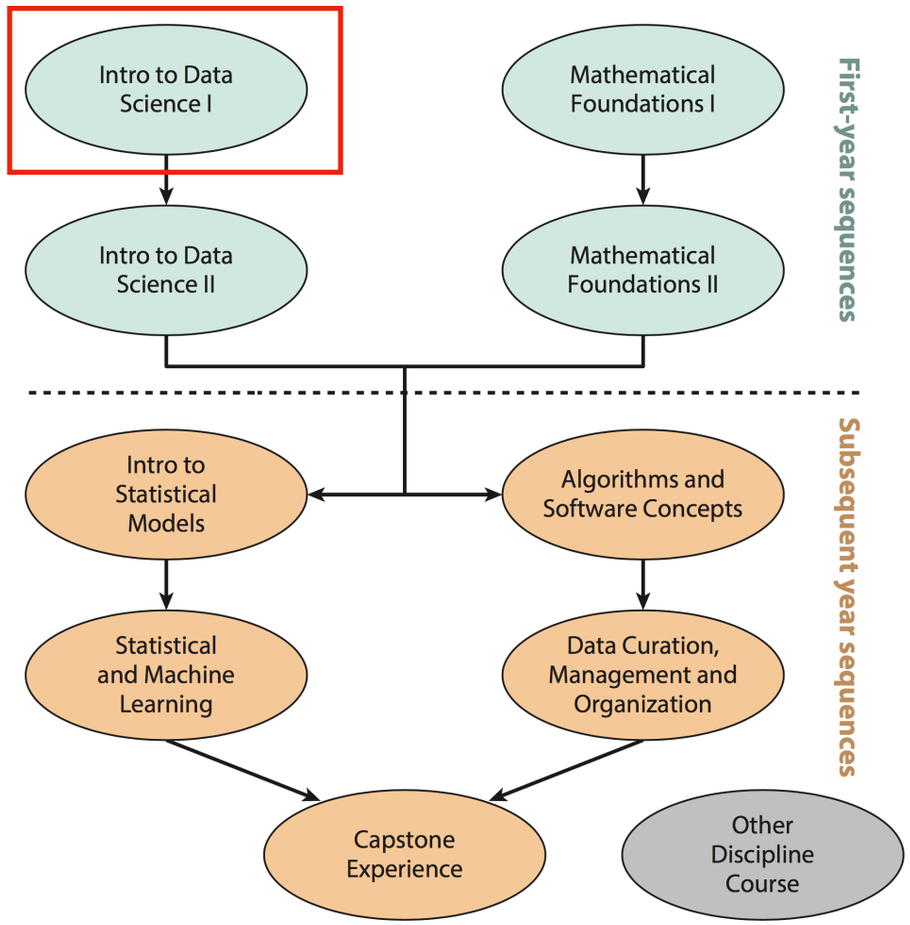

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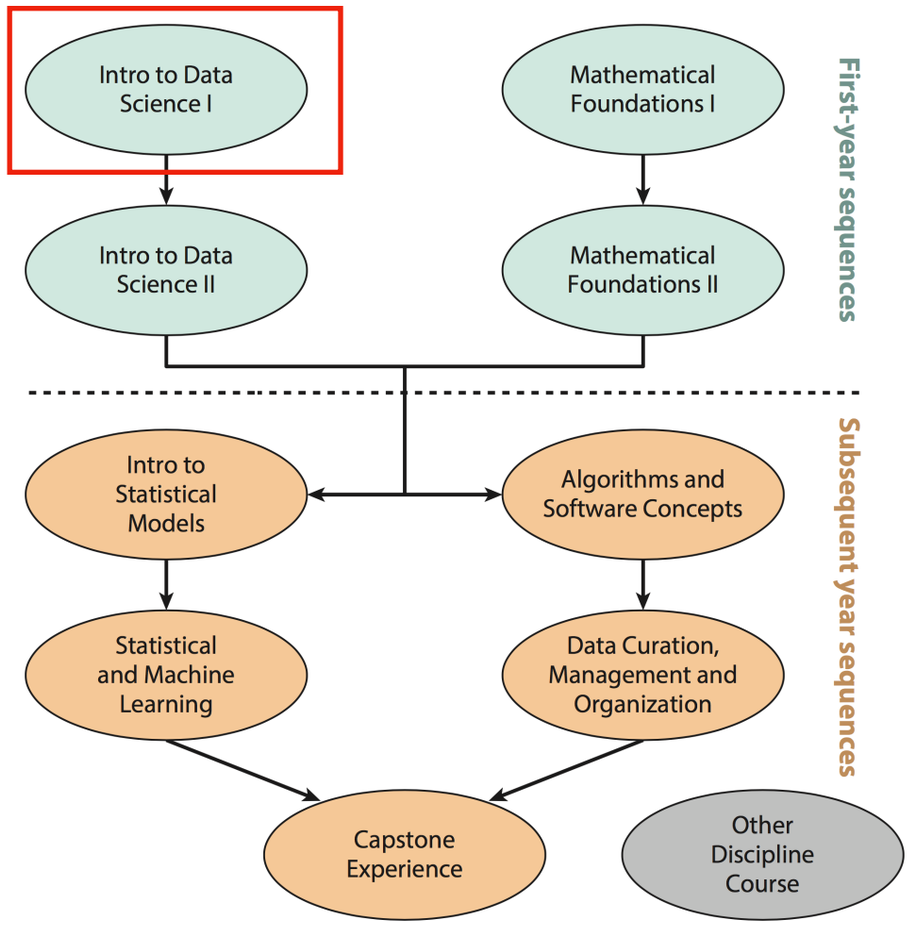
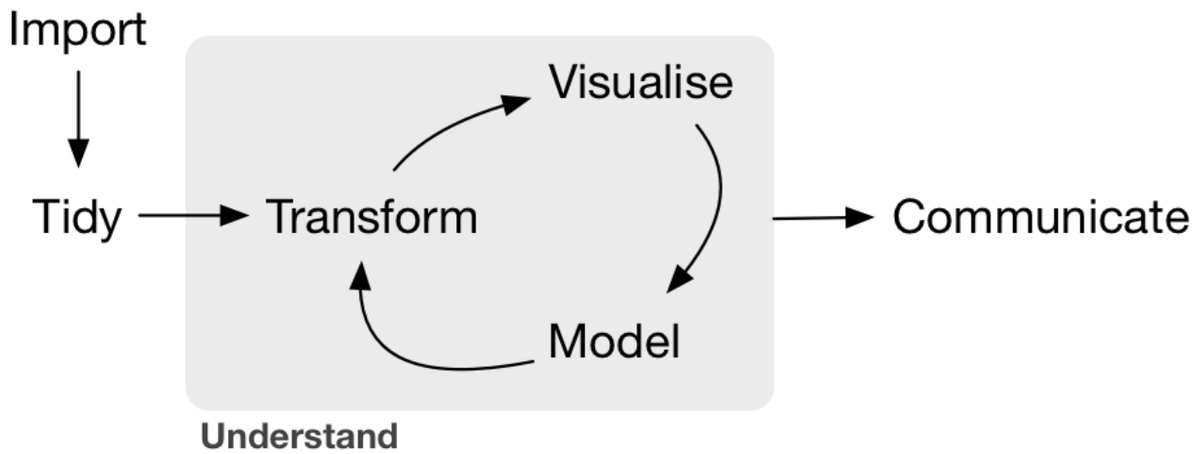


Minimally viable "alpha to omega" first pass through the data/science pipeline:



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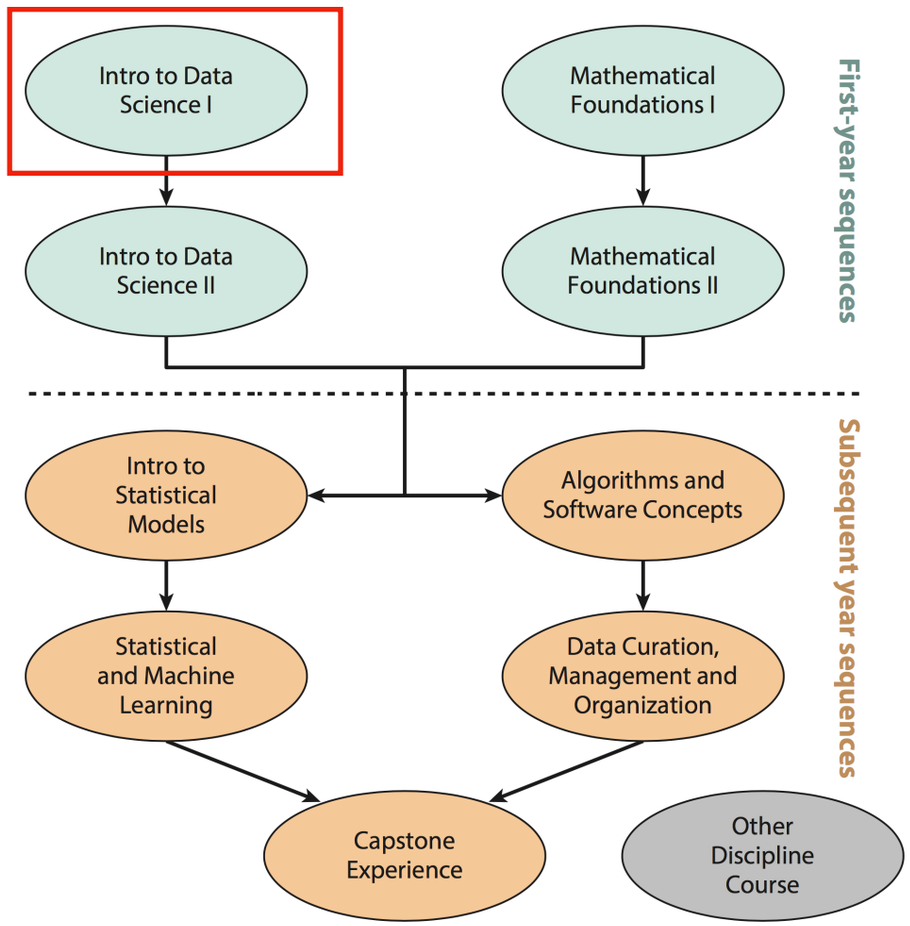

