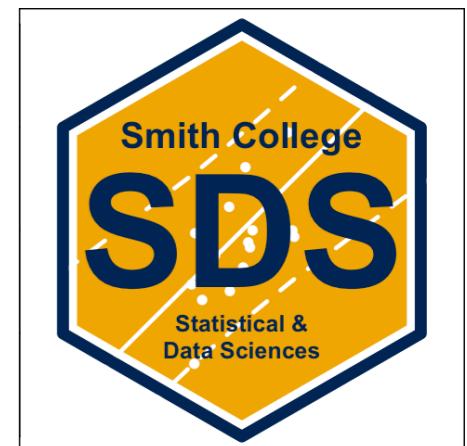


Dismantling Math, Stats, and CS Silos: PCMI Guidelines for Undergraduate Majors in Data Science

Albert Y. Kim [@rudeboybert](https://twitter.com/rudeboybert)
Thursday August 2nd, 2018



2016 PCMI Undergraduate Faculty Program

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

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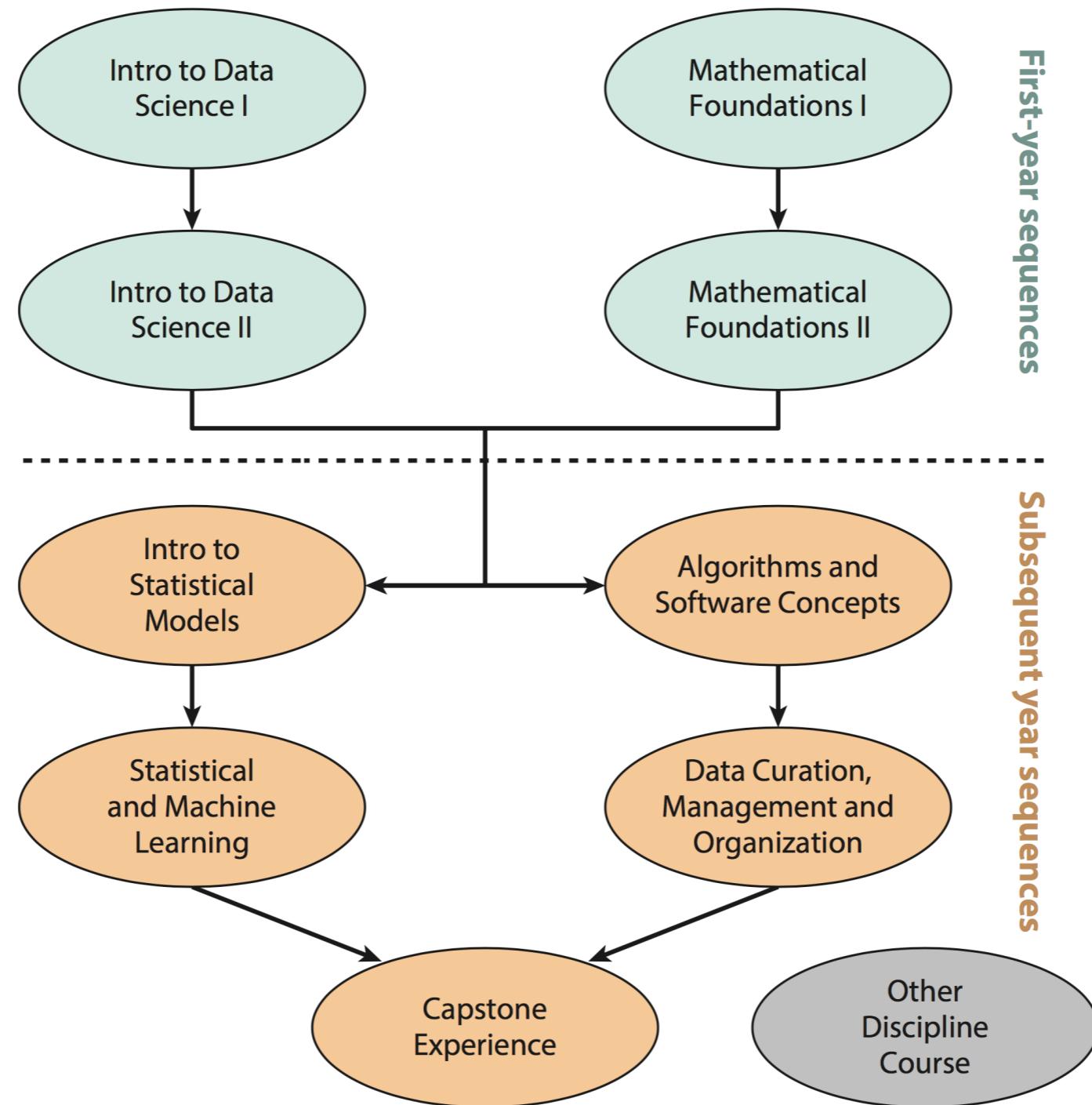
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- What do we include, but also *what do we leave out?*
If you try to include everything, soon you'll end up with nothing.
- Among the first proposals with interdisciplinary representation
- Ben Baumer asked: “*What if we blew up math, stats, CS, and 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**

