

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

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# 2016 PCMI Undergraduate Faculty Program

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

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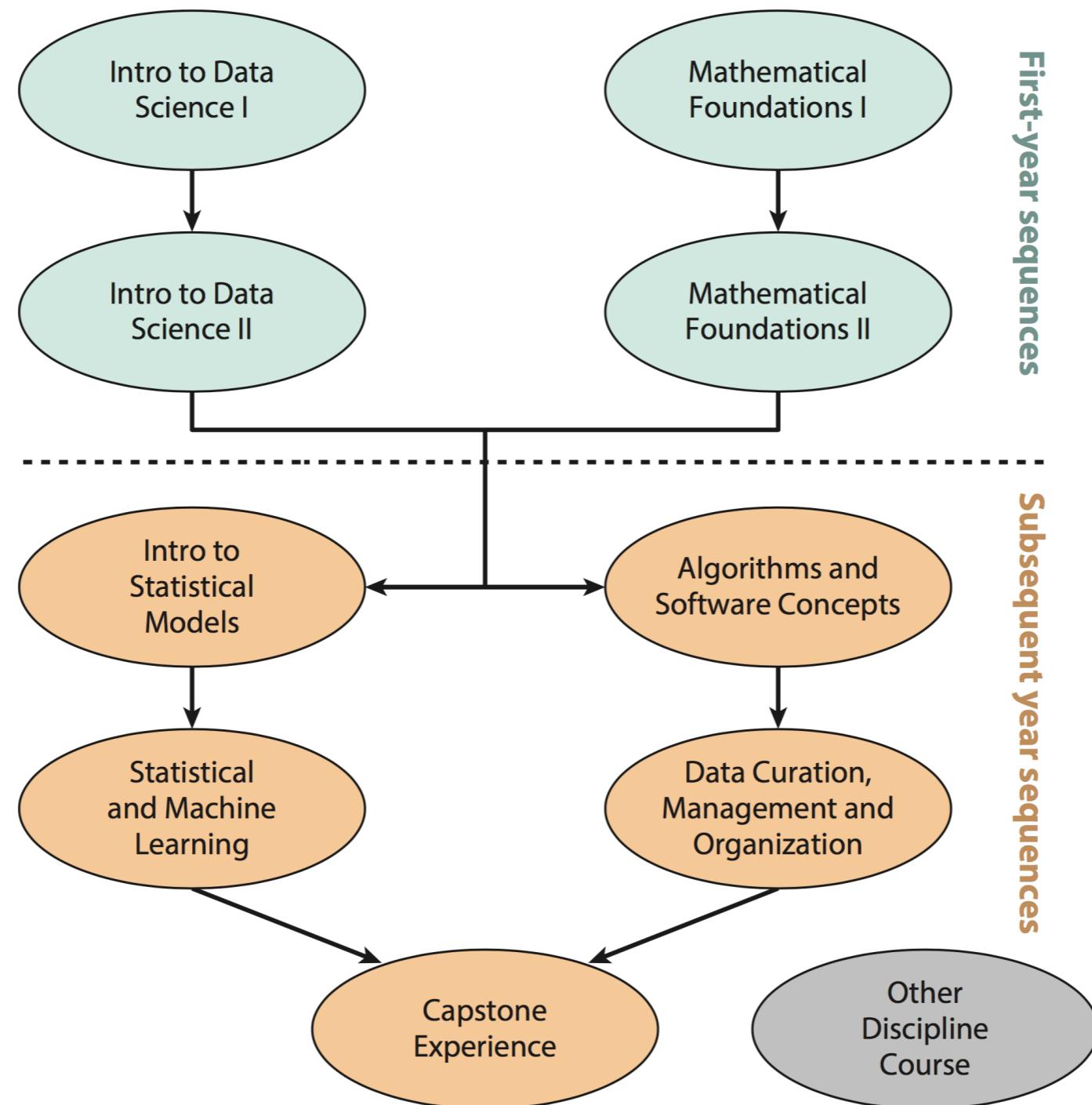
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If you try to include everything, soon you'll end up with nothing.
- Among the first proposals with interdisciplinary representation
- Ben Baumer asked: “*What if we blew up math, stats, CS, and all their legacies and started over? What would this 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**

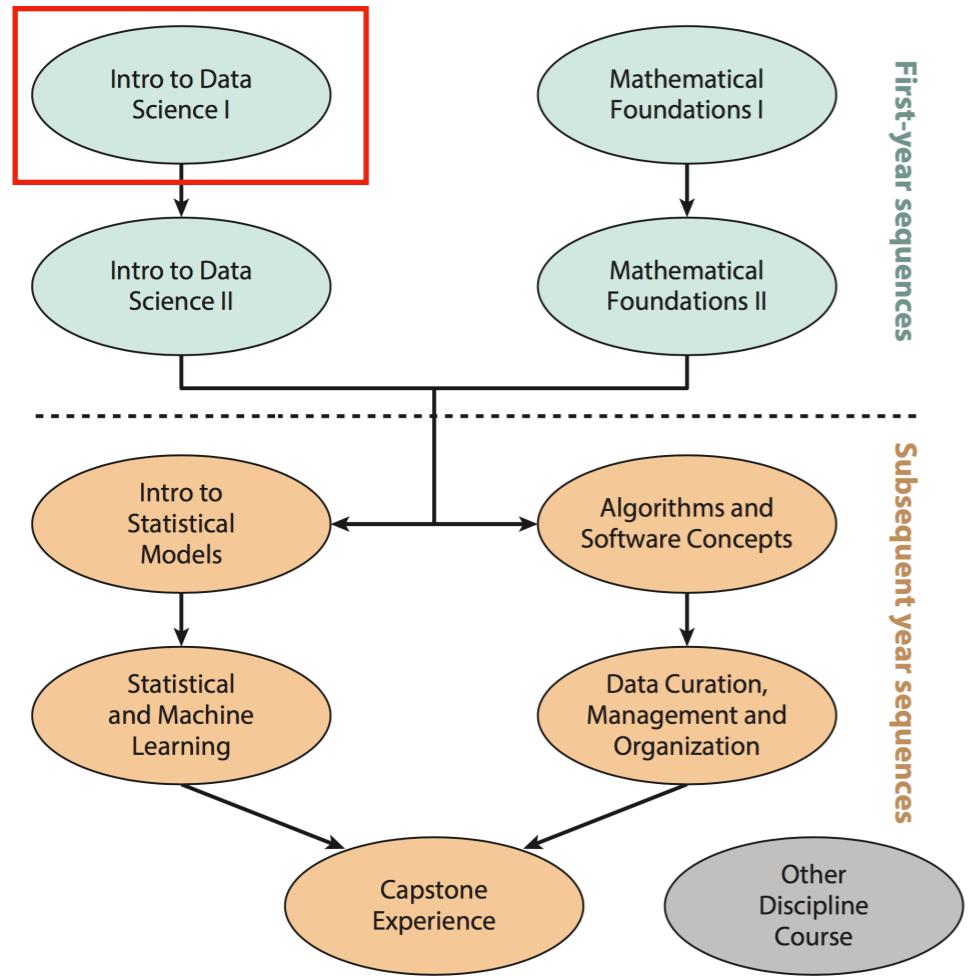
# Result: PCMI Guidelines

Curriculum Guidelines for Undergraduate Programs in Data Science ([link](#))