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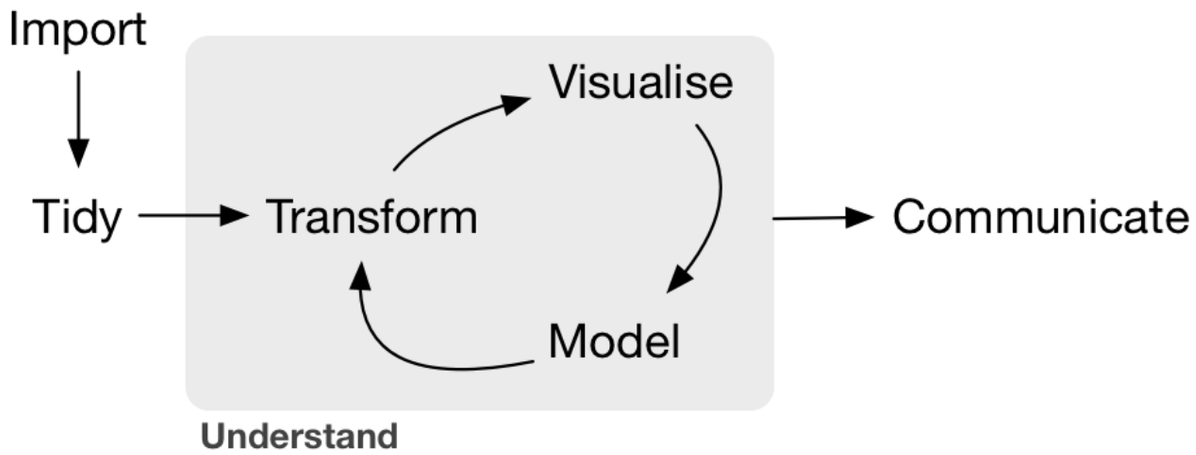
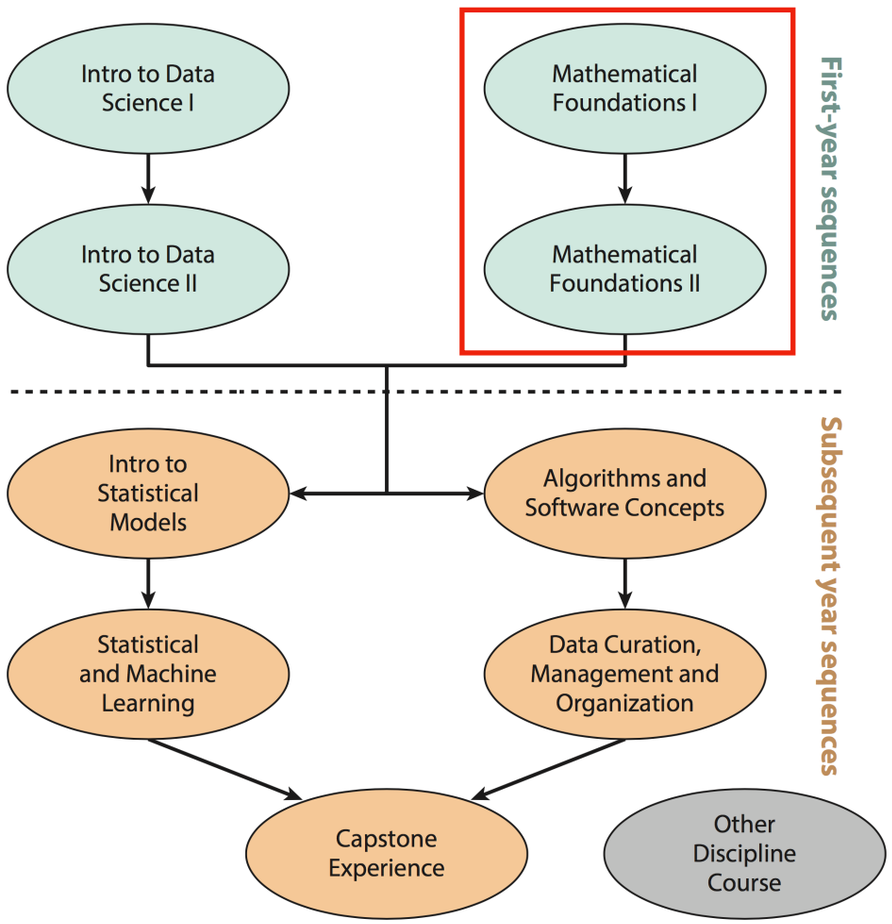


Notes:

- **Minimal prerequisites i.e. "Expanding the Tent"**
- **Intro to Data Science II reinforces this first pass**

À-la-carte: From the “Math” Menu:



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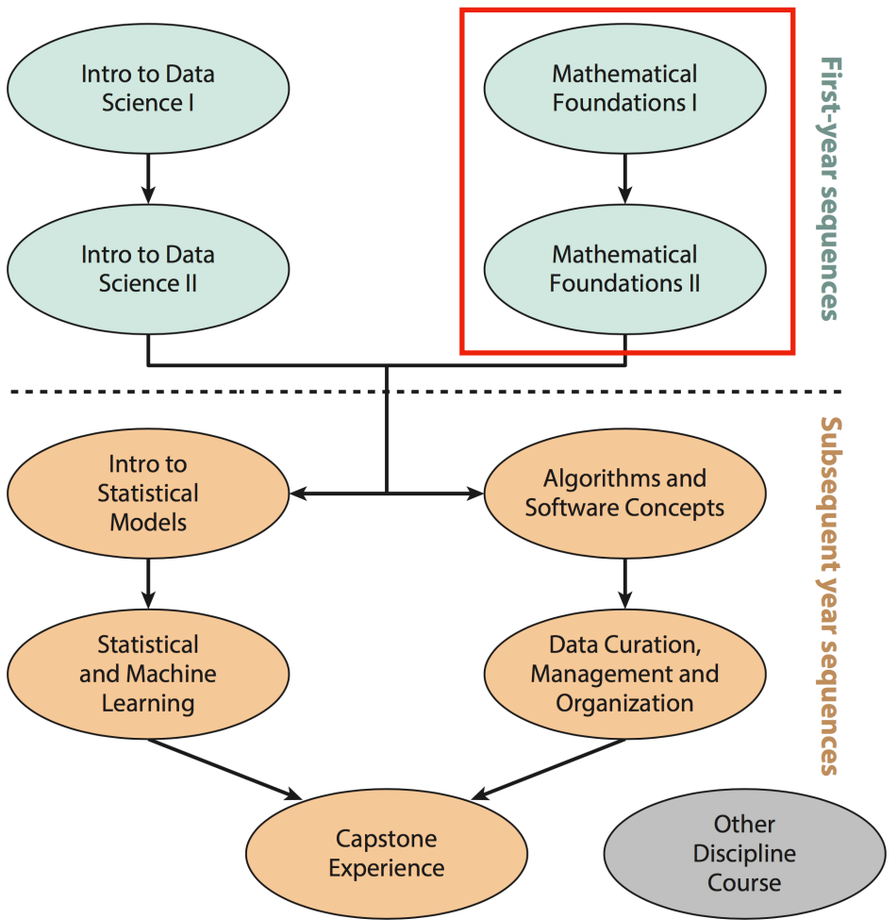

Linear Algebra

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix}$$

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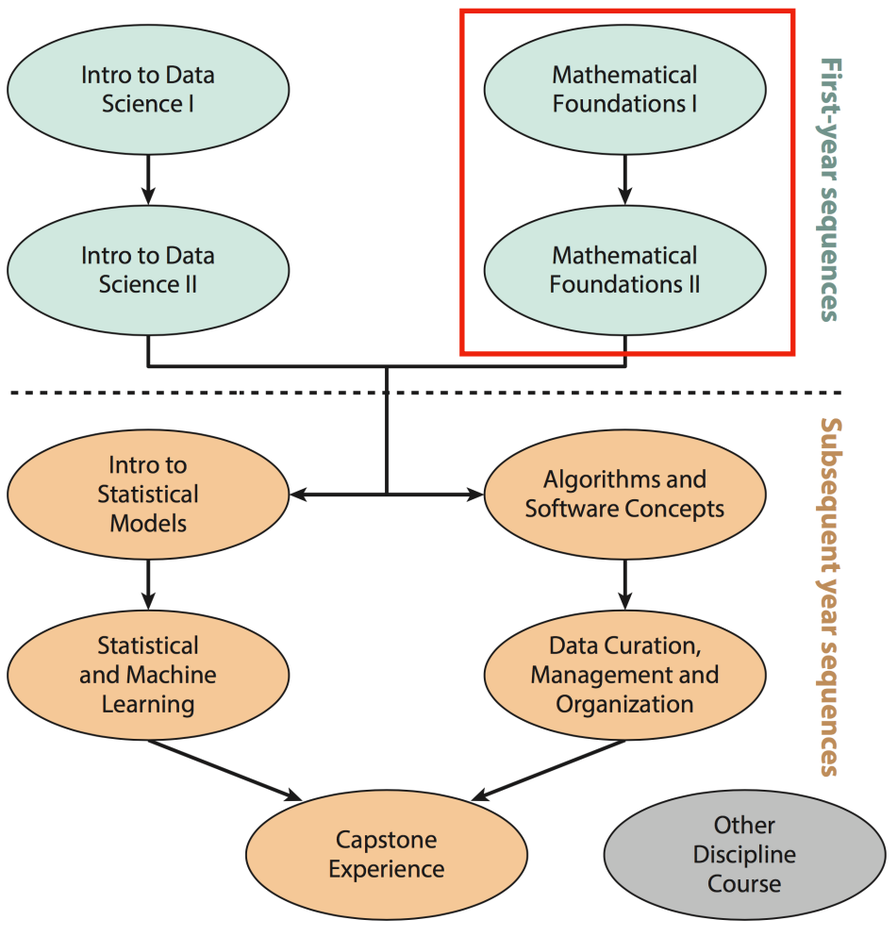

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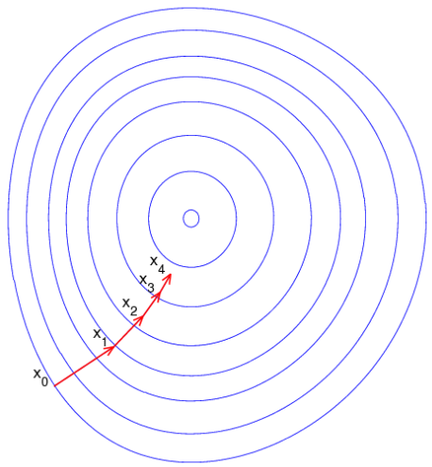
Calculus & Optimization