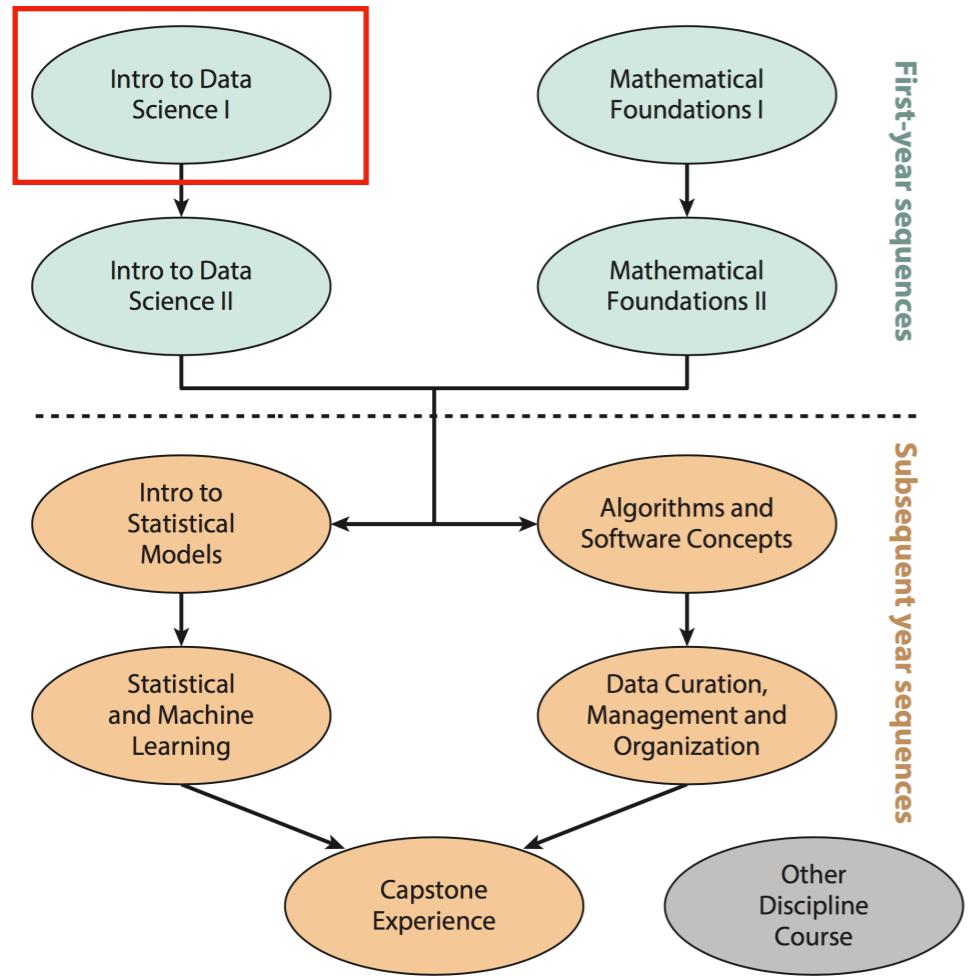
Result: PCMI Guidelines

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

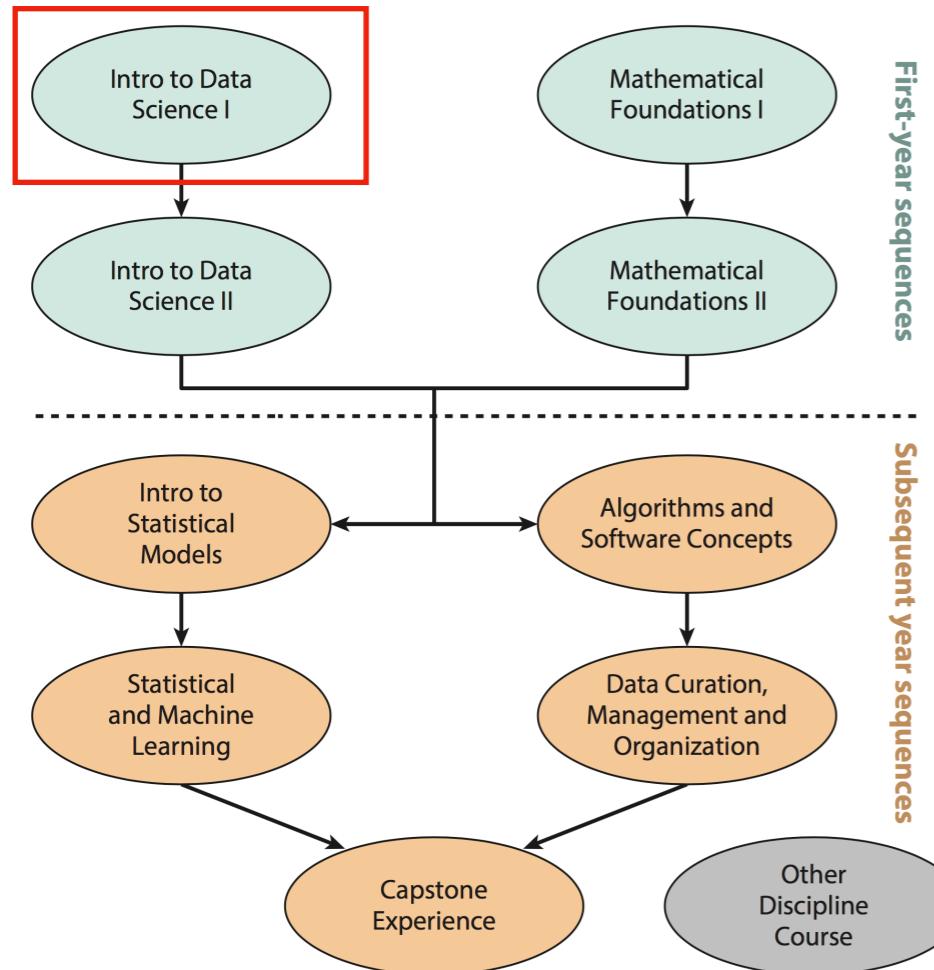


Intro to Data Science I

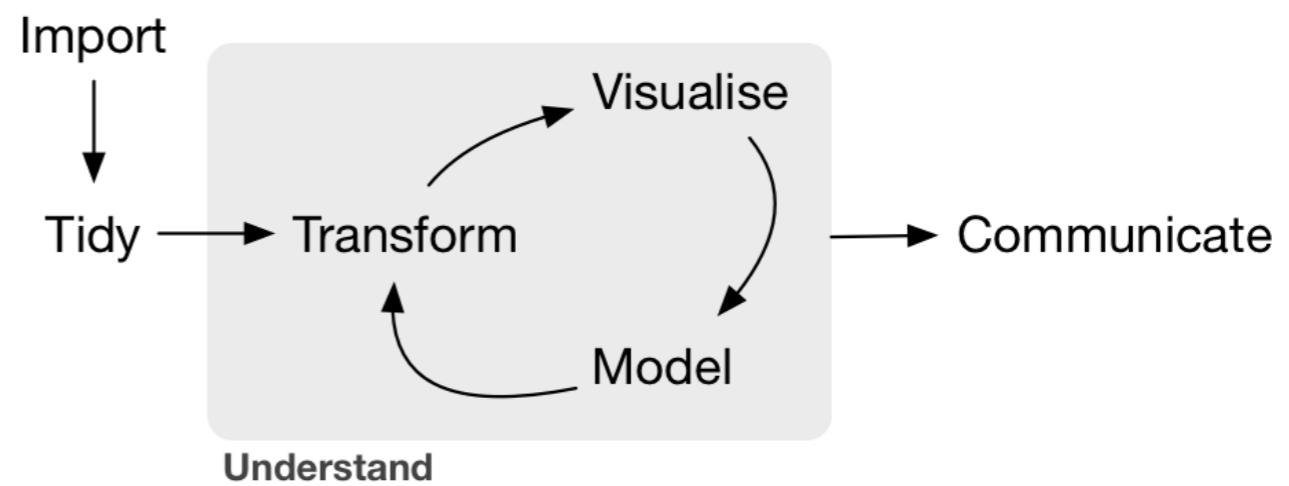