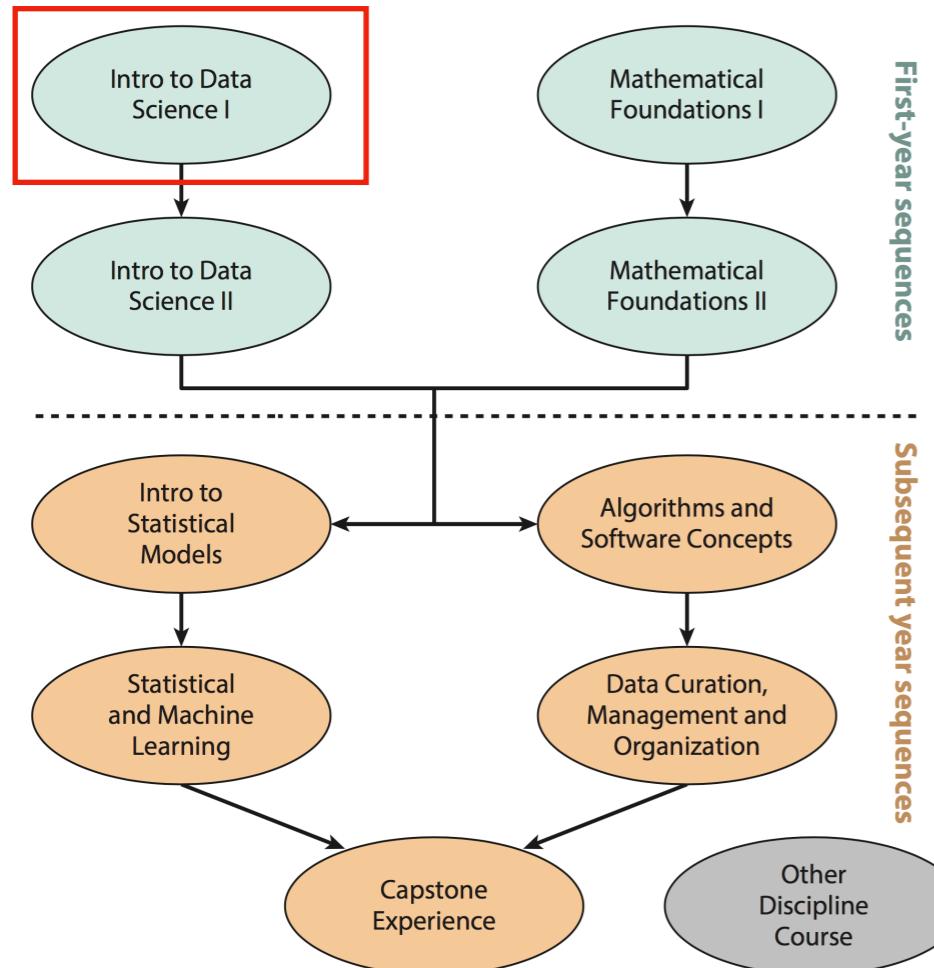


# **Intro to Data Science I**

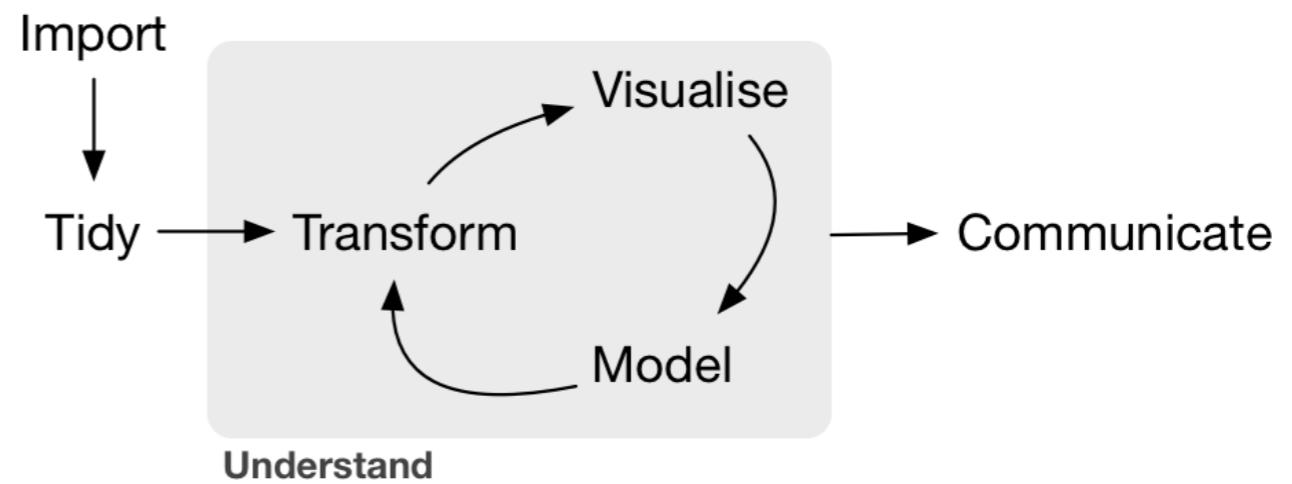
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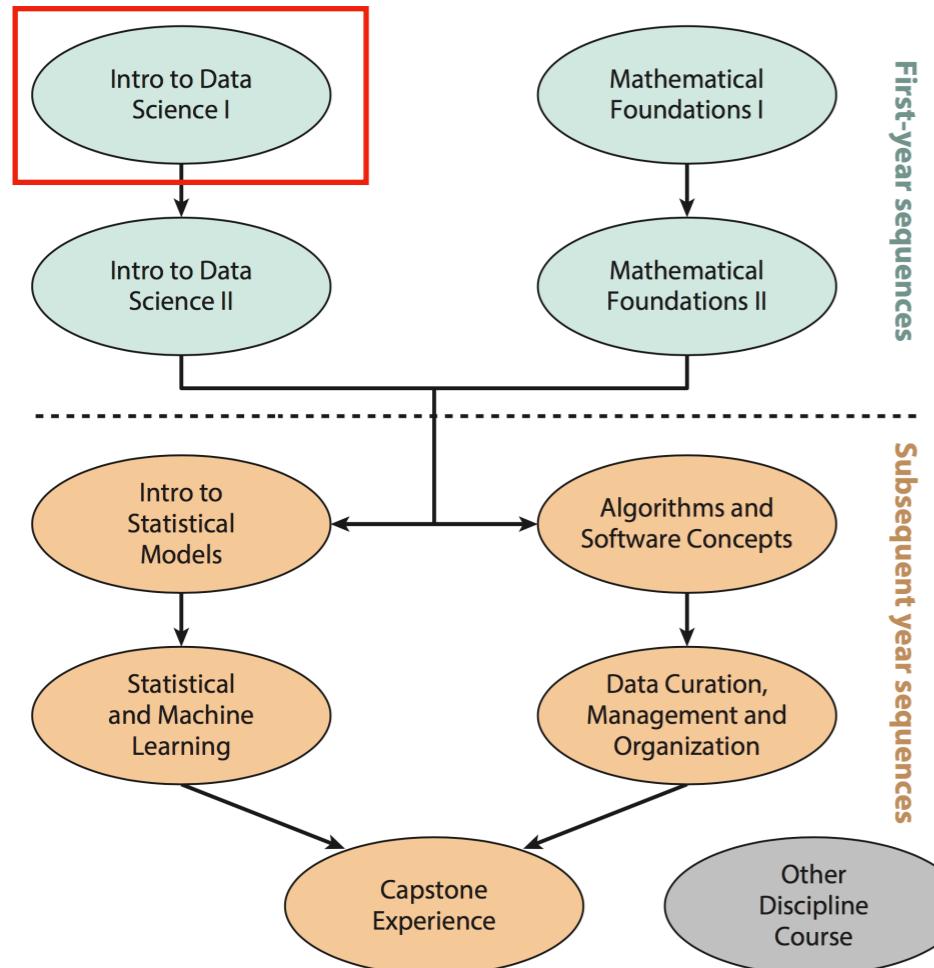
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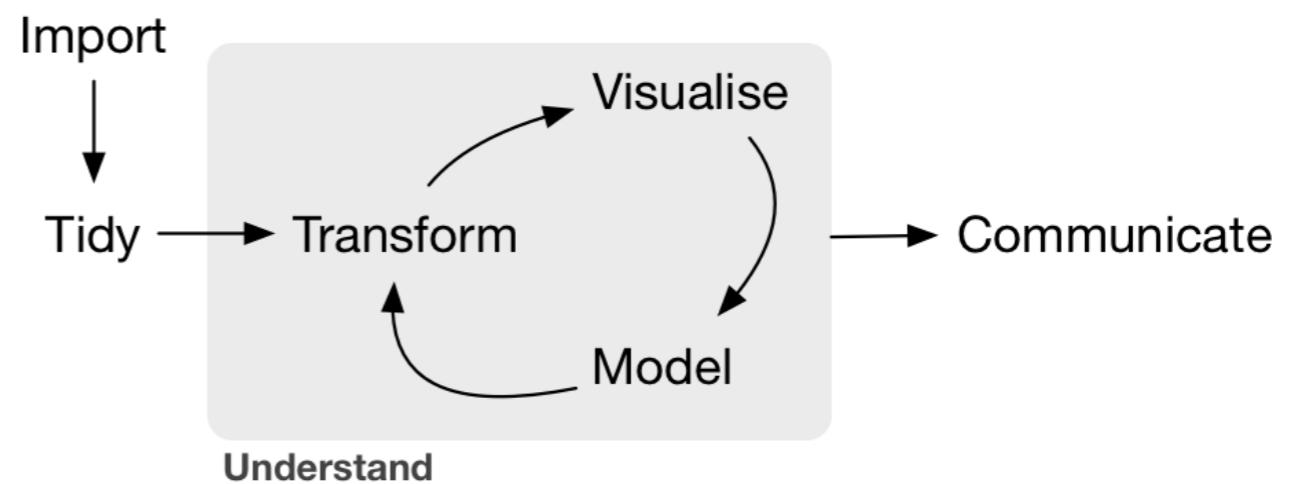
**Minimally viable “alpha to omega” first pass through the data/science pipeline:**



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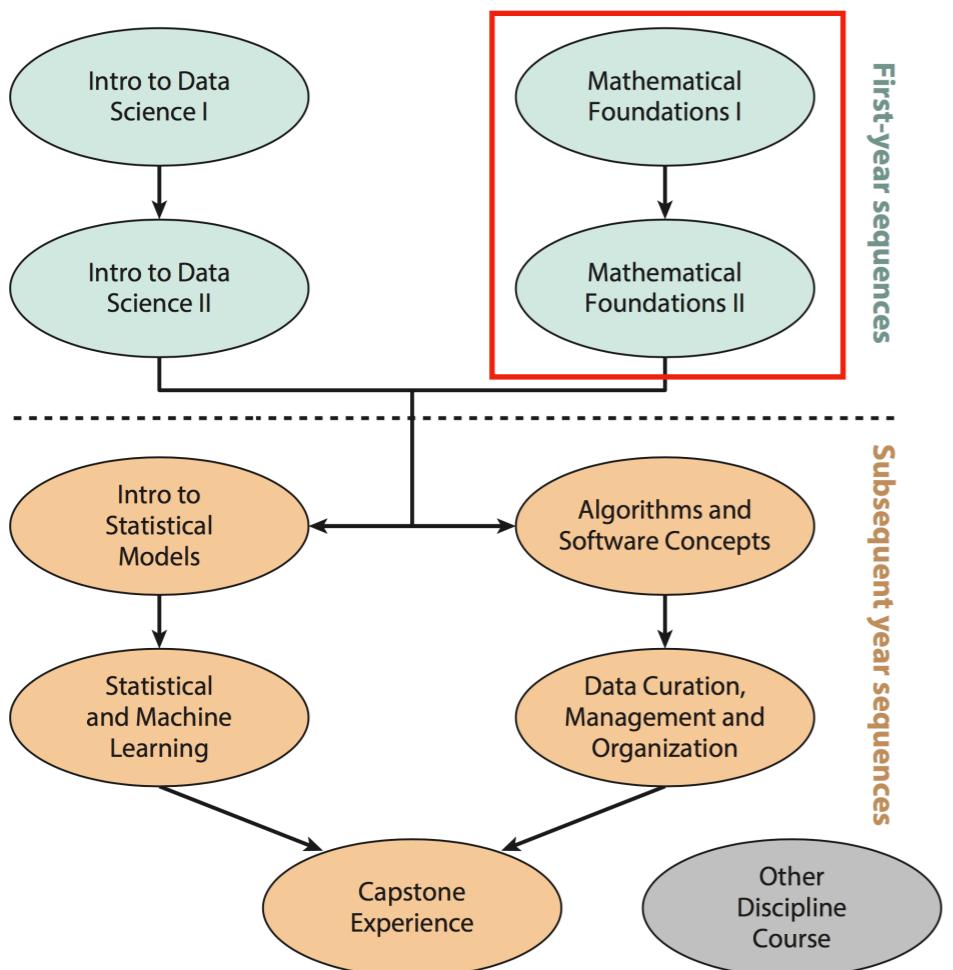
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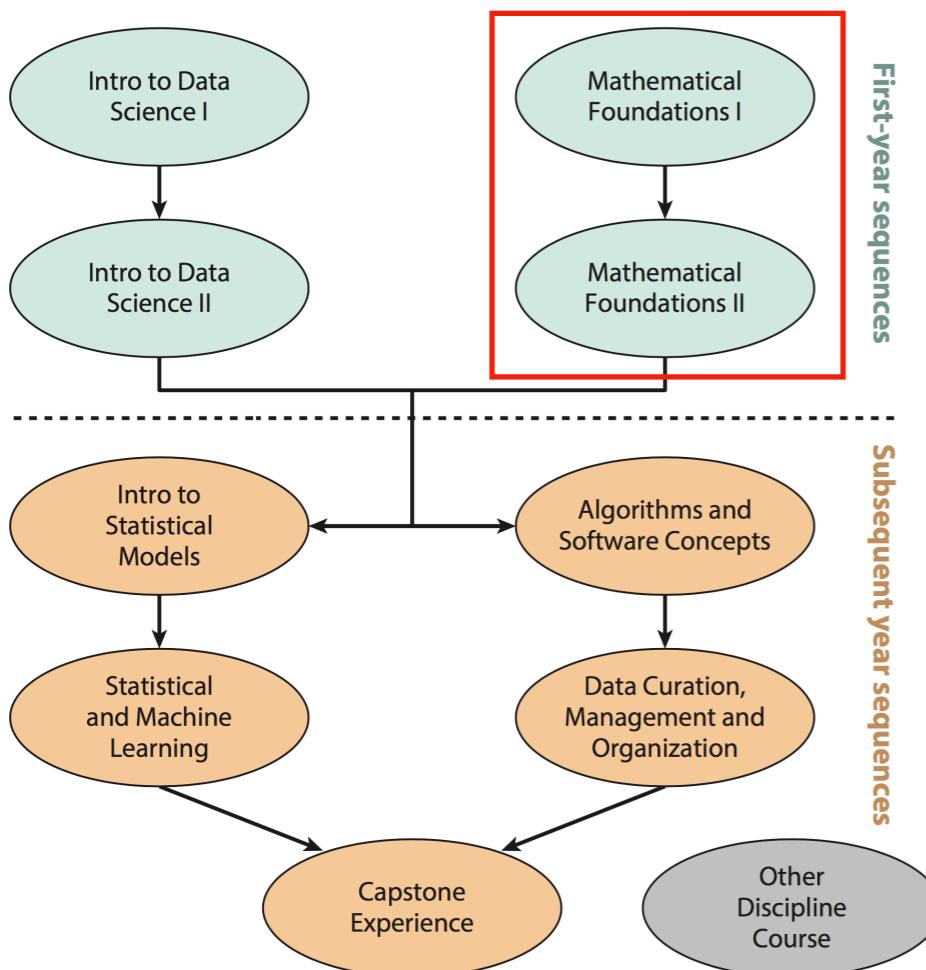
## Notes:

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

# À-la-carte: From the “Math” Menu:



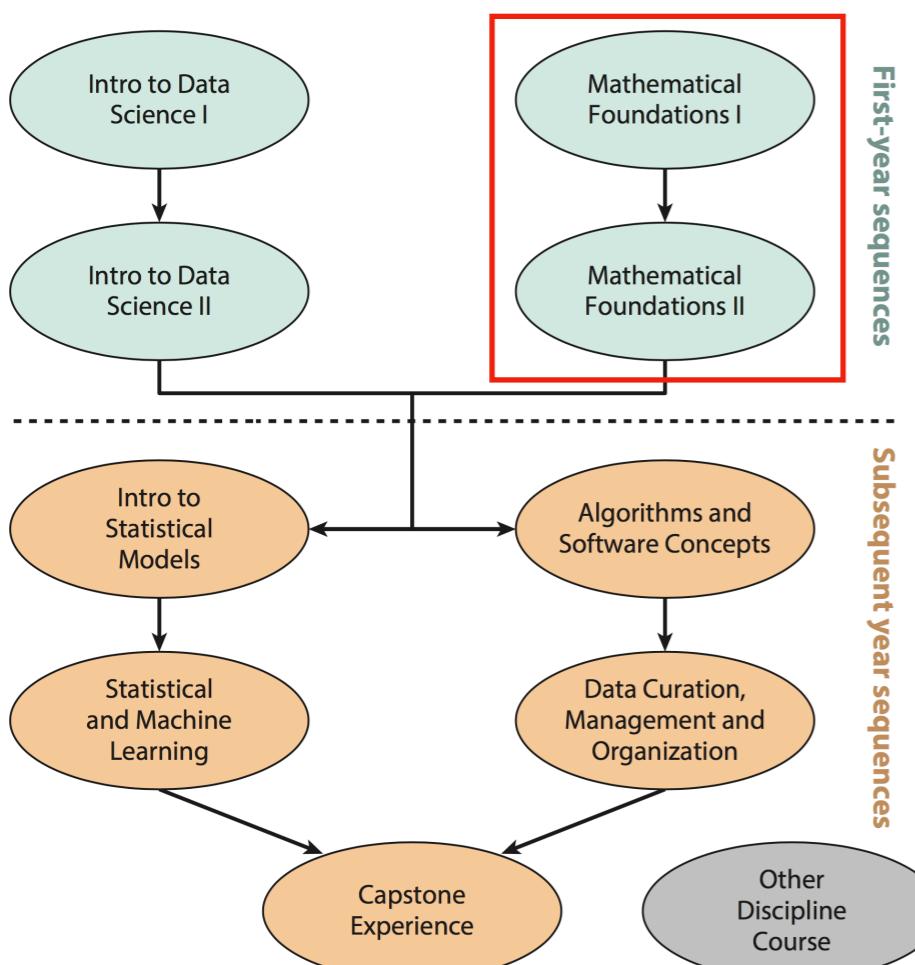
# À-la-carte: From the “Math” Menu:



## Linear Algebra

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

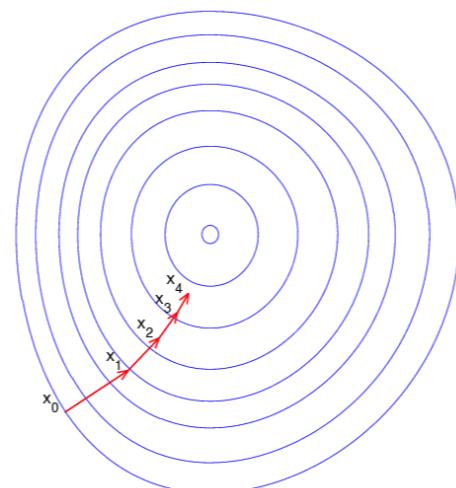
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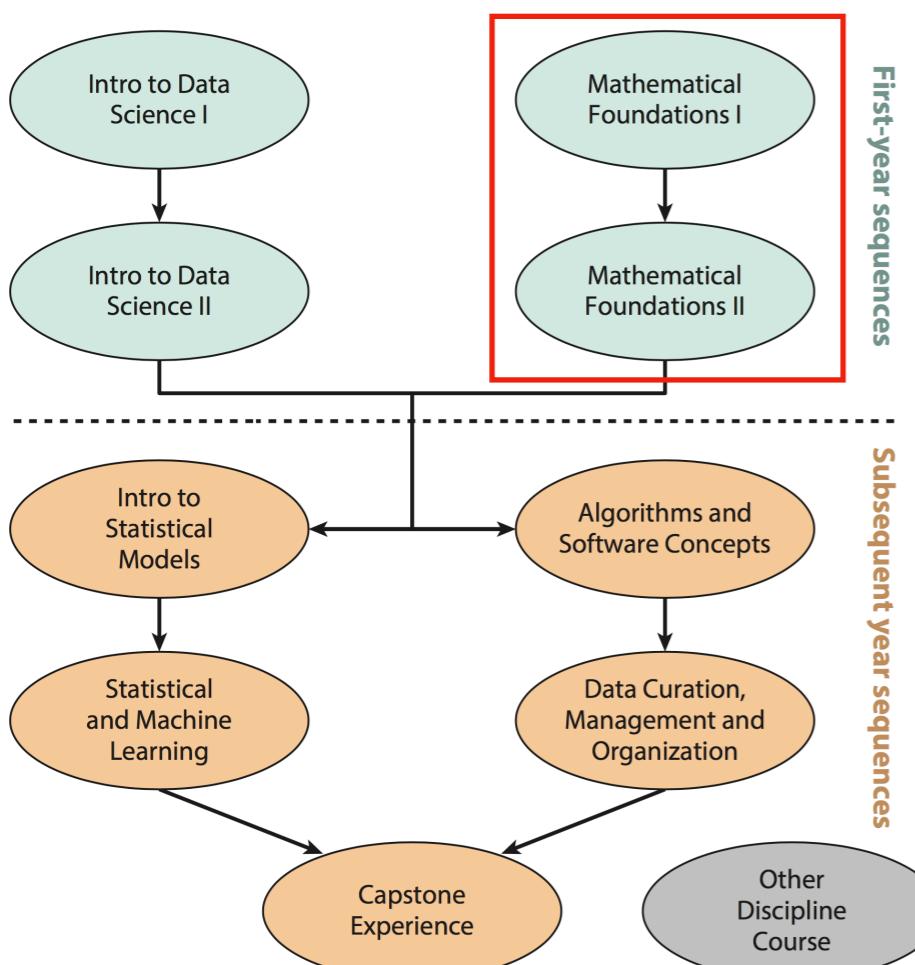
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## Calculus & Optimization



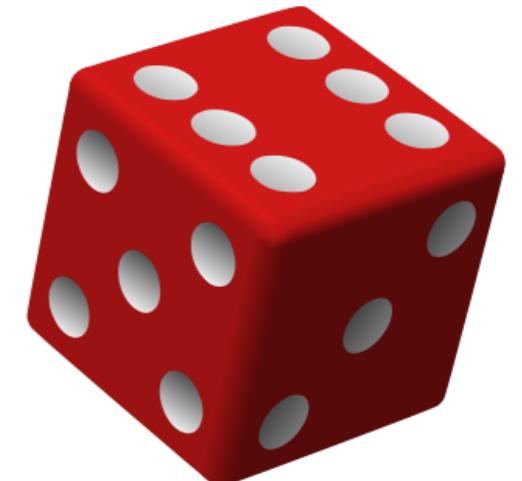
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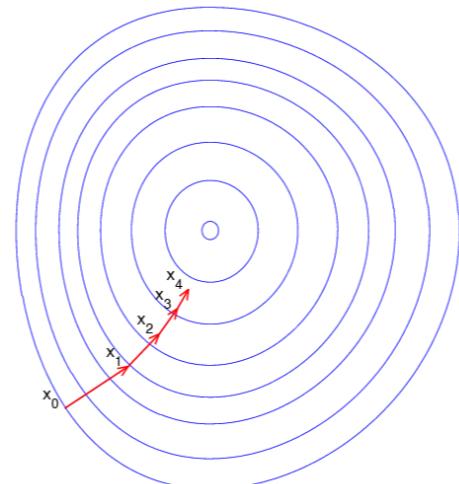
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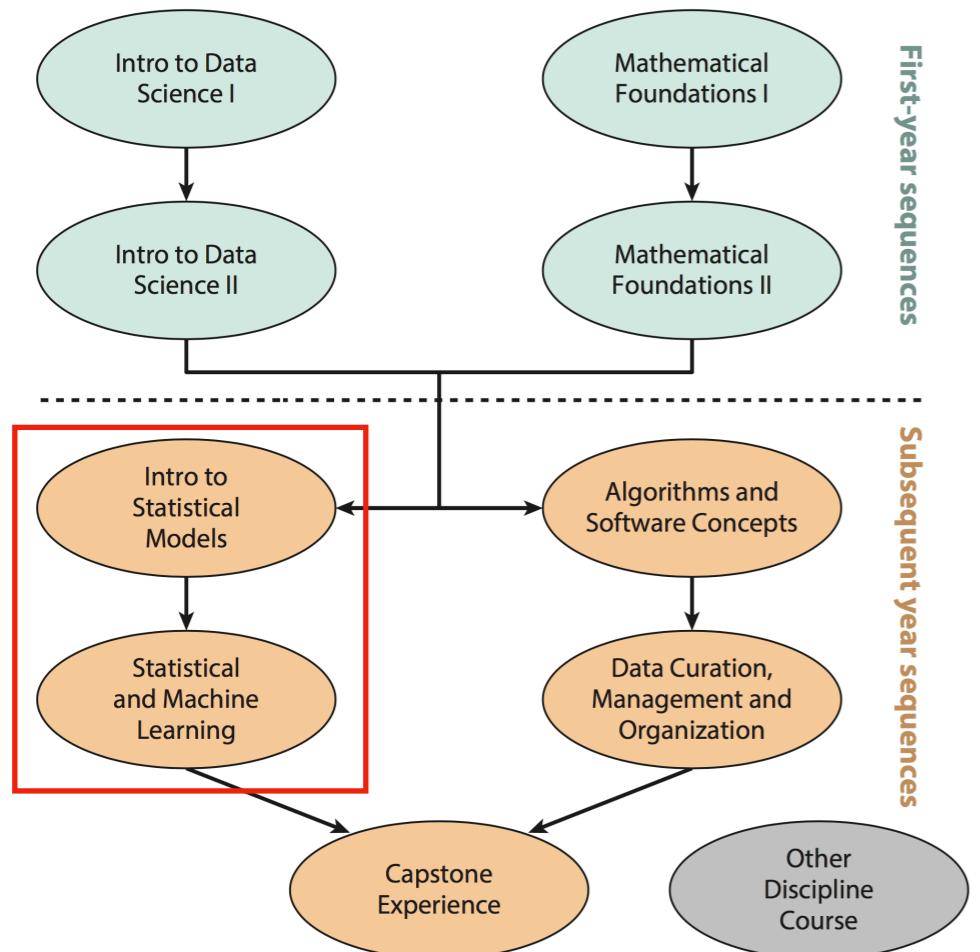
## Probability