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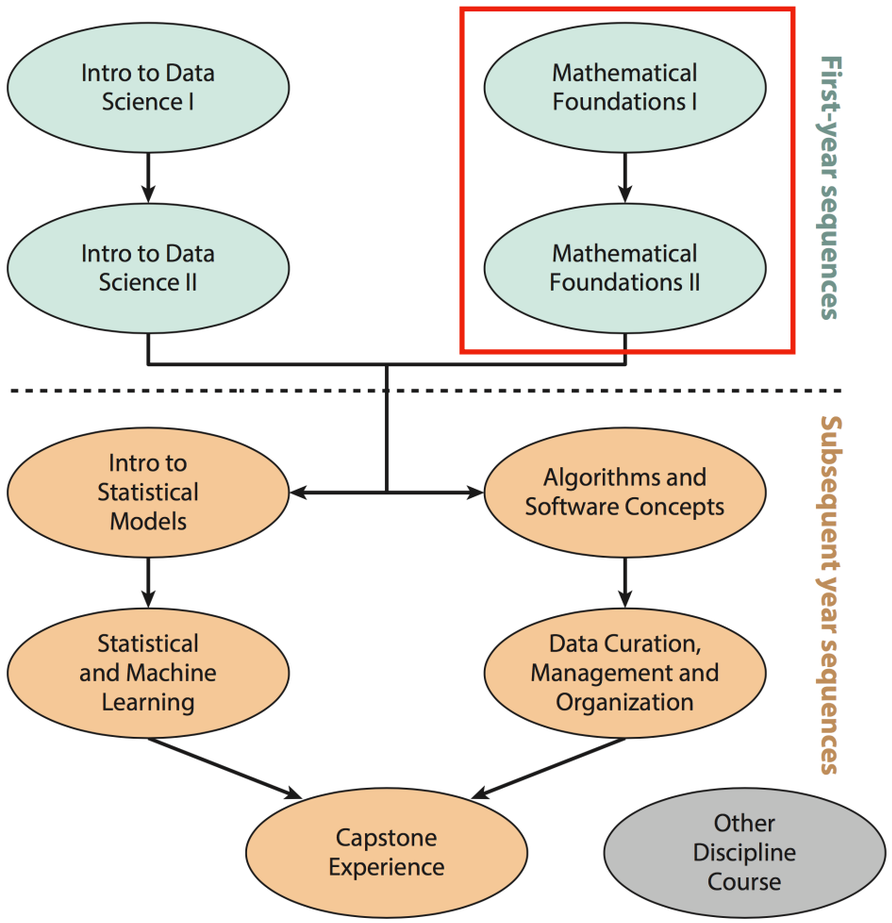

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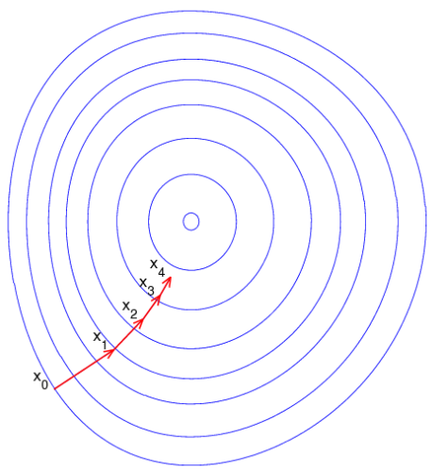

Probability

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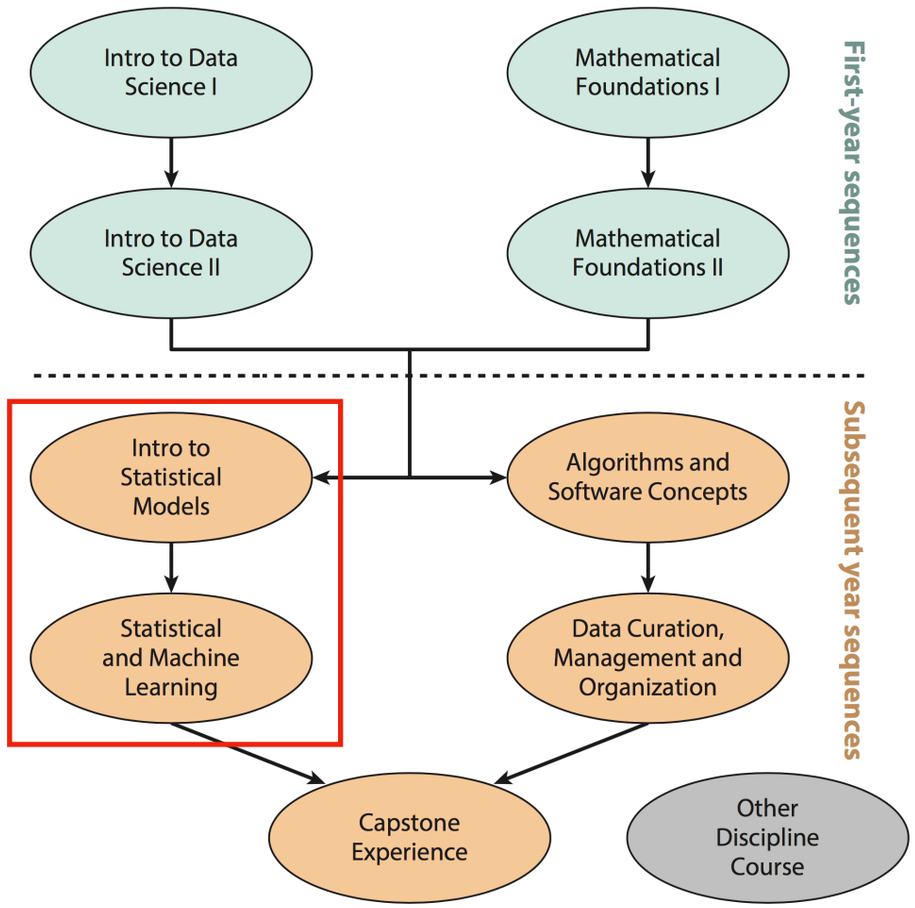

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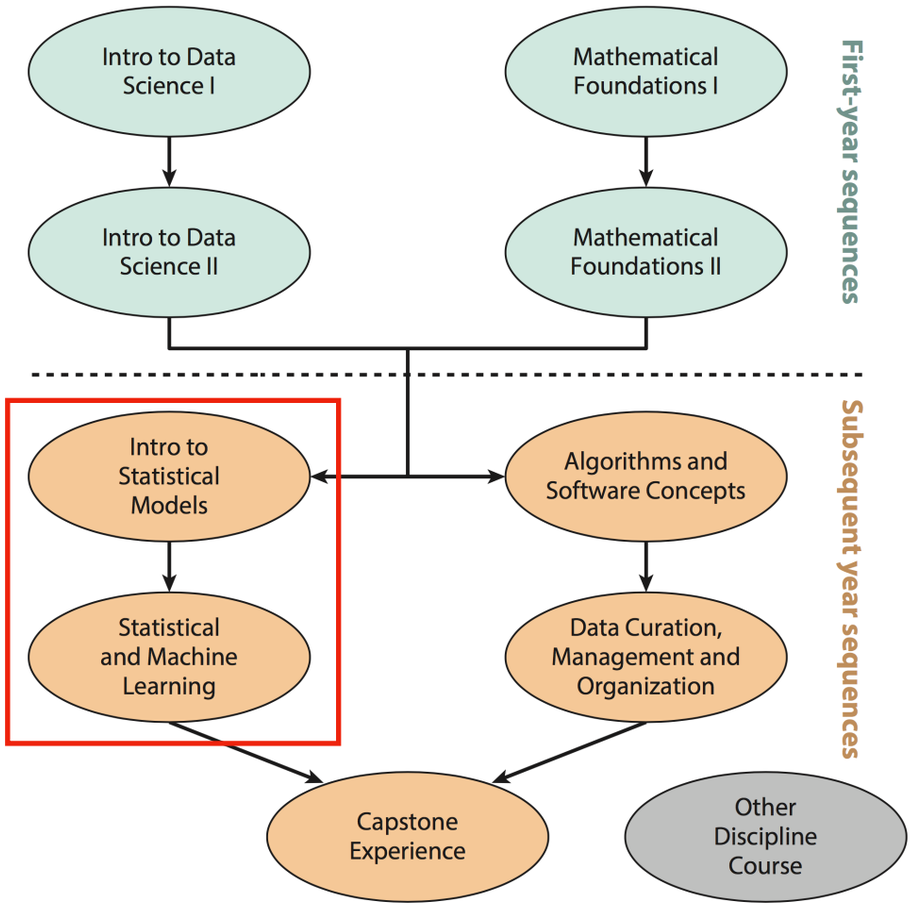
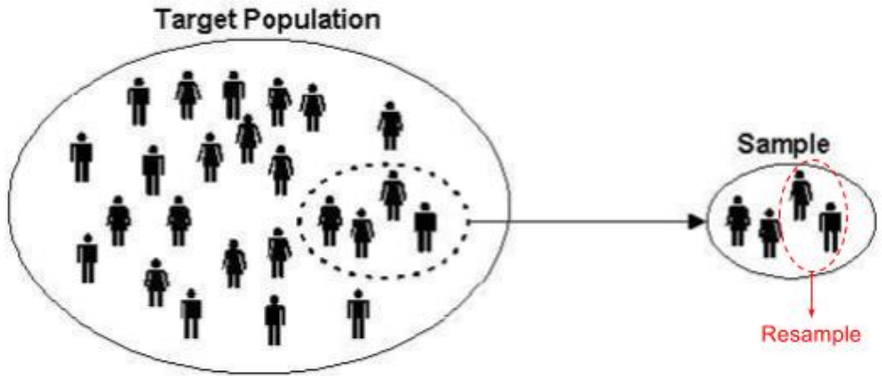