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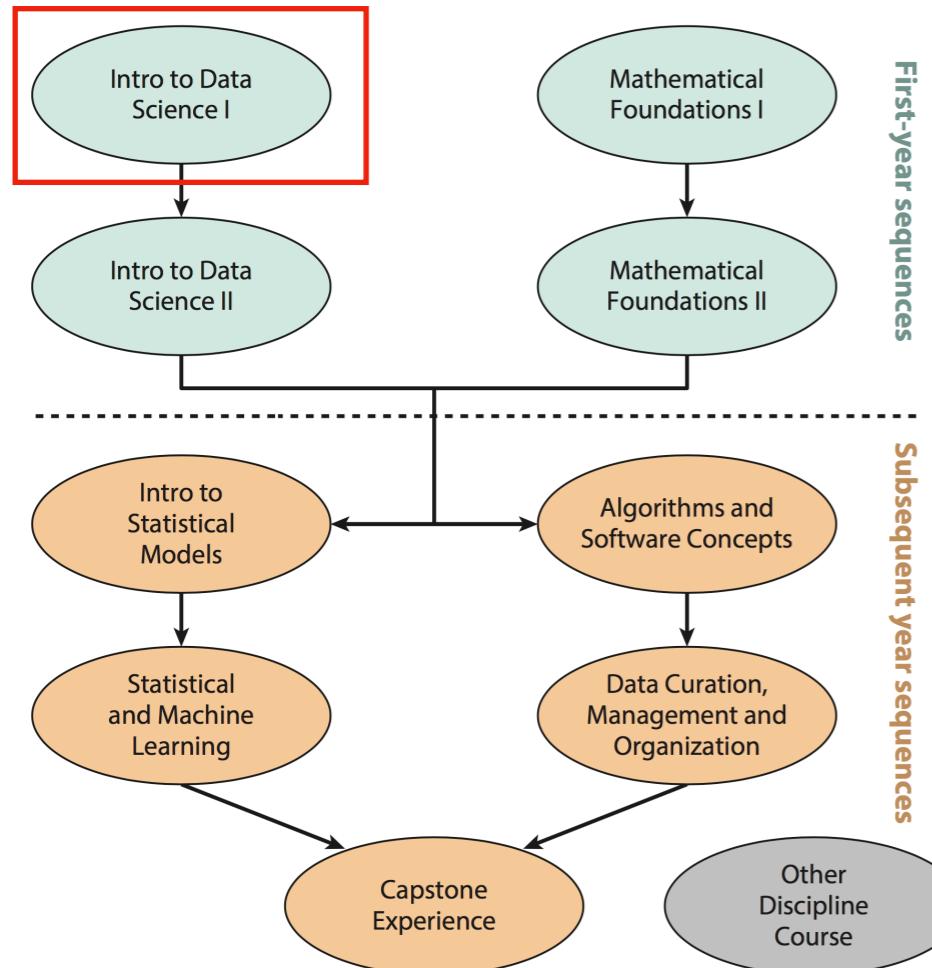
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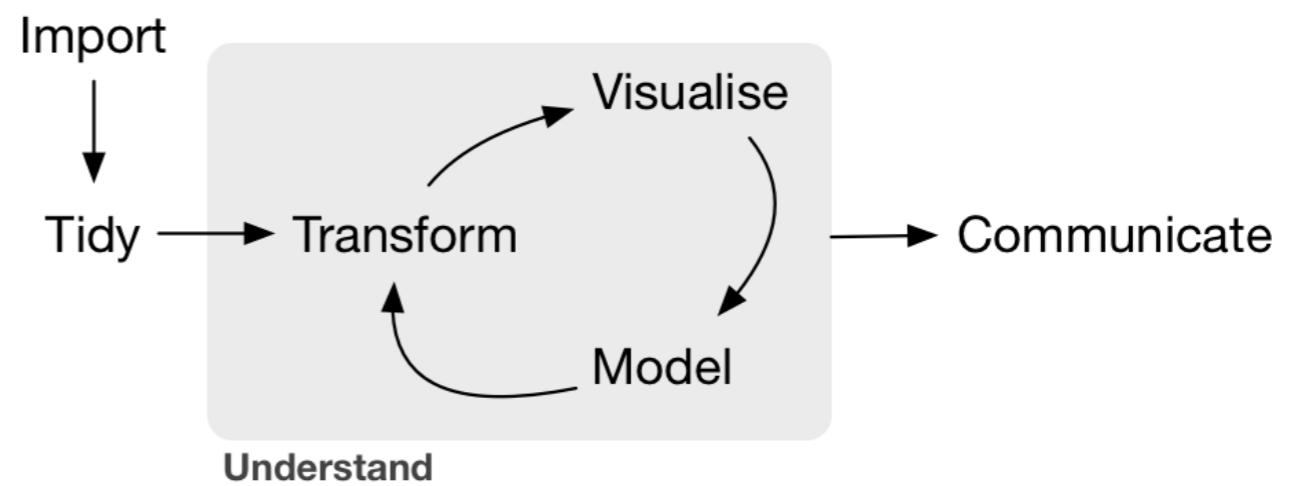
Minimally viable “alpha to omega” first pass through the data/science pipeline:



Intro to Data Science I



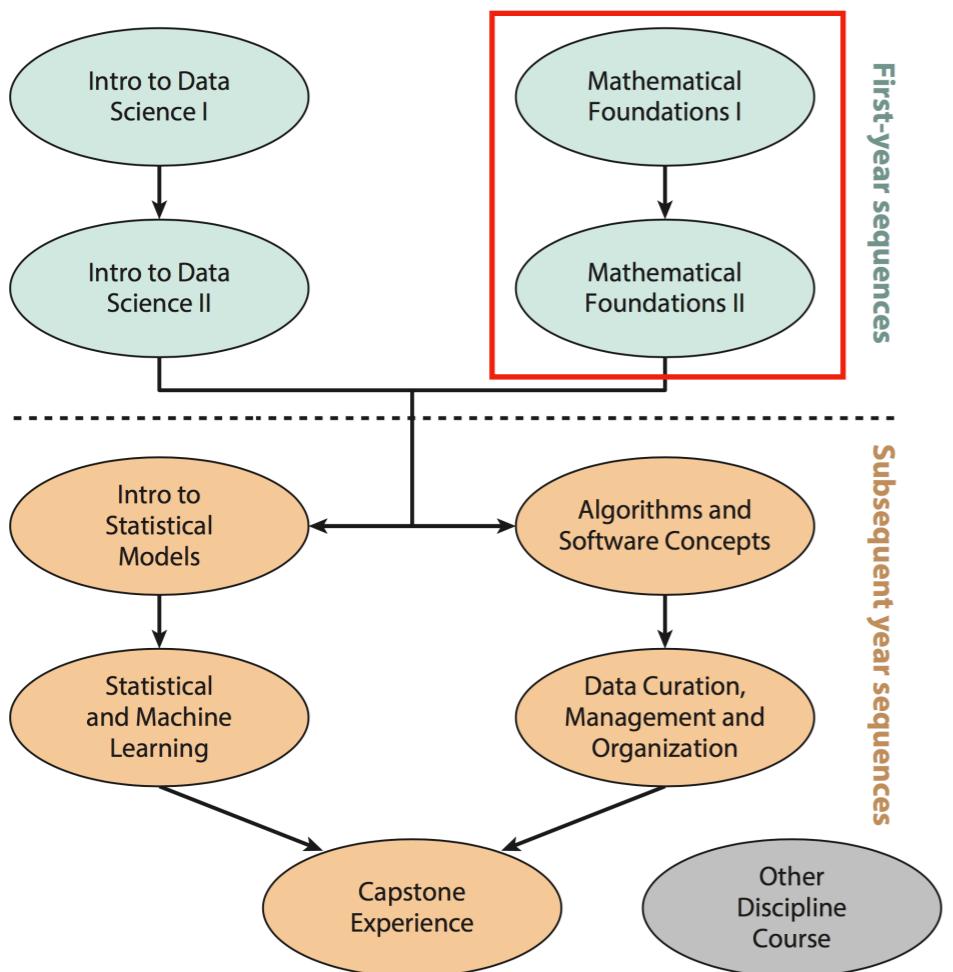
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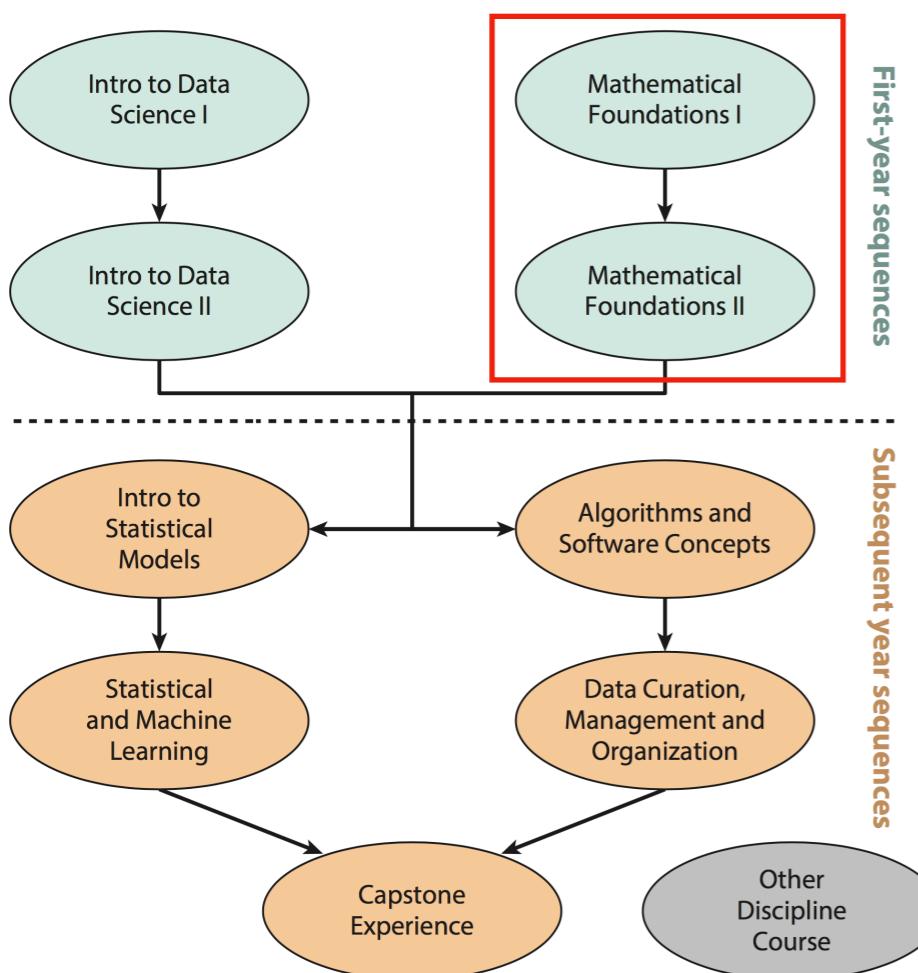
Notes:

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

À-la-carte: From the “Math” Menu:



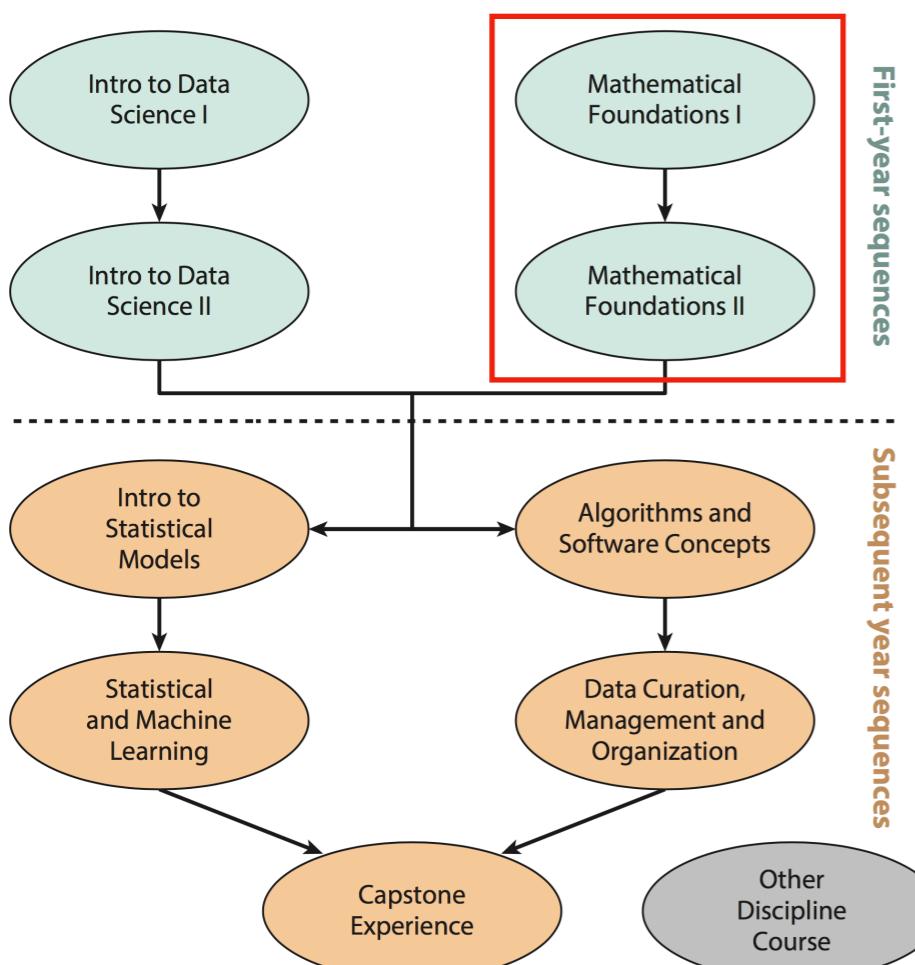
À-la-carte: From the “Math” Menu:



Linear Algebra

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

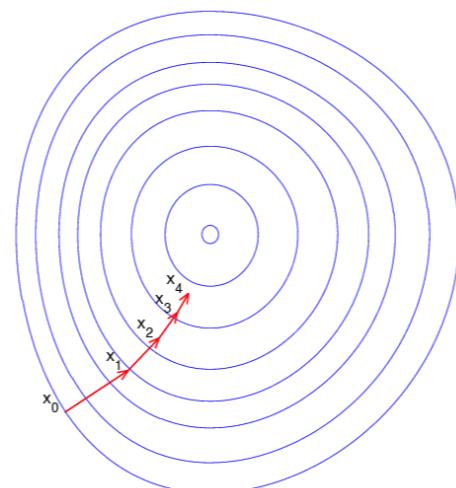
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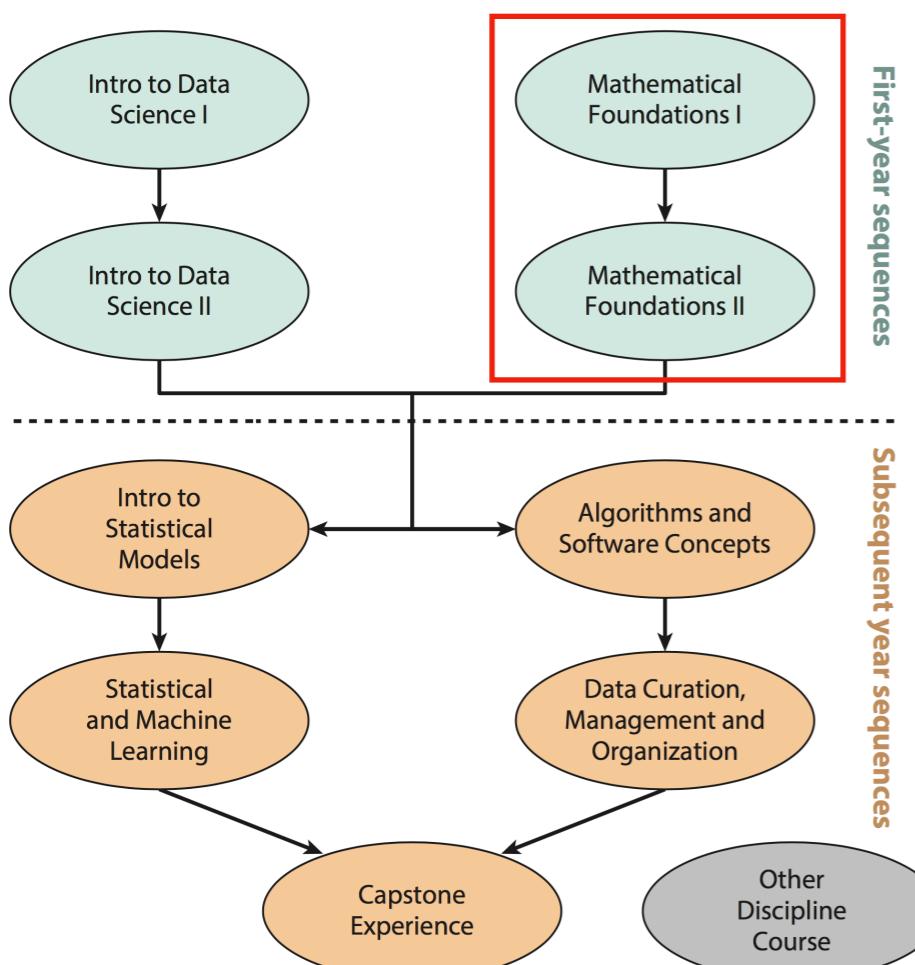
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Calculus & Optimization