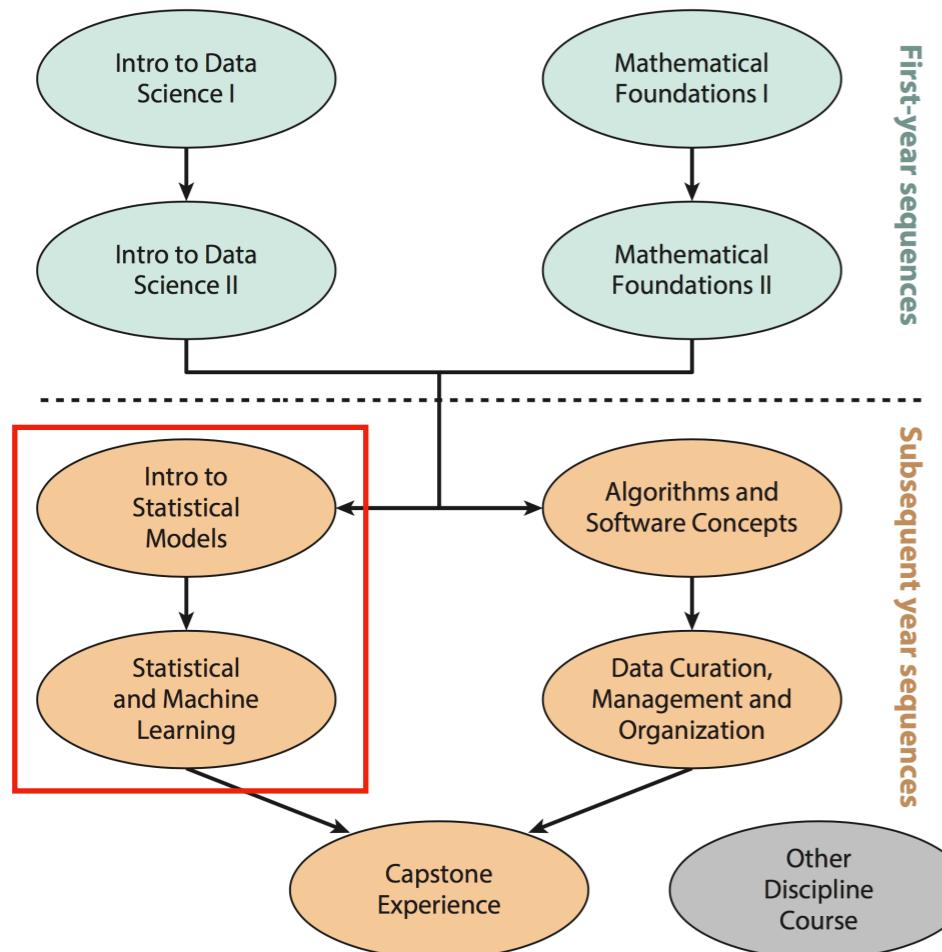
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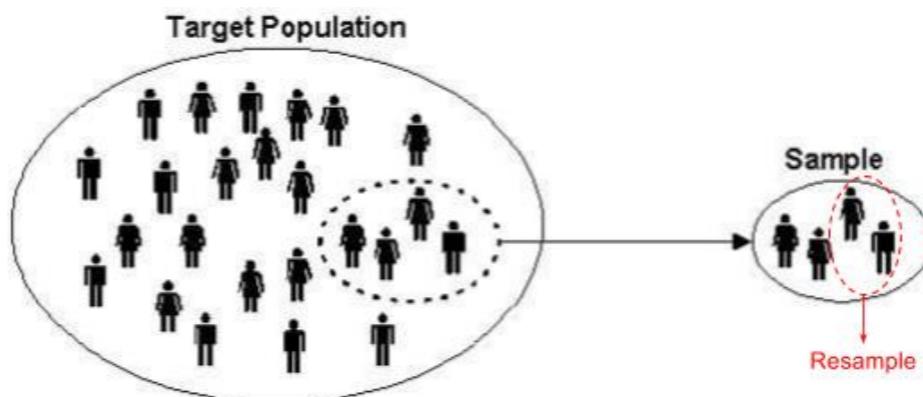
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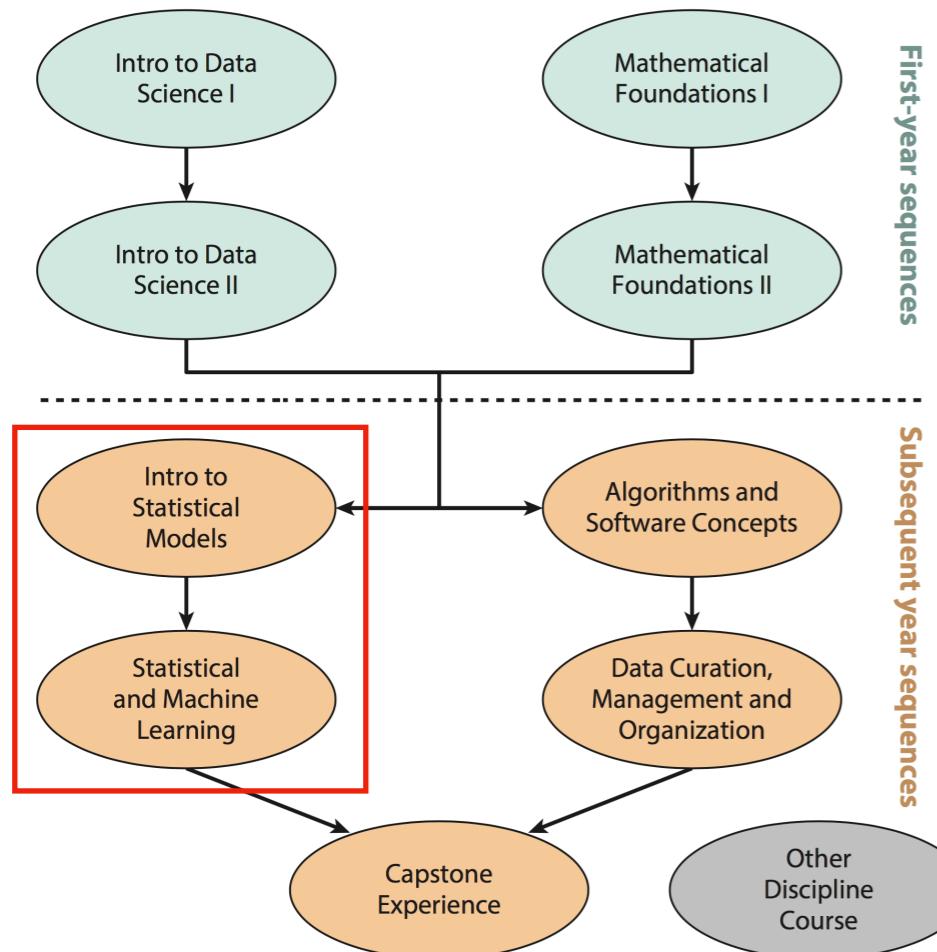
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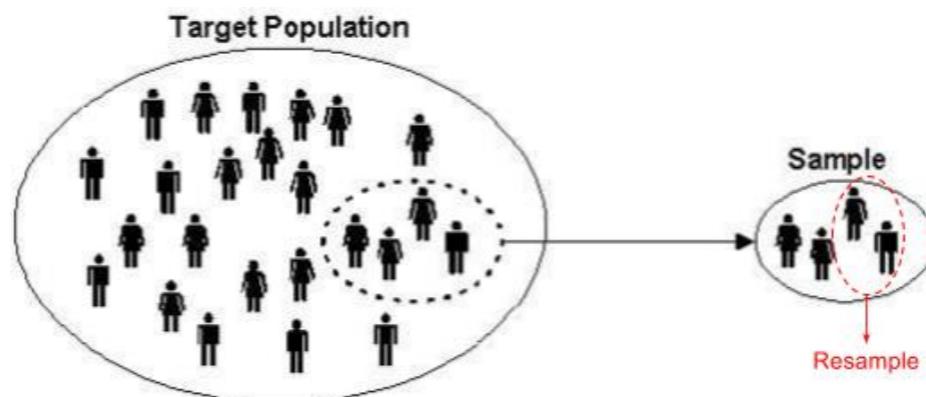
## Statistical Inference



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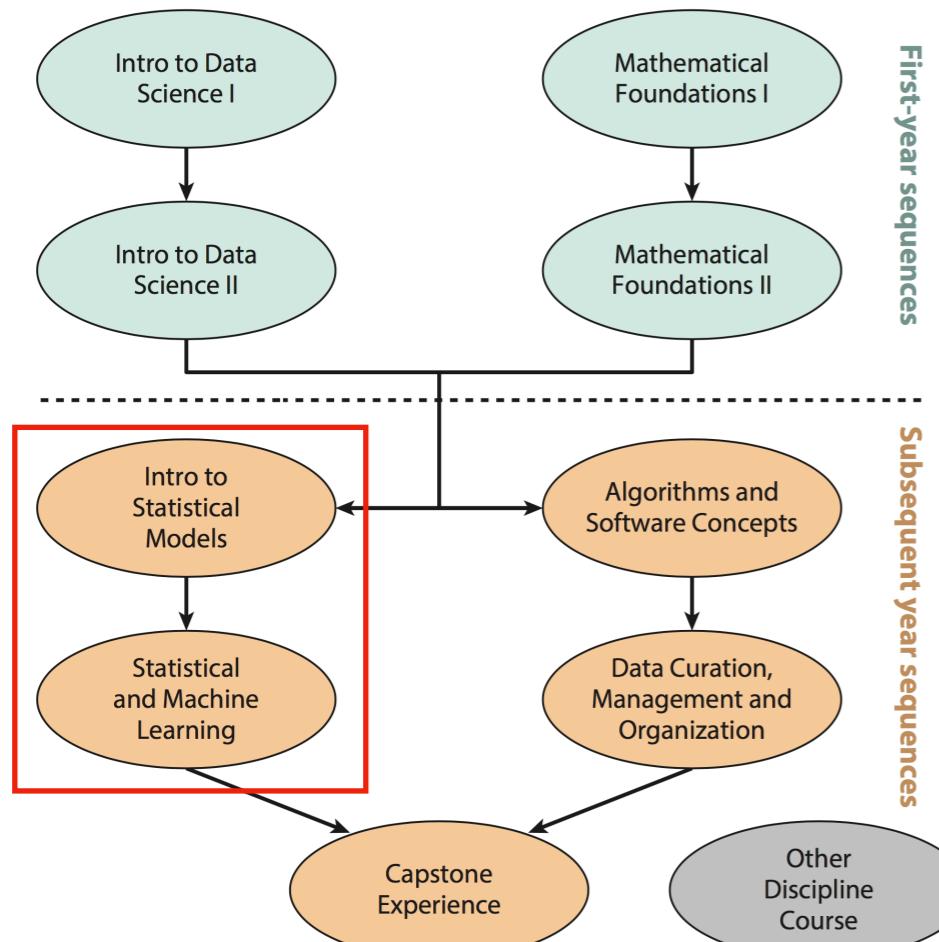
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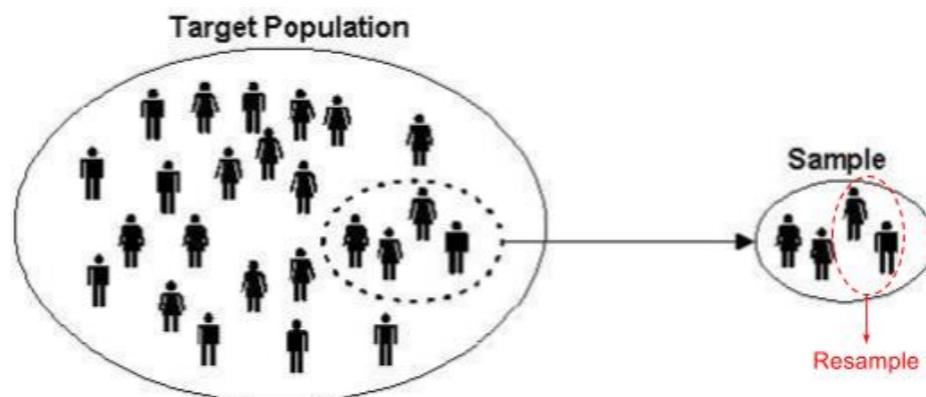
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$$y = f(\vec{x}) + \epsilon$$