Statistical Inference



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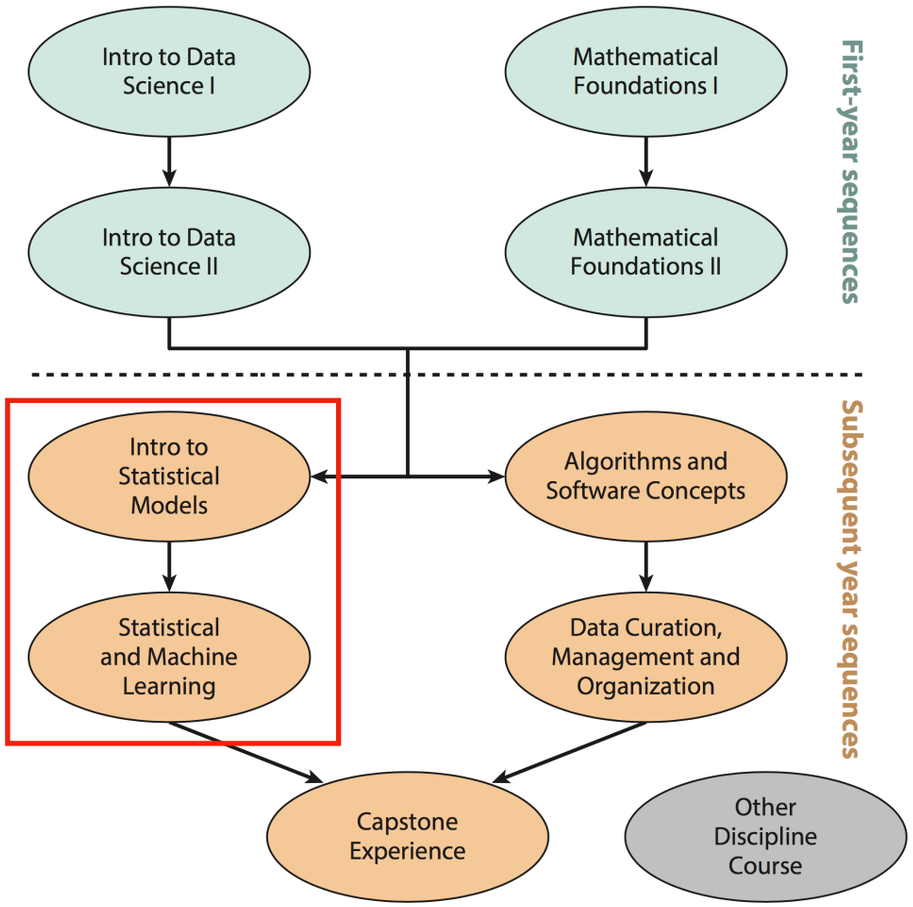

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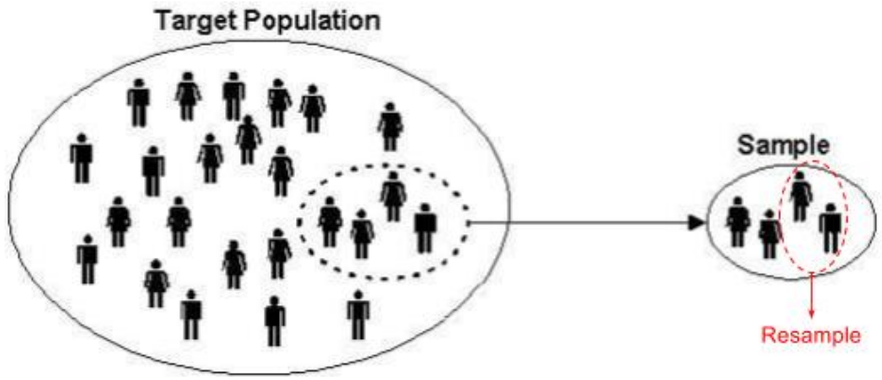

Modeling

$$y = f(\vec{x}) + \epsilon$$

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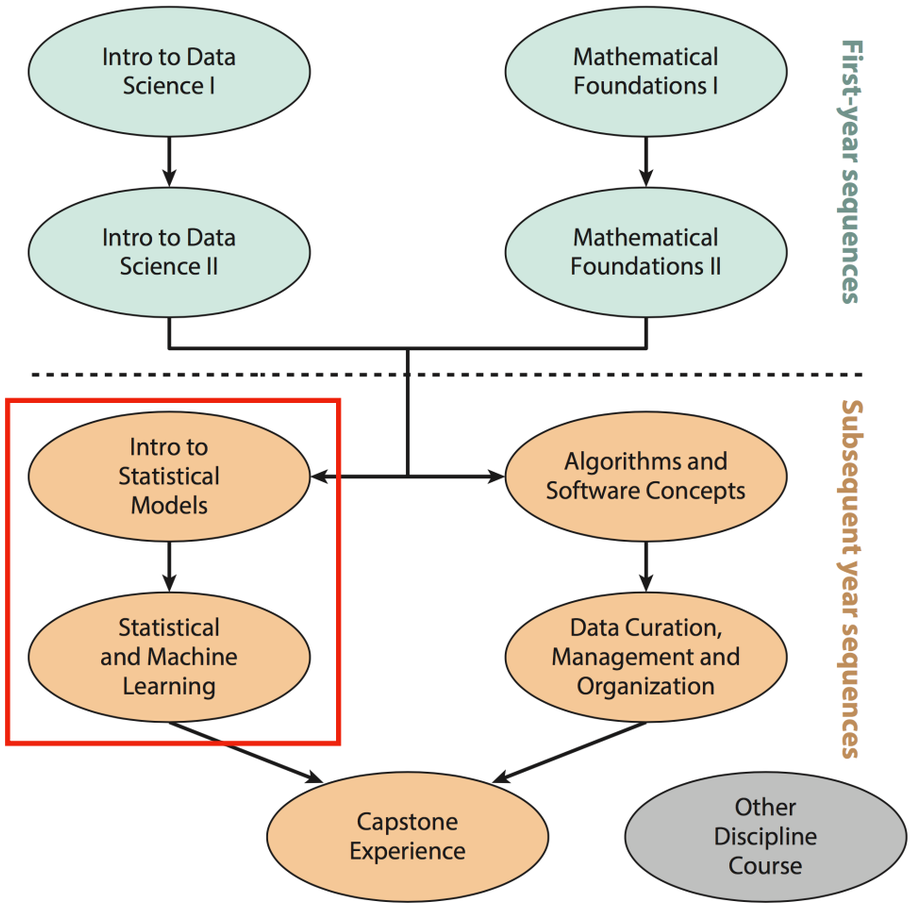

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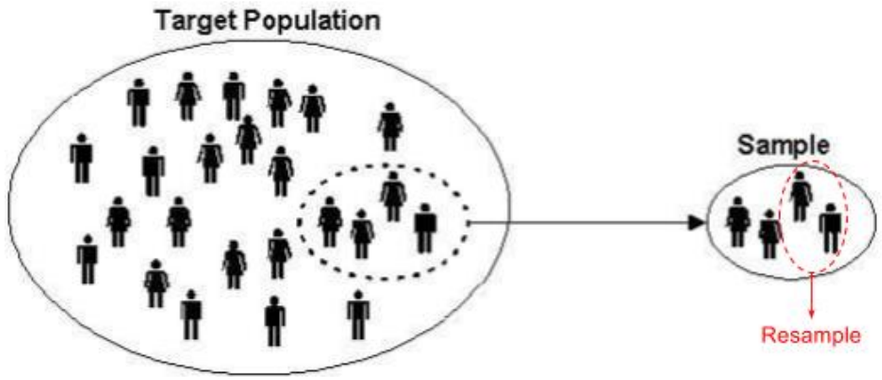

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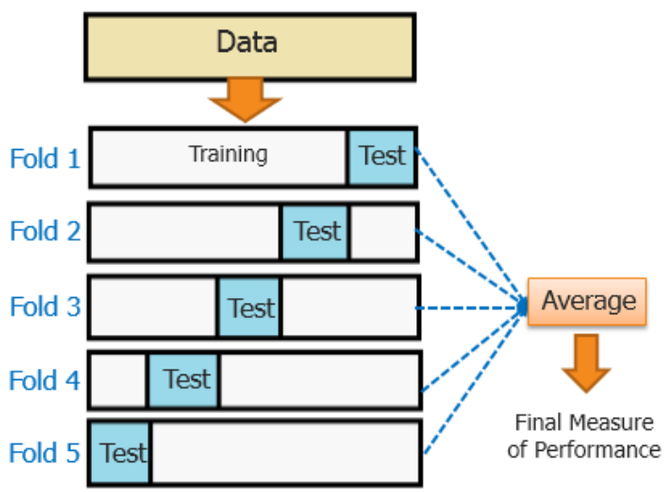
Machine Learning



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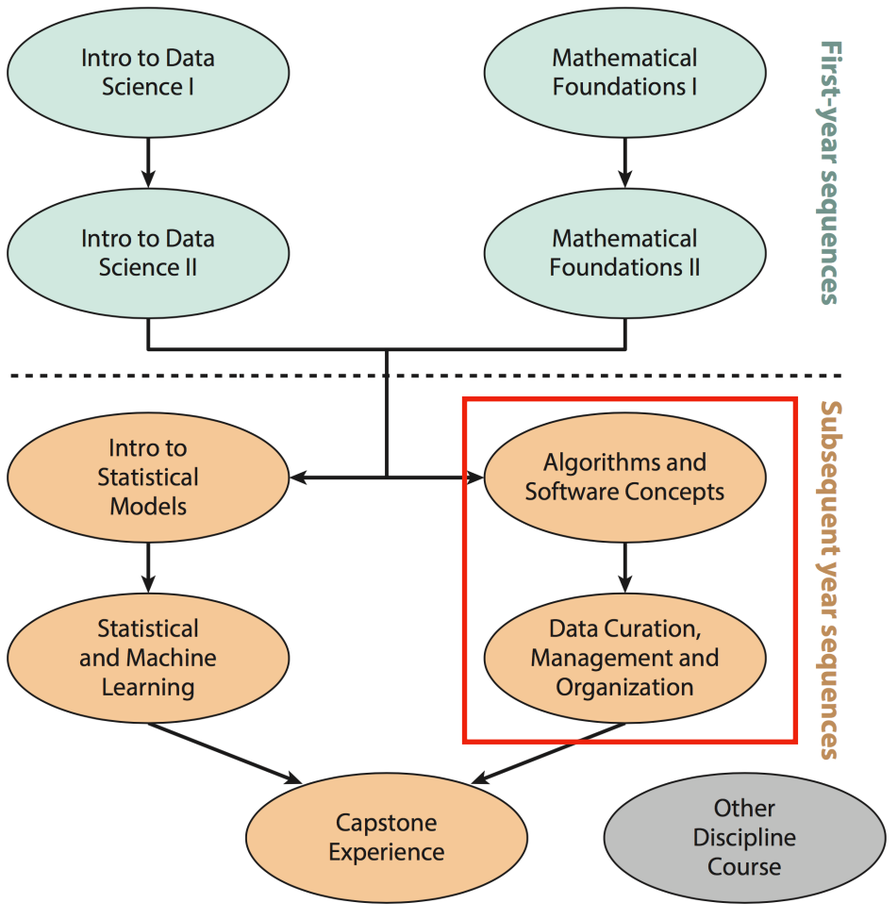