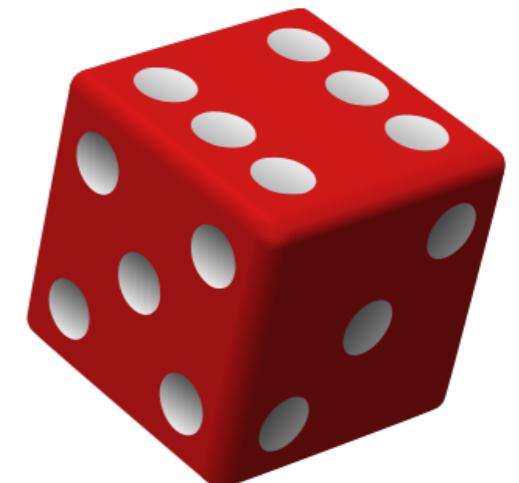
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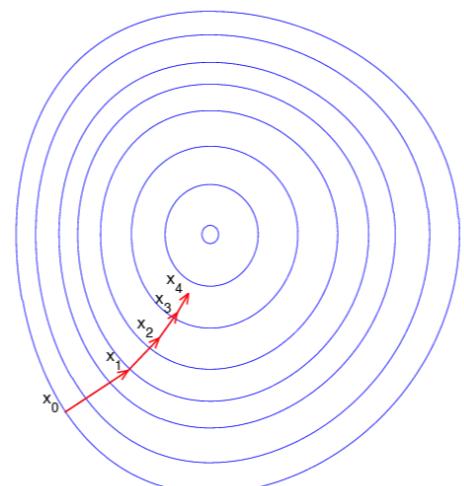
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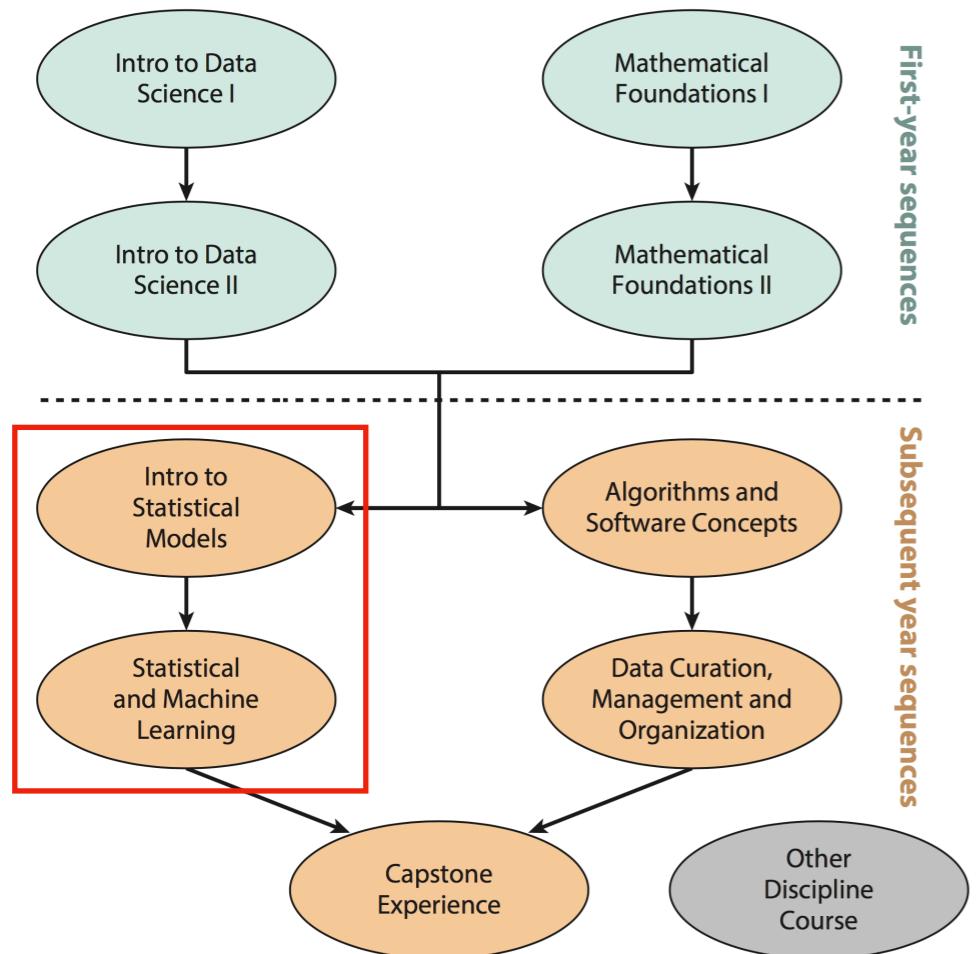
Probability