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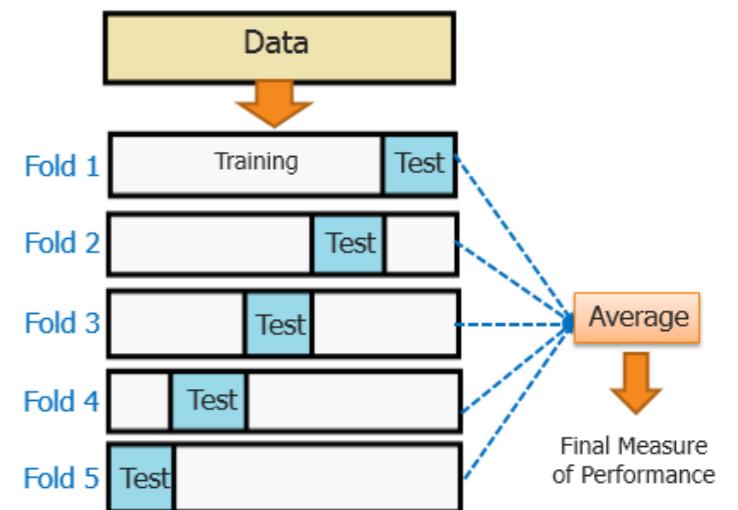
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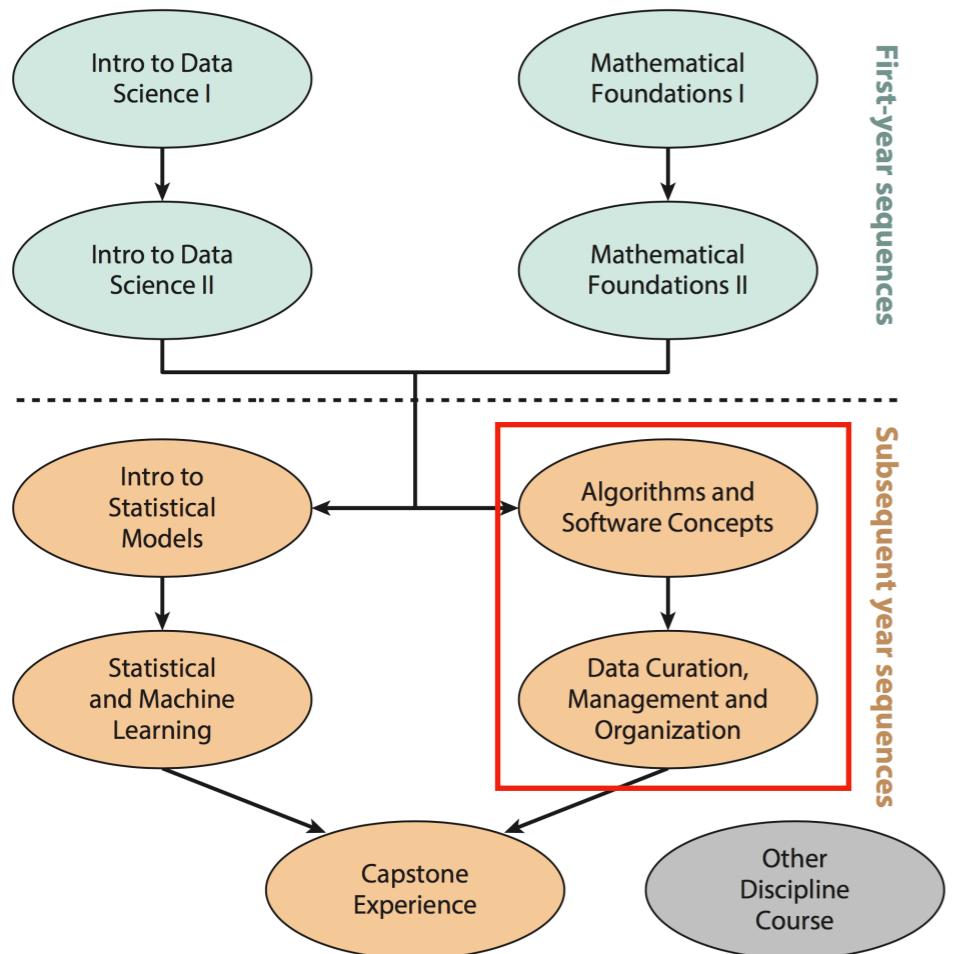
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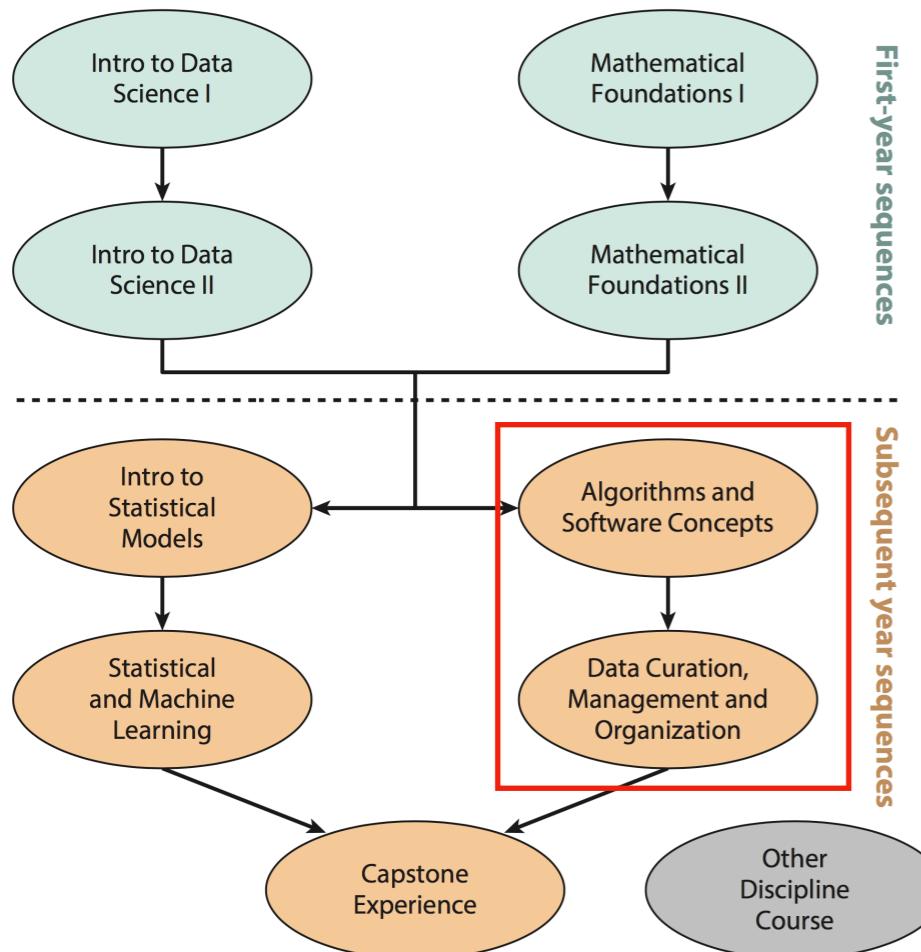
## Machine Learning



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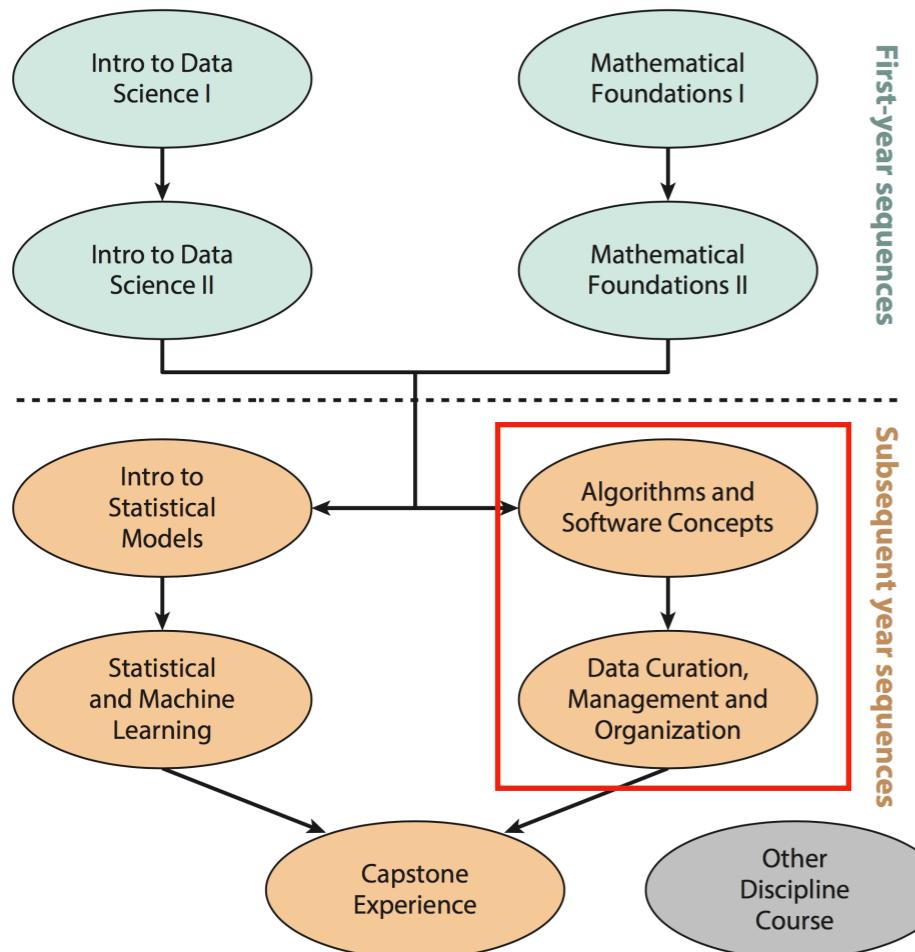
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# Coding as a skill