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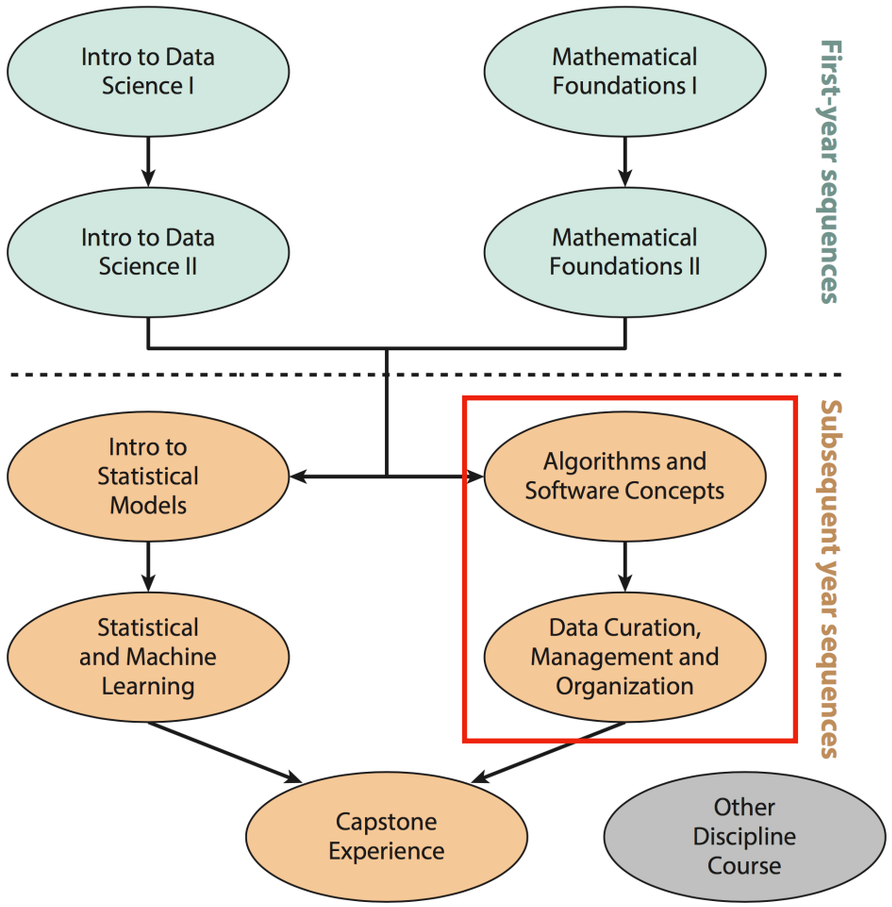
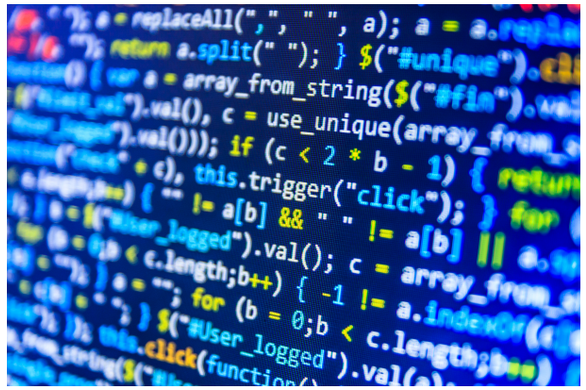


Coding as a skill



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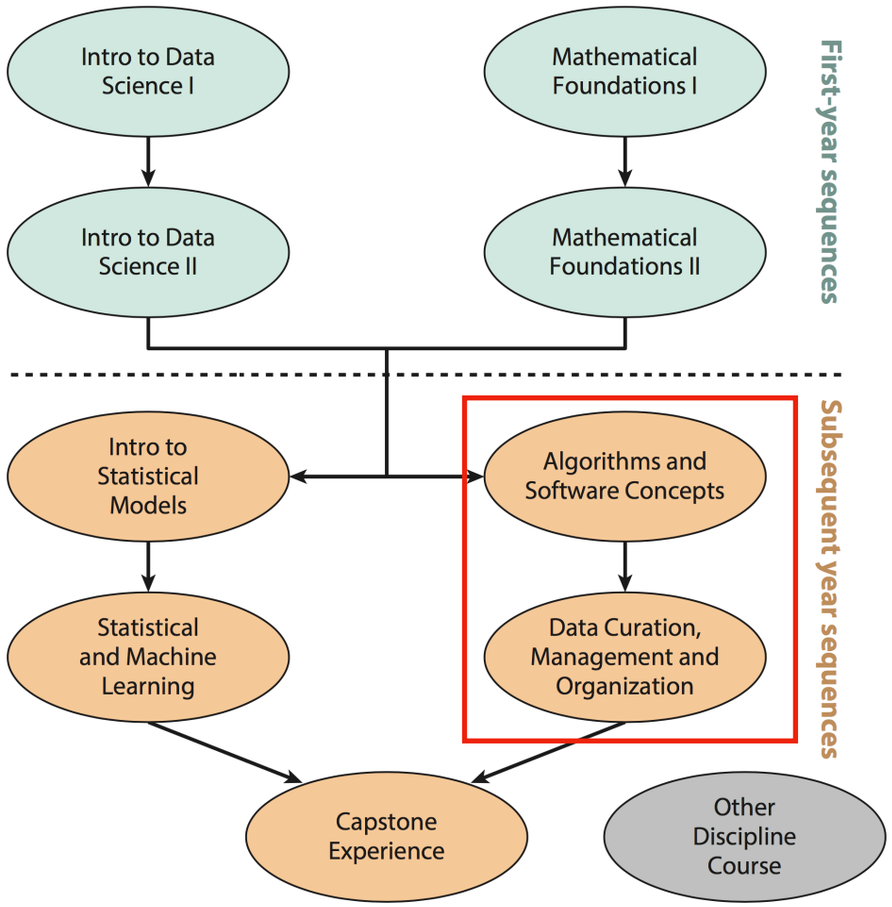

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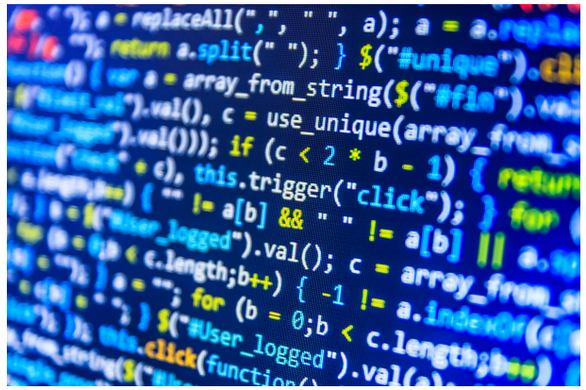
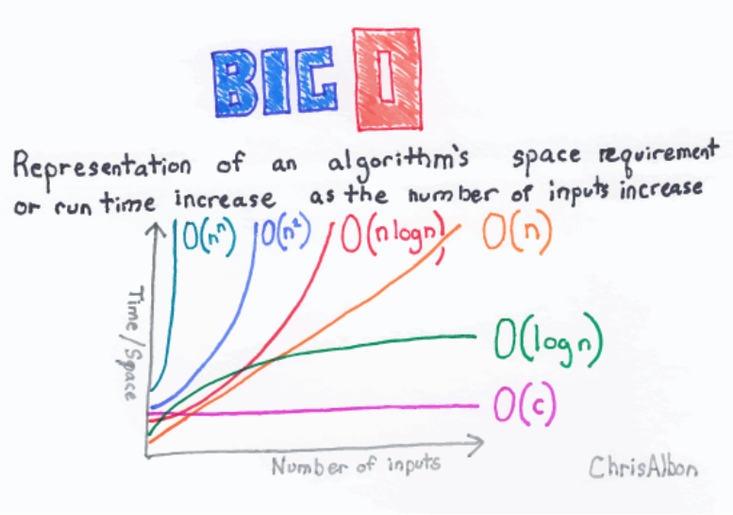


Algorithms



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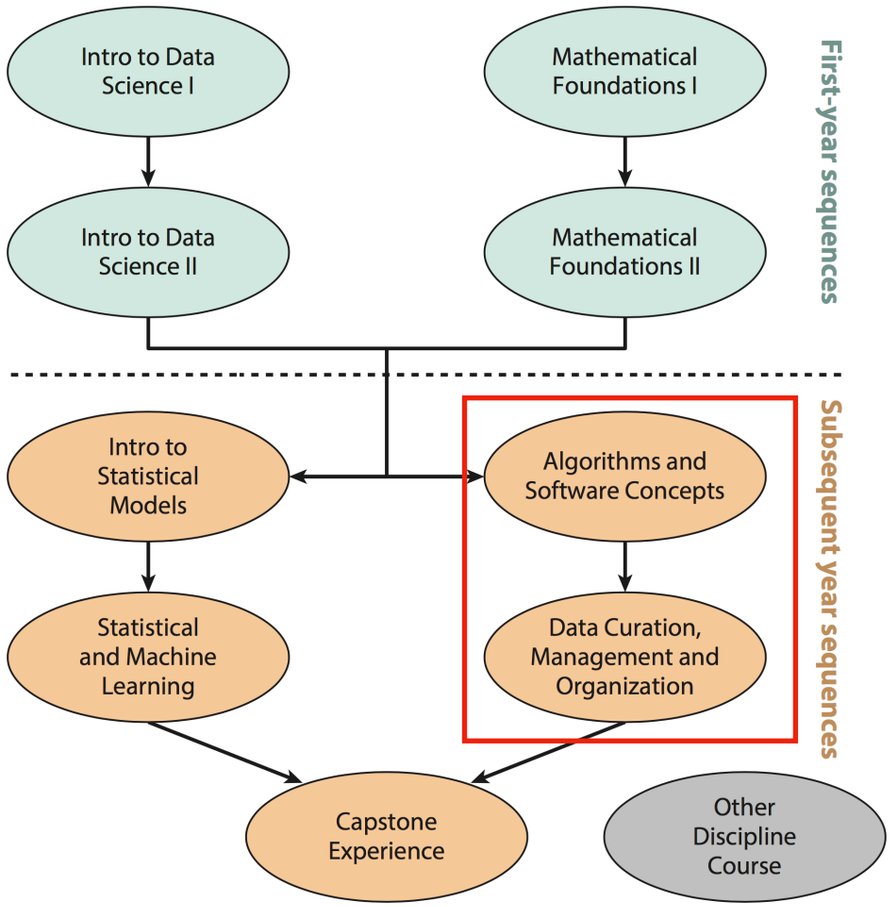

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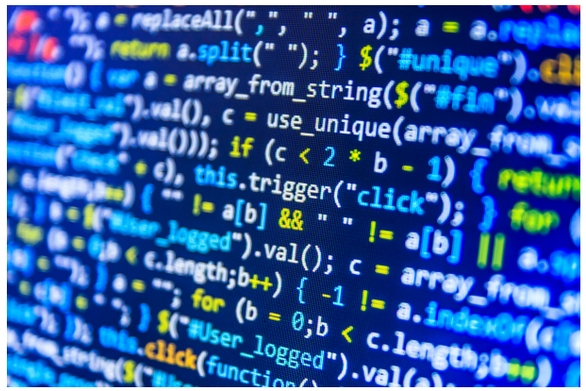

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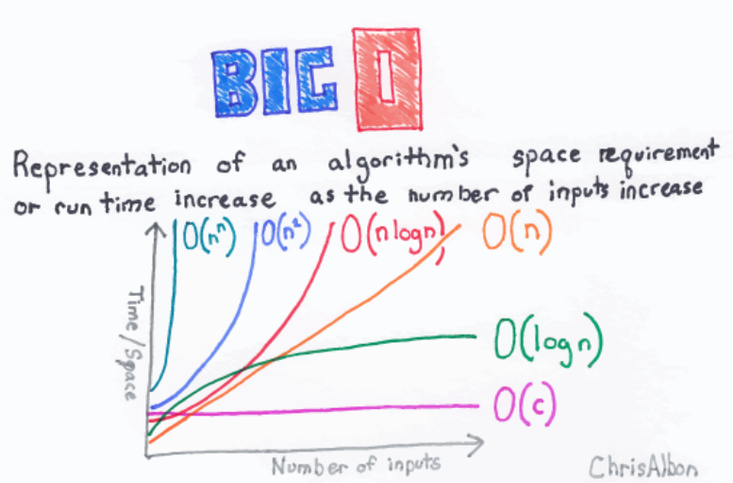
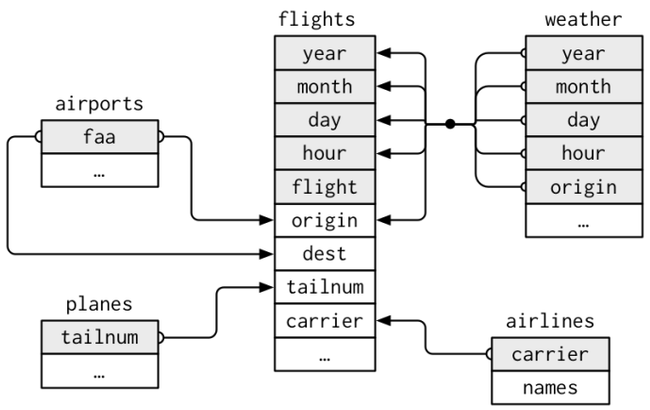


Data Representation



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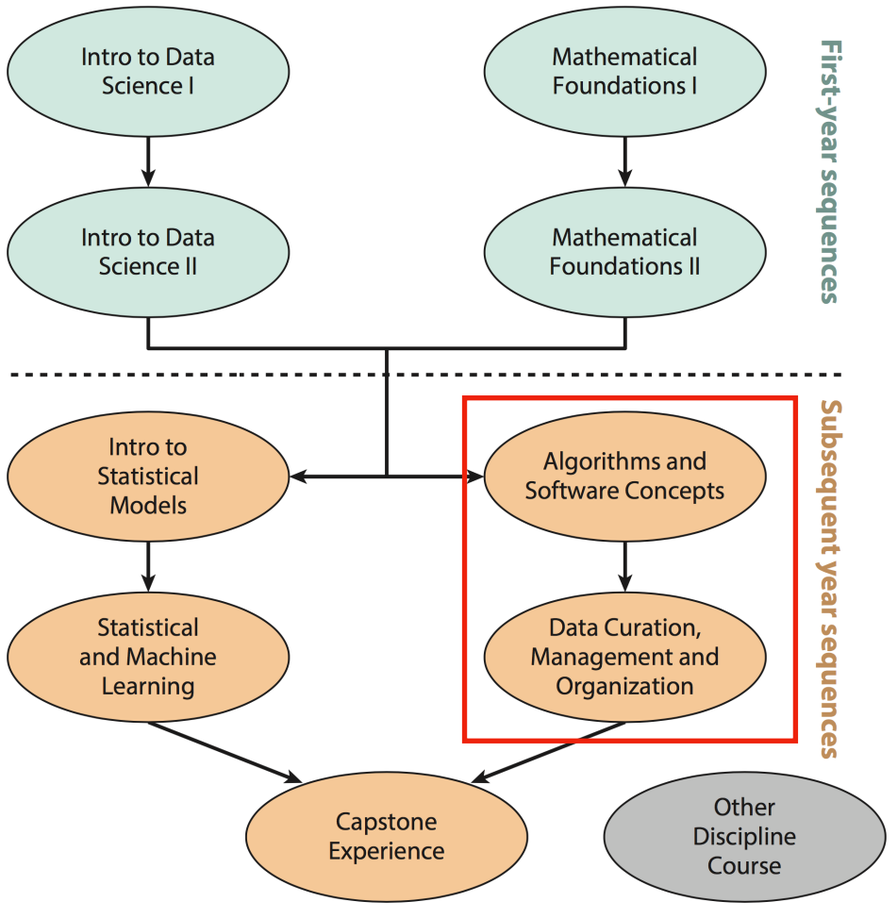

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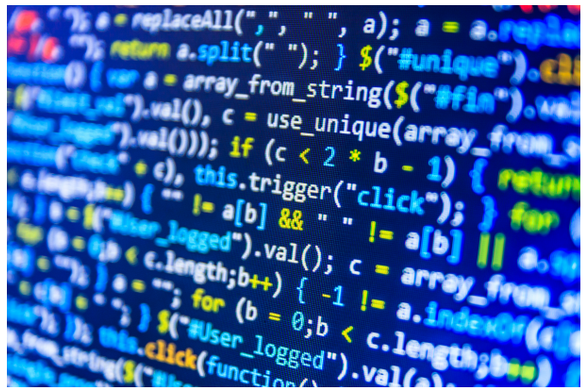

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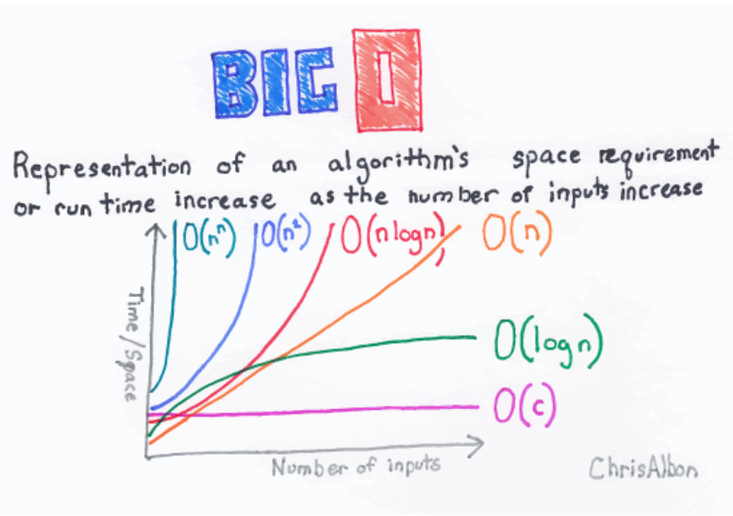