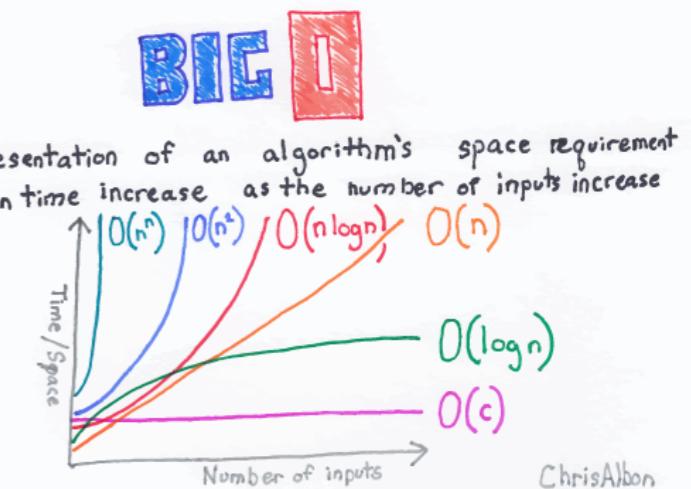
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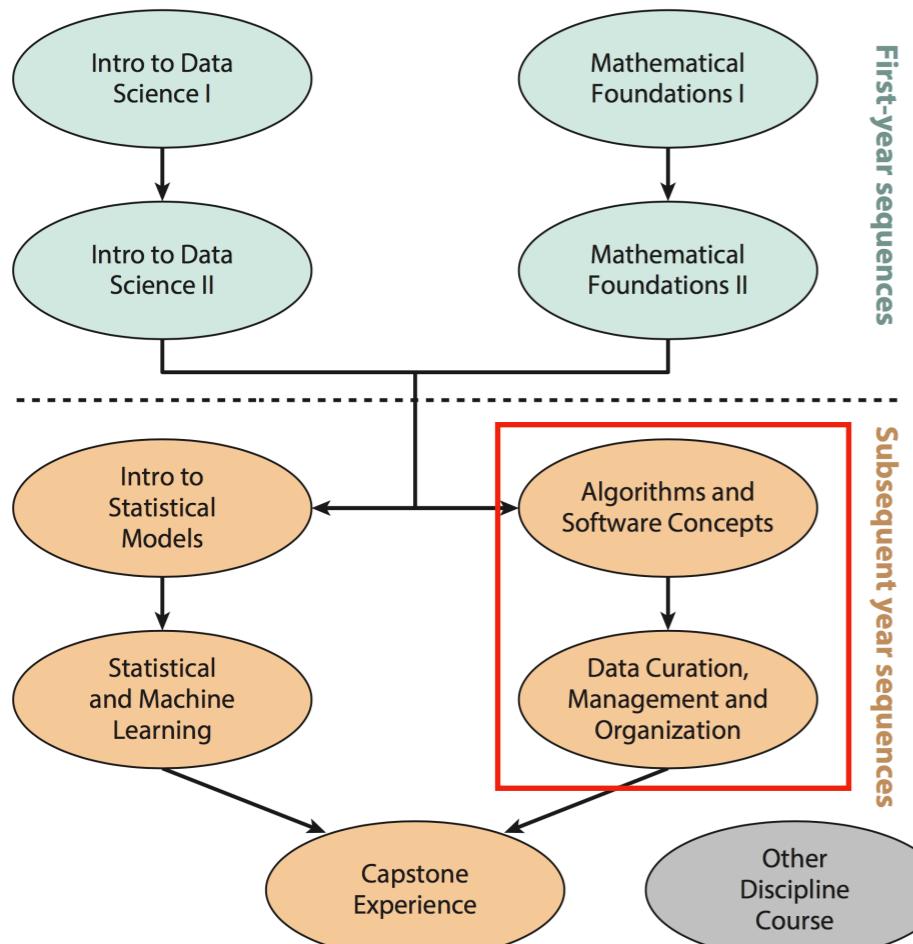
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## Algorithms



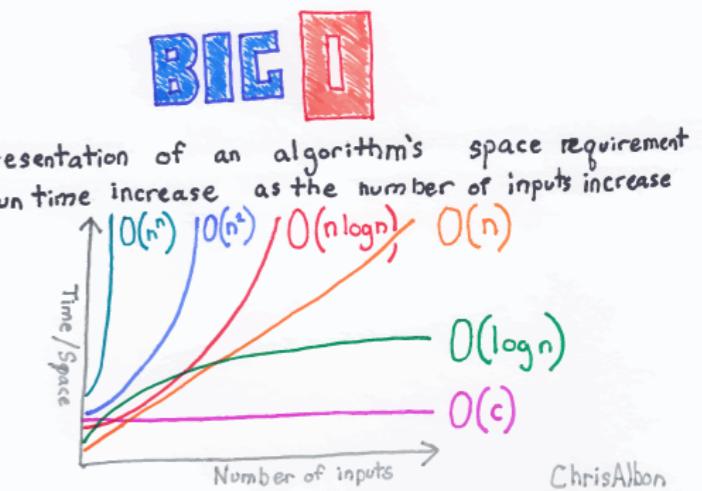
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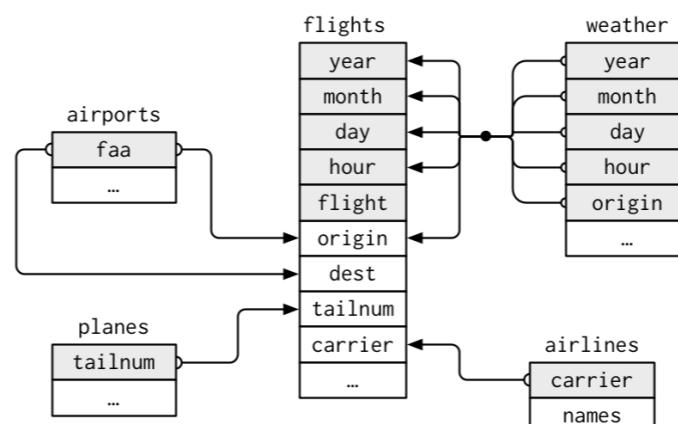
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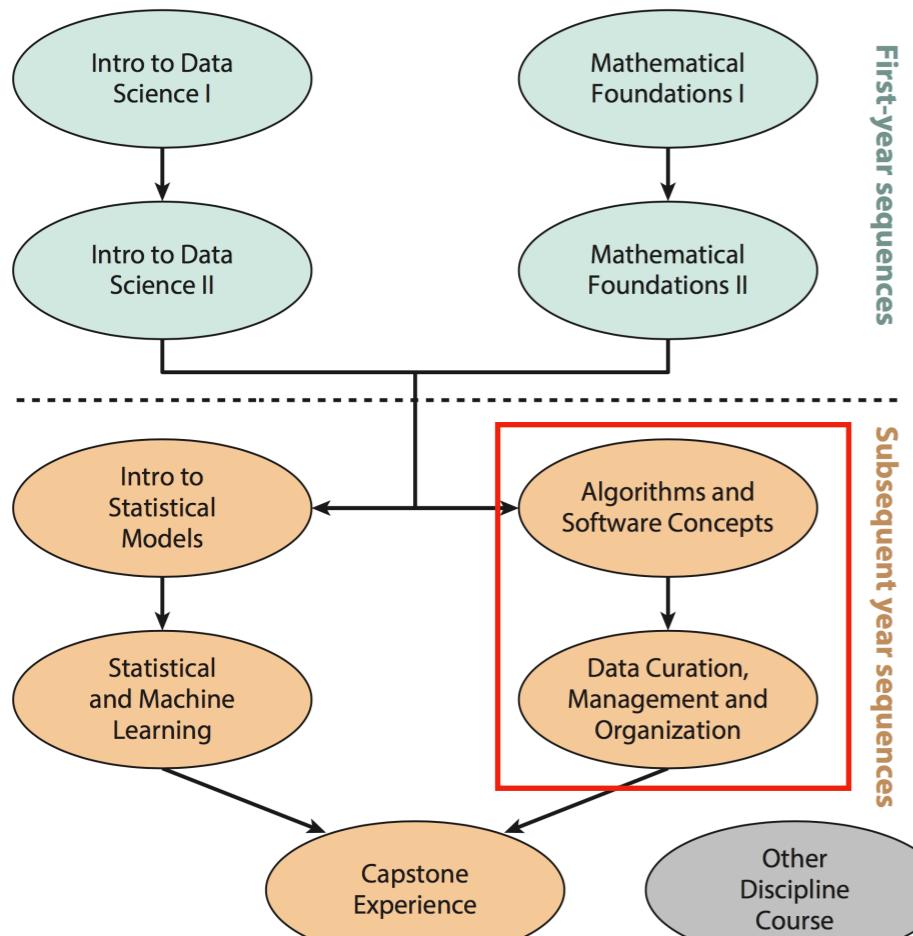
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## Data Representation



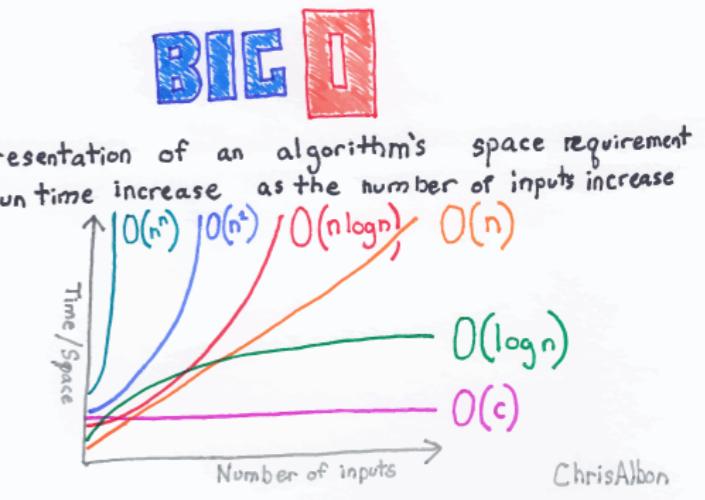
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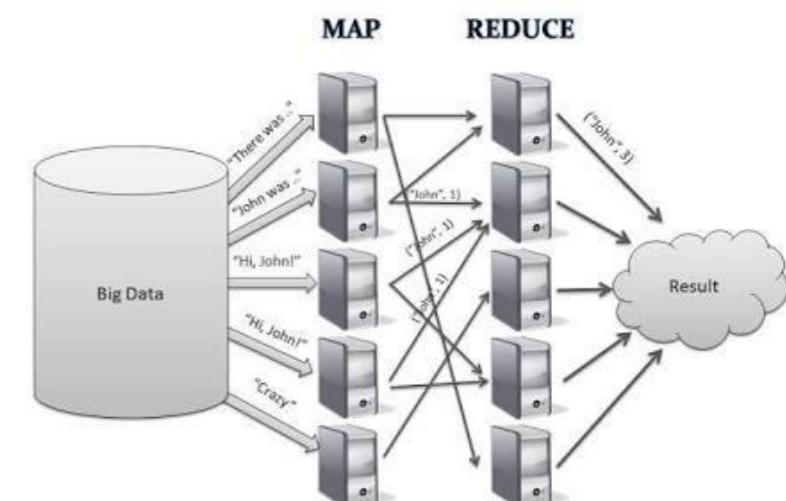
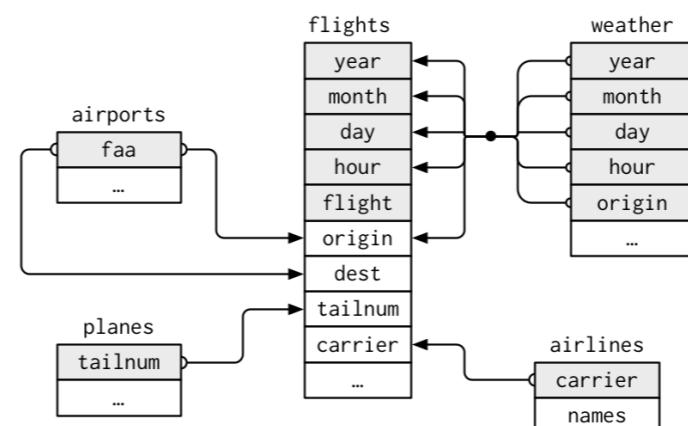