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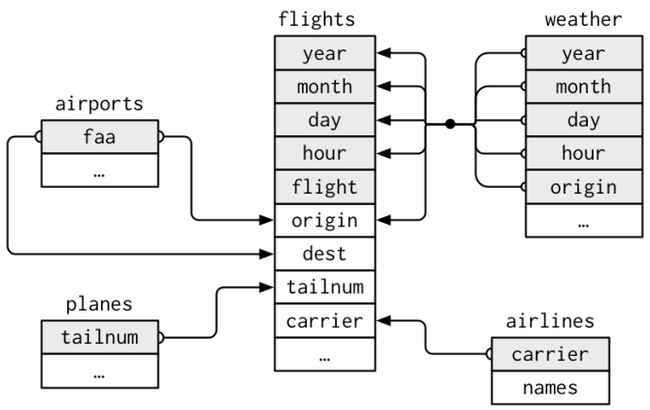
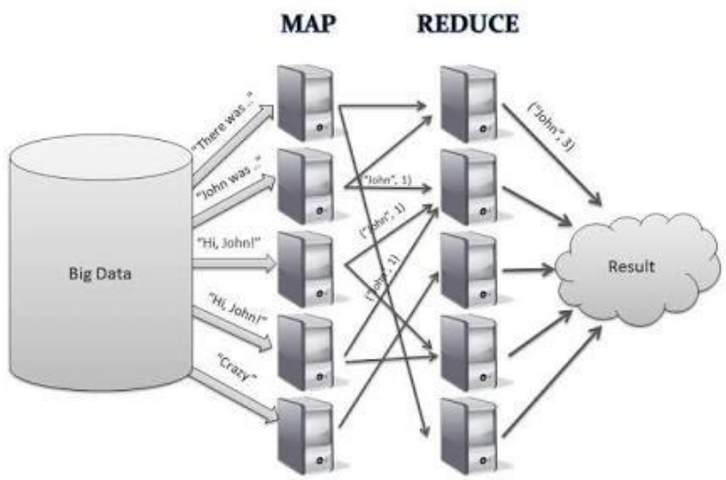
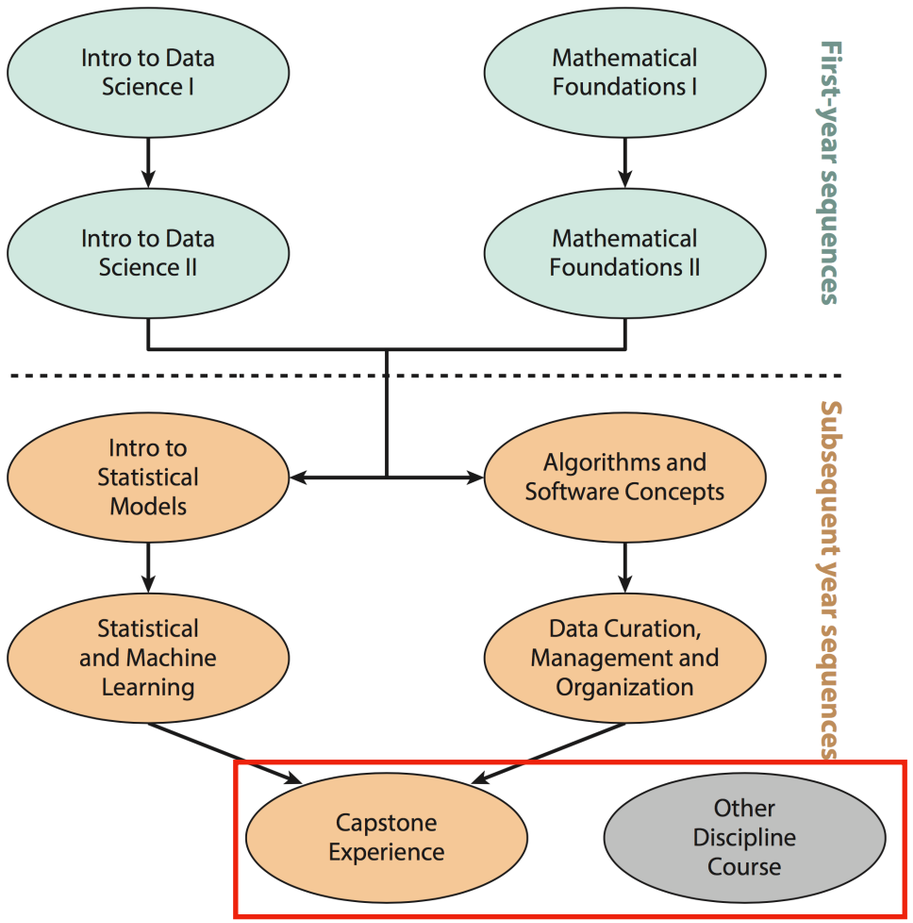


“Big Data”



Capstone Experience & Domain Courses



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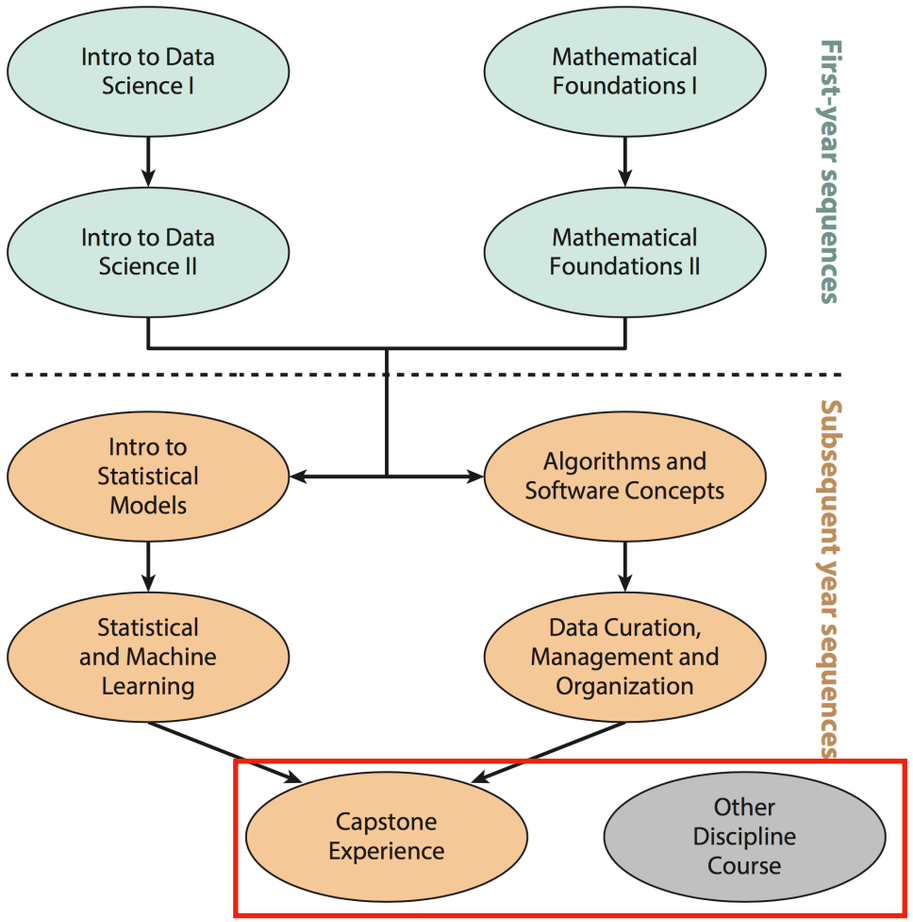
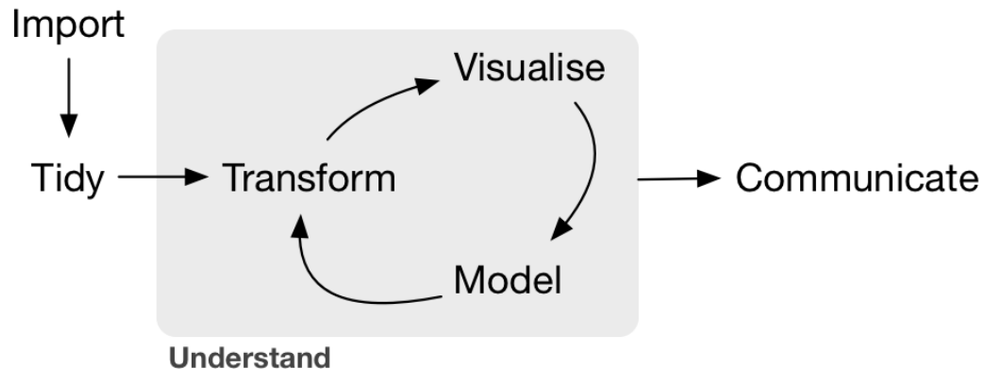


Capstone: Revisit entirety of pipeline



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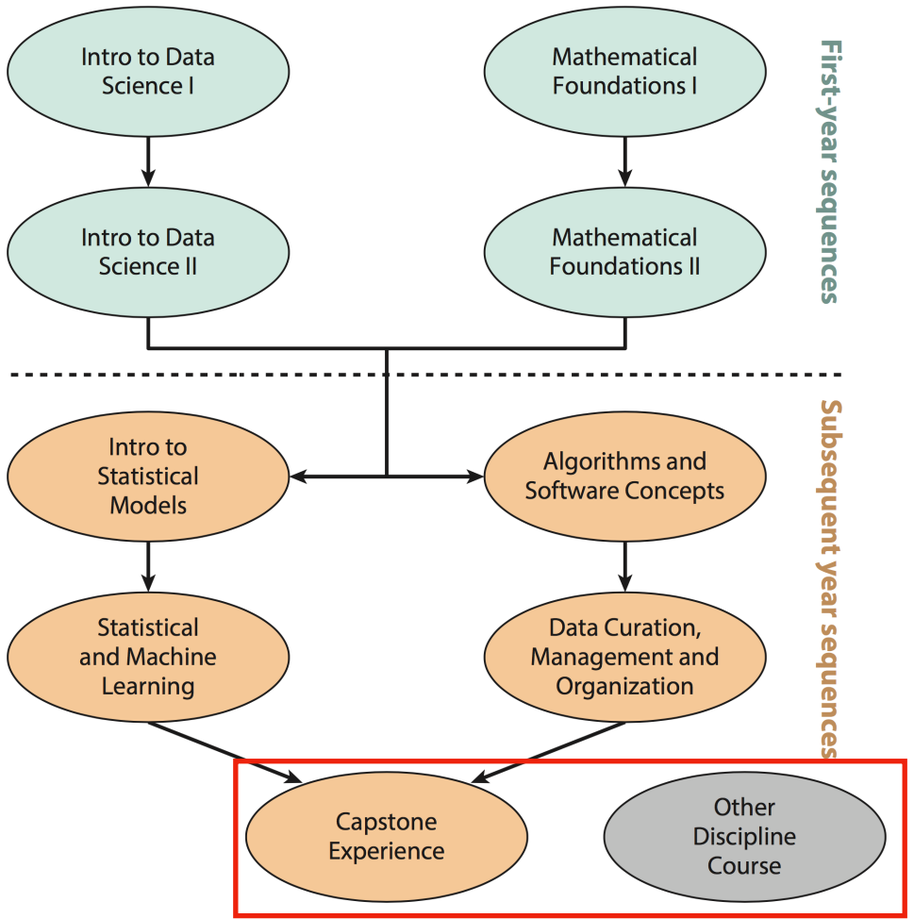