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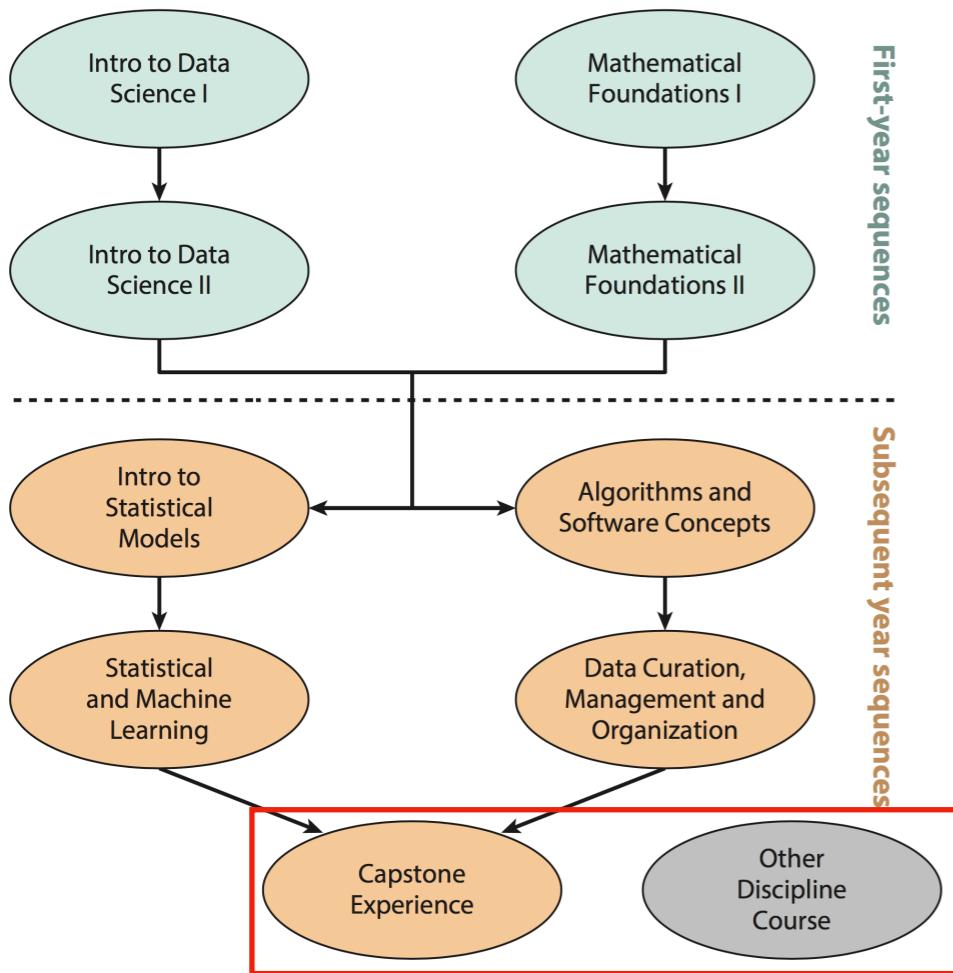


## “Big Data”

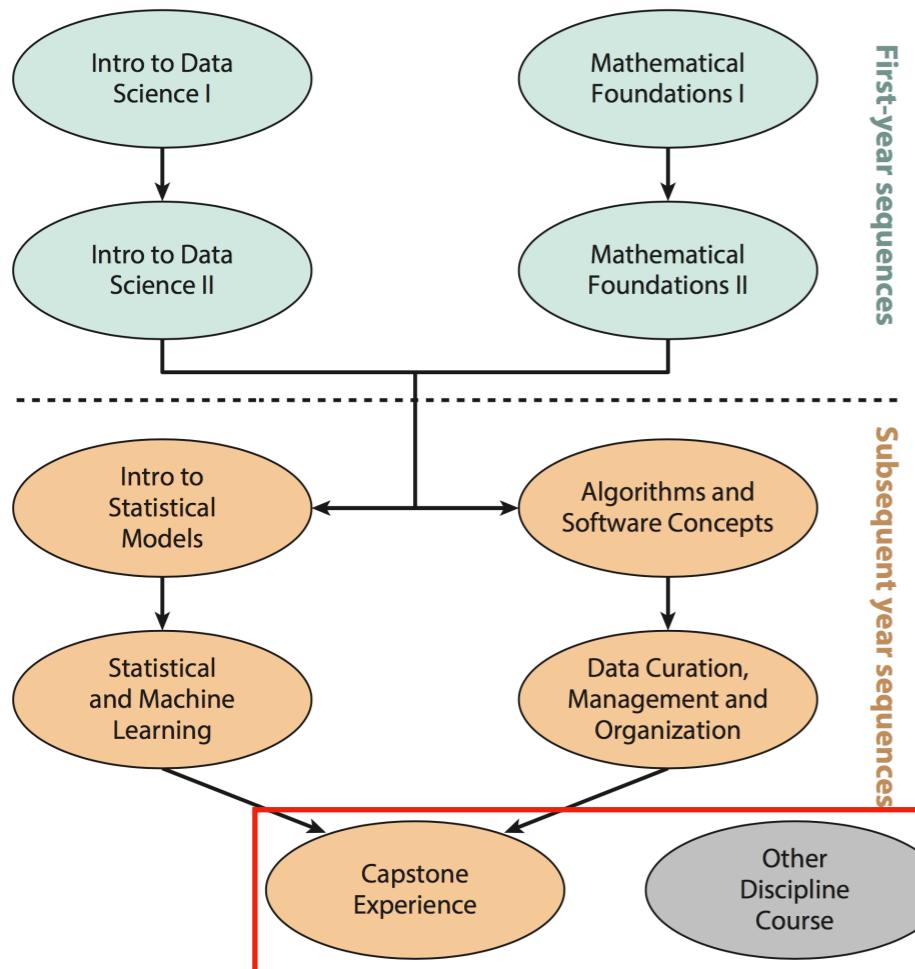
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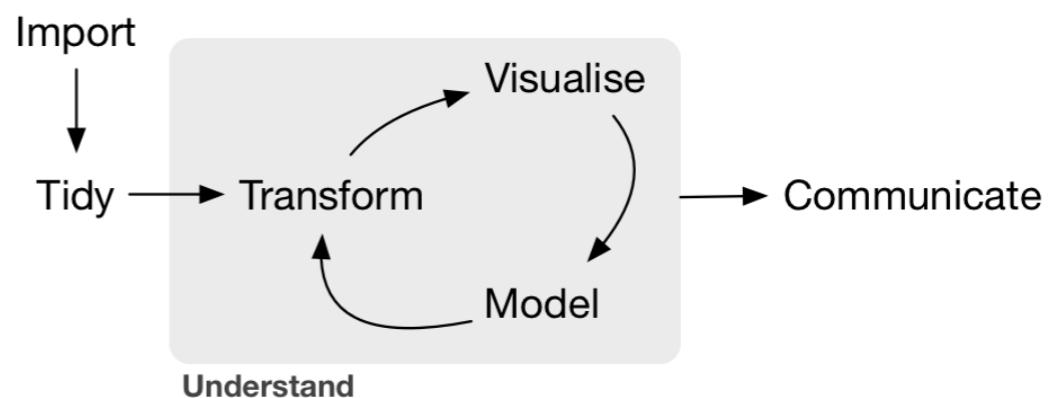
# Capstone Experience & Domain Courses