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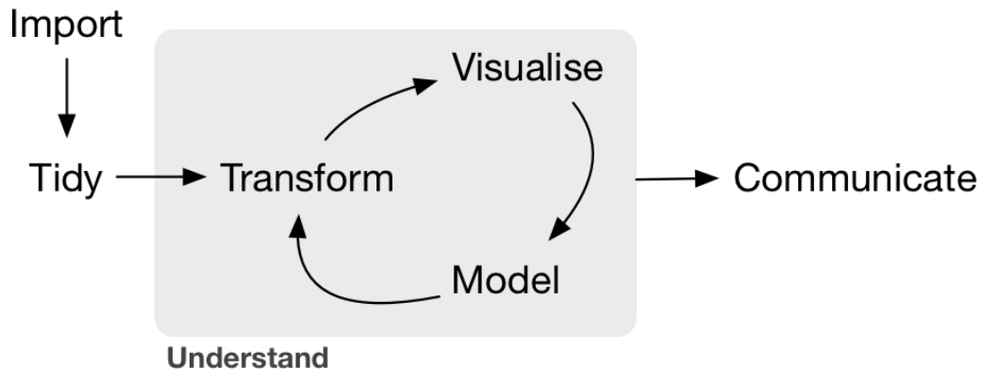
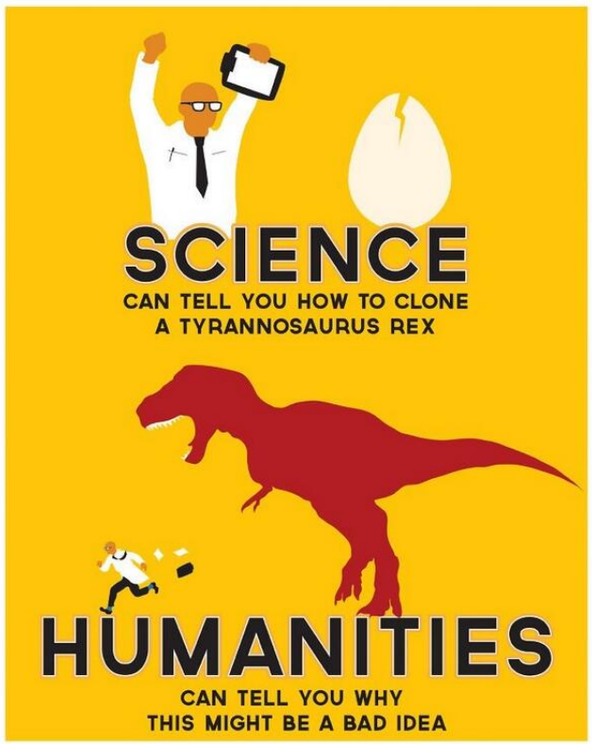


Ethics



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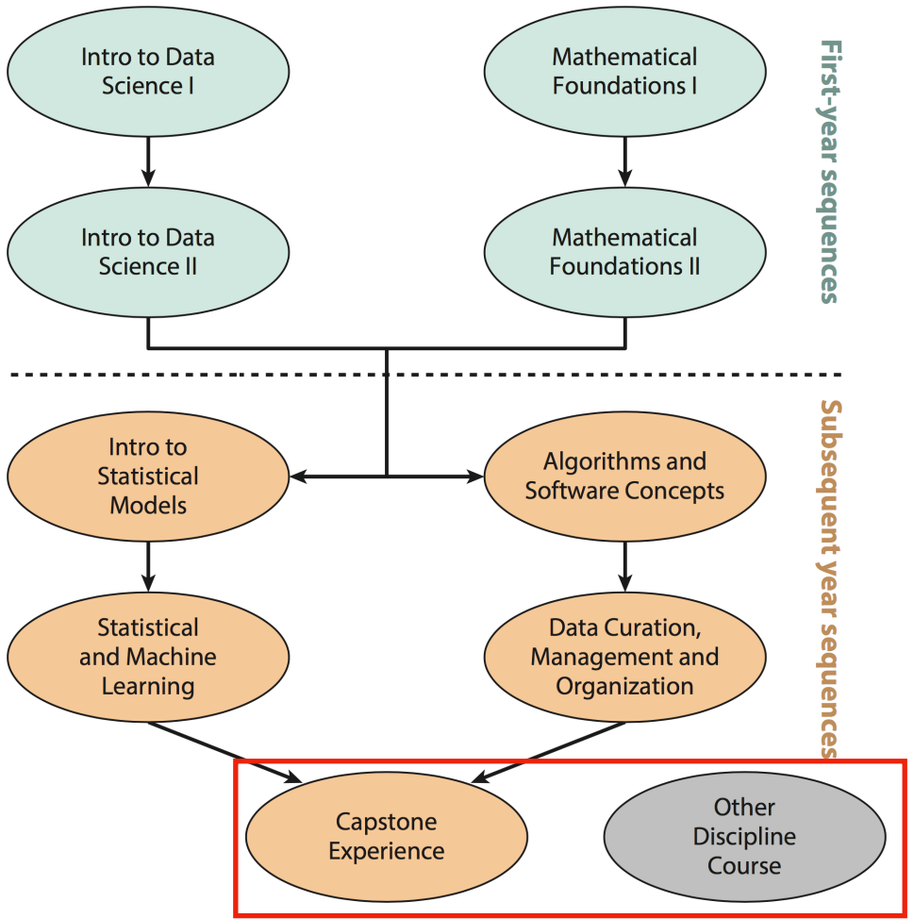

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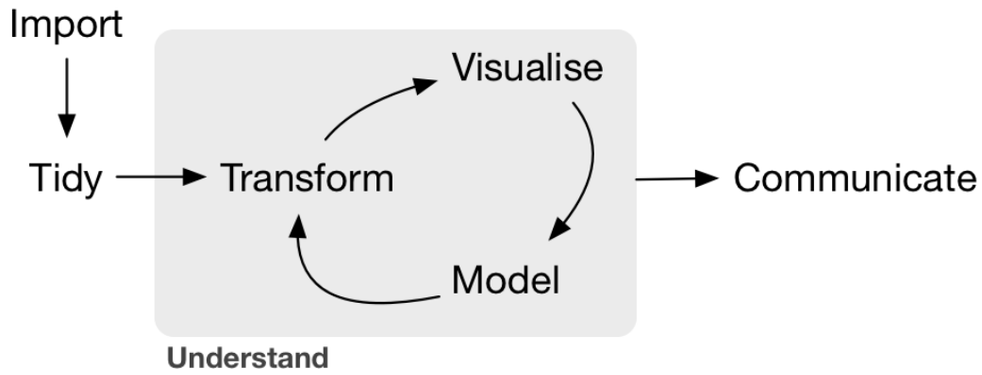

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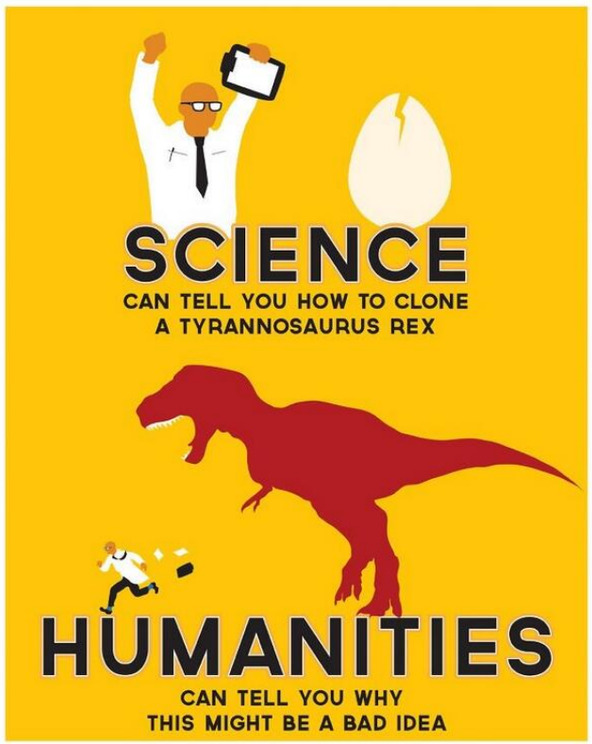

Other Disciplines:

“Numbers are numbers, but data has context”

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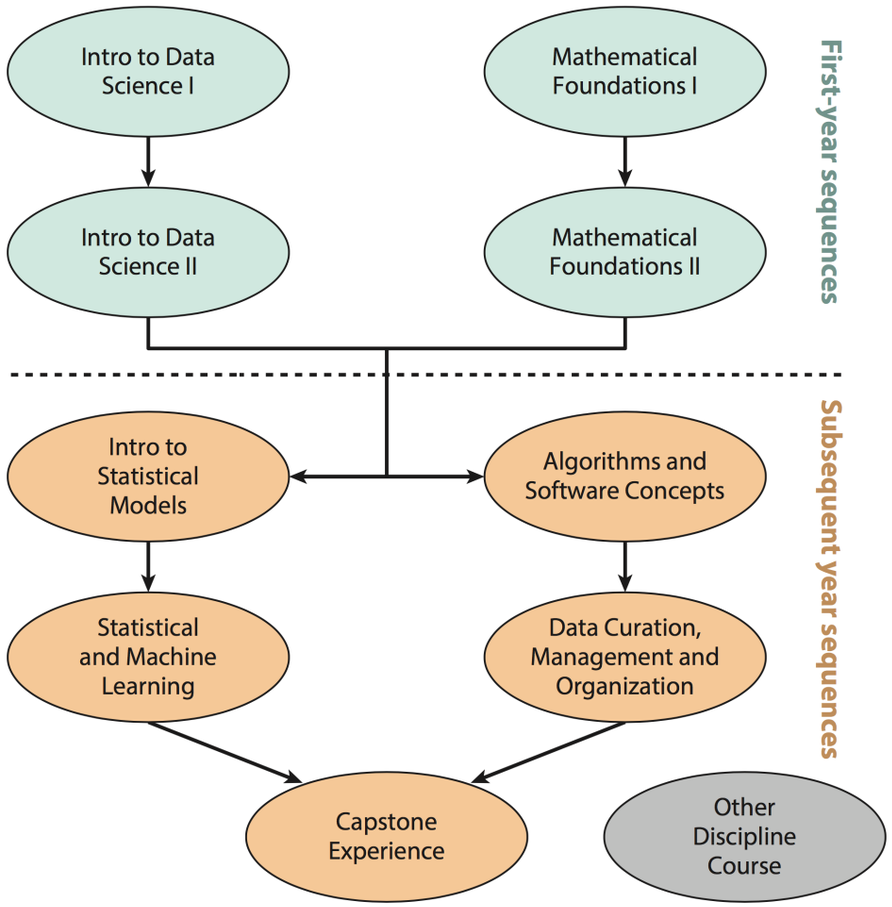
2. Courses from the traditional disciplines of mathematics, statistics, and computer science **provide the basic infrastructure** for the major at present.
3. A **redesign of the curriculum**, integrating the elements of mathematical foundations and computational and statistical thinking at all levels, **will provide** a rich and effective series of courses to prepare graduates for a career in data science.

Example: Smith College SDS Major



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