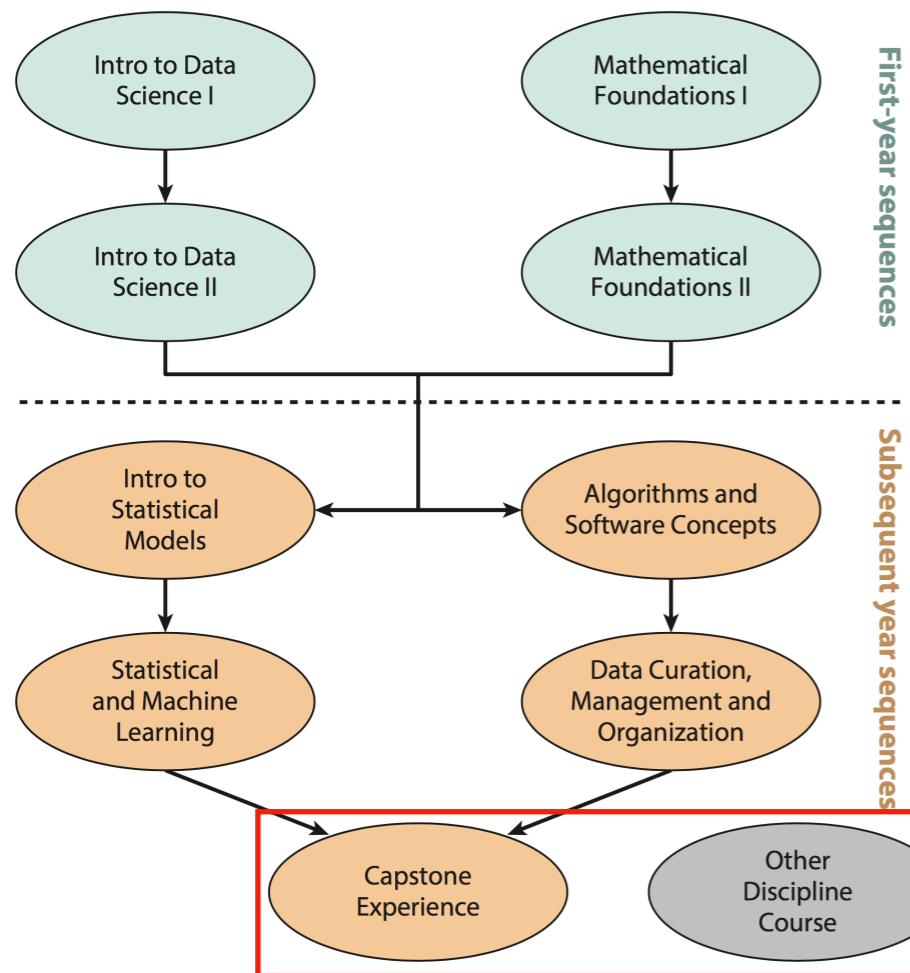
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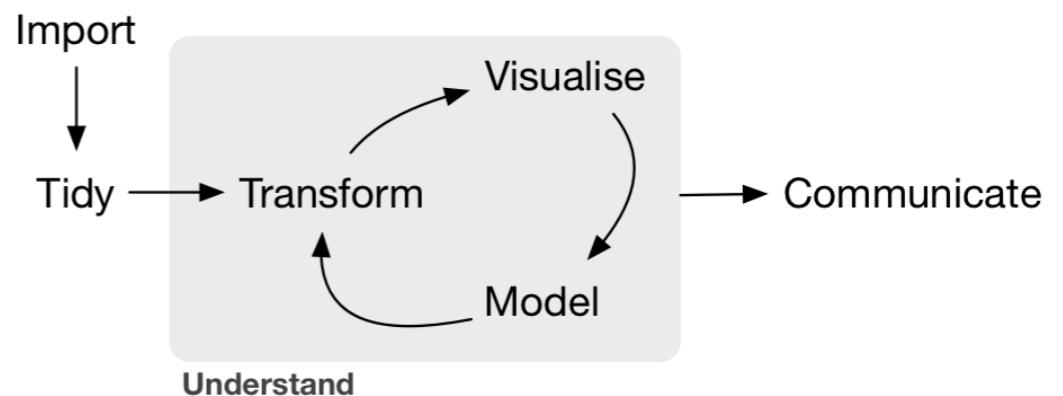
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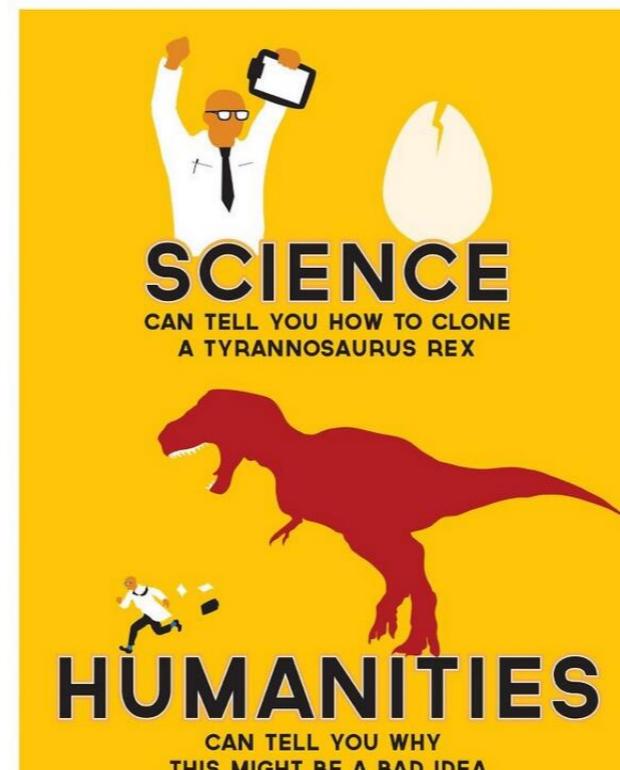
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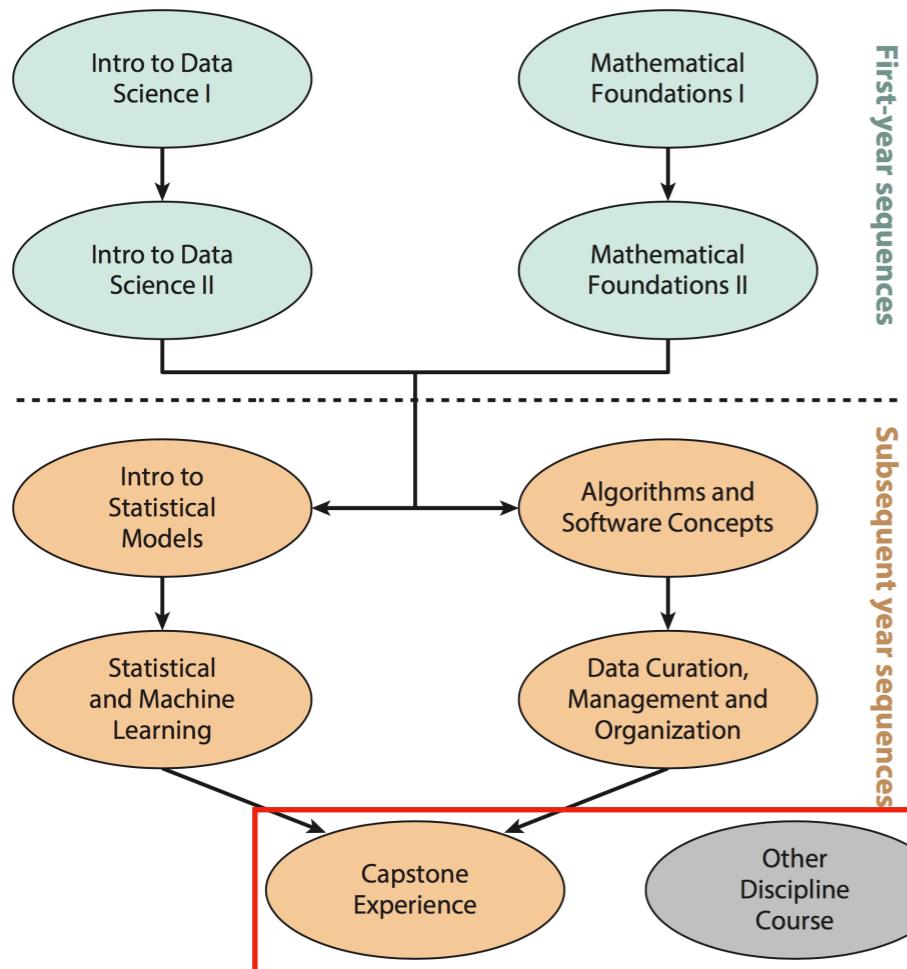
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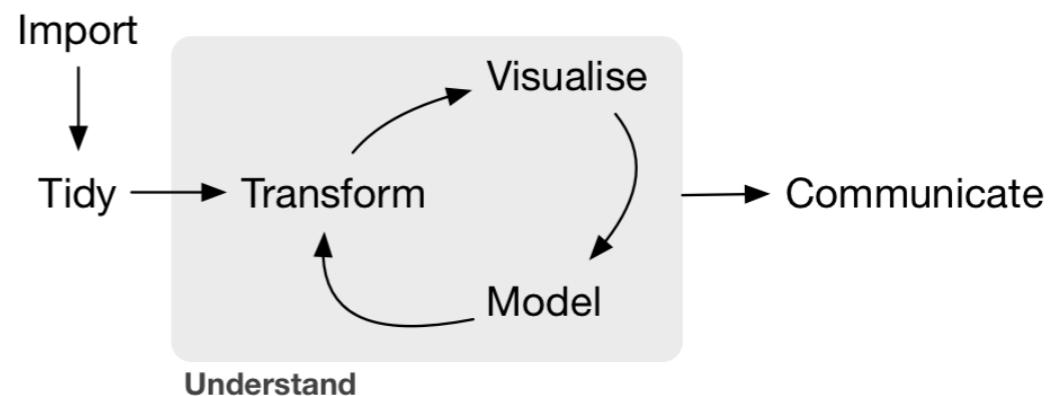
**Ethics**



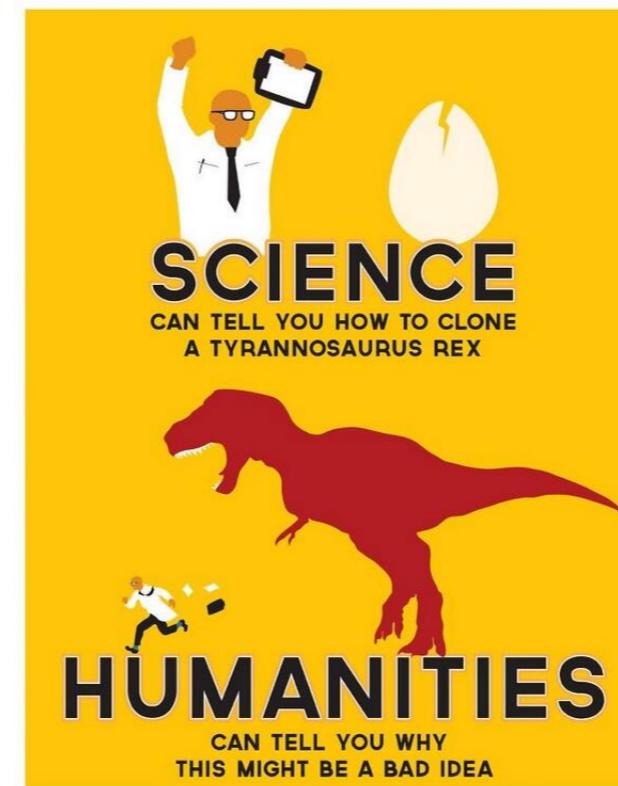
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**Capstone: Revisit entirety of pipeline**



**Ethics**



**Other Disciplines:**

**“Numbers are numbers, but data has context”**

# **Summary Points of Proposal**

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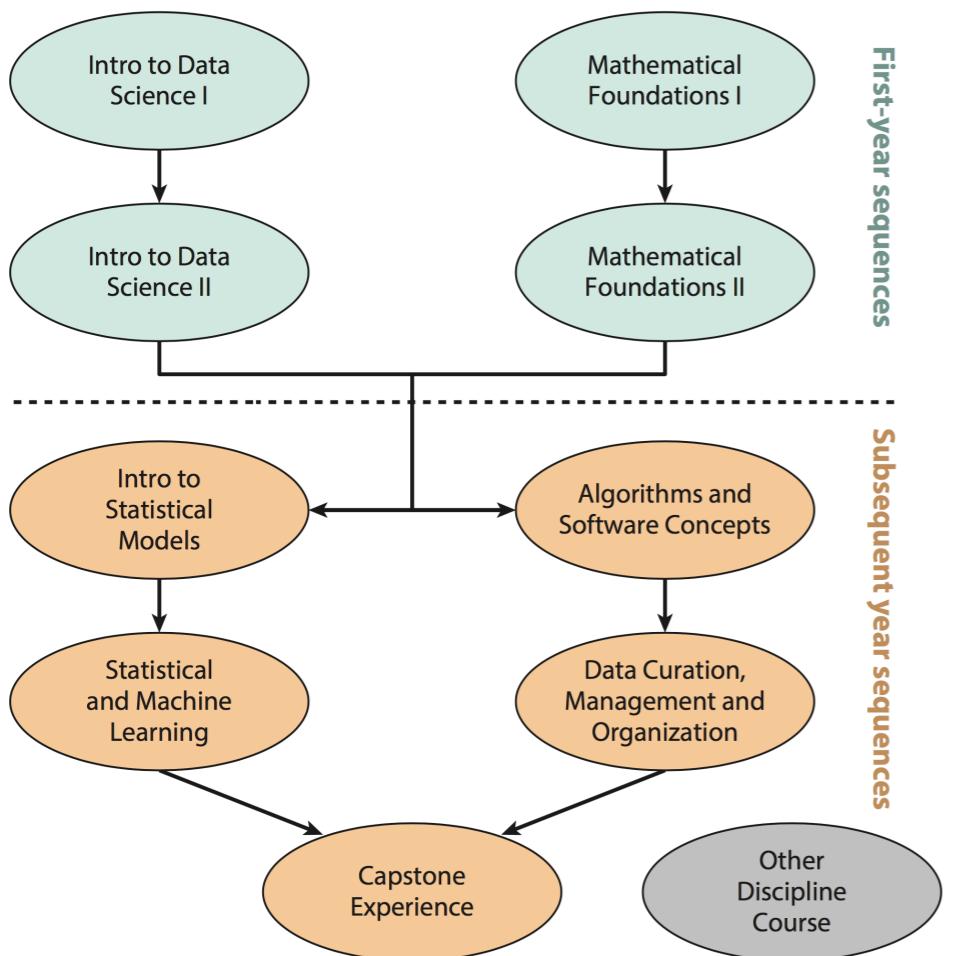
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2. Courses from the traditional disciplines of mathematics, statistics, and computer science **provide the basic infrastructure** for the major at present.
3. A **redesign of the curriculum**, integrating the elements of mathematical foundations and 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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