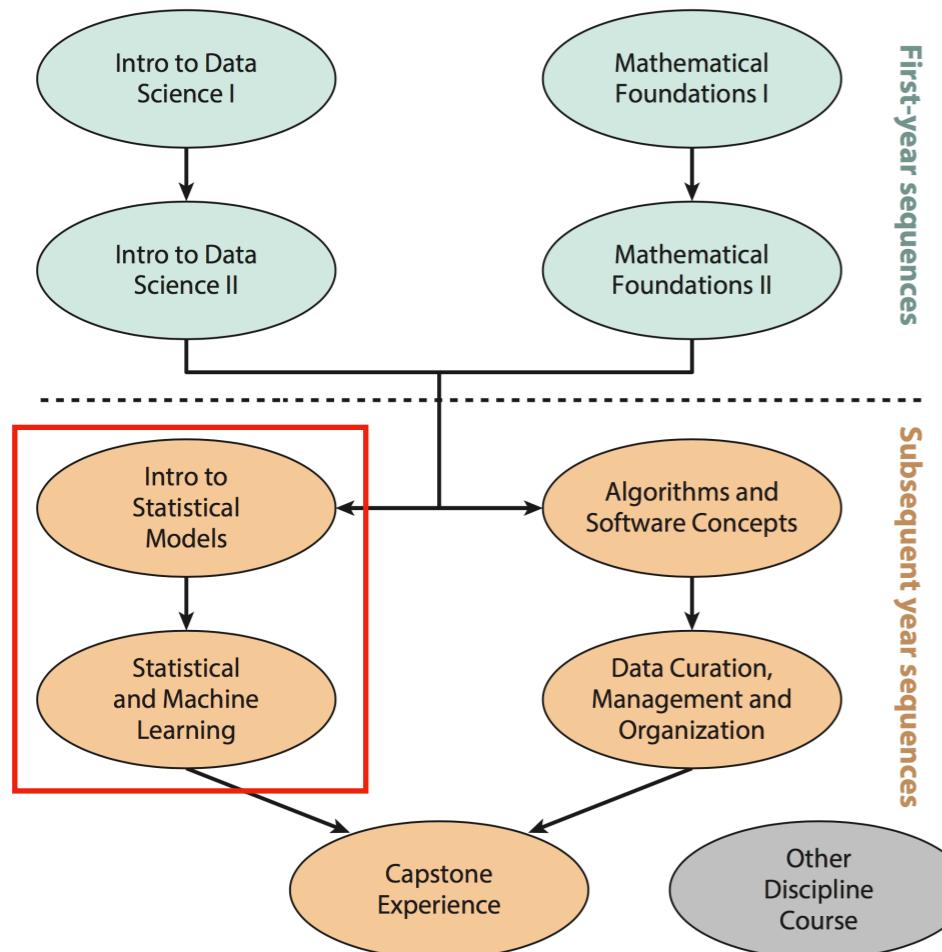
Calculus & Optimization



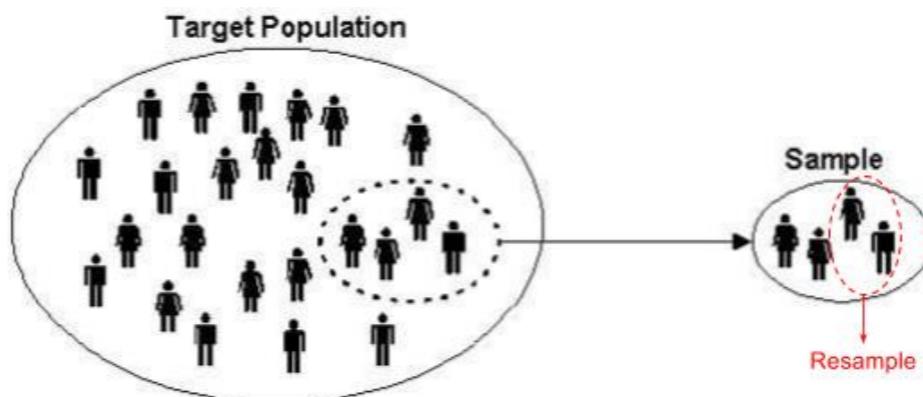
À-la-carte: From the “Stats” Menu:



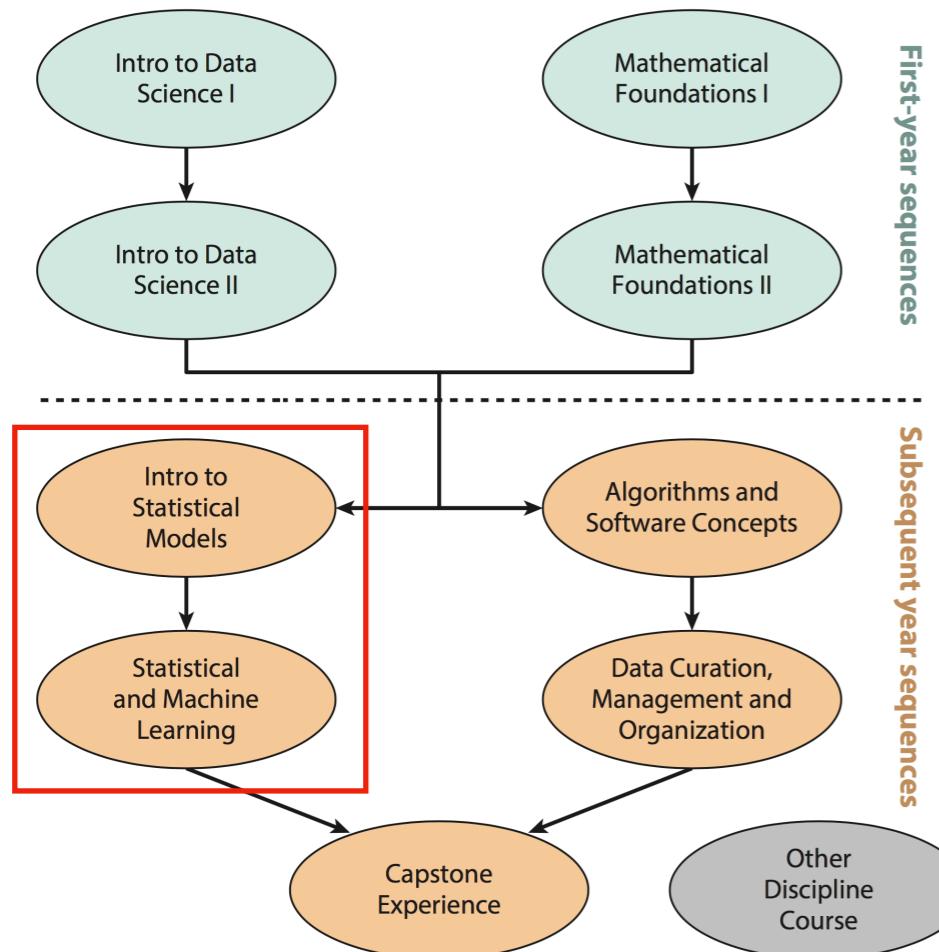
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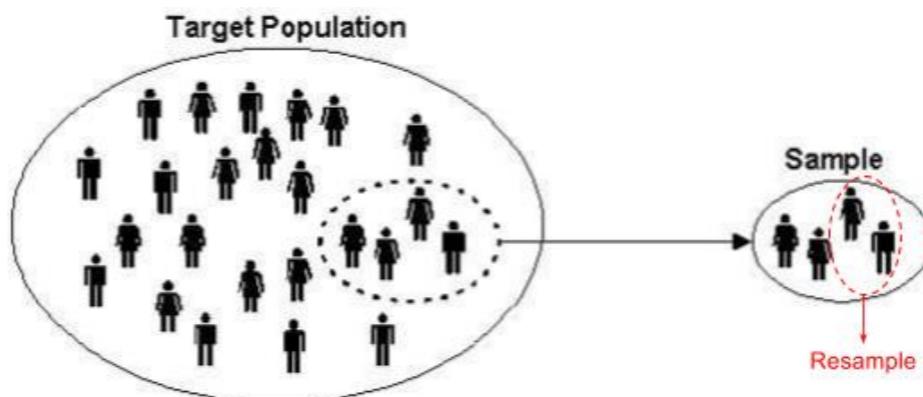
Statistical Inference



À-la-carte: From the “Stats” Menu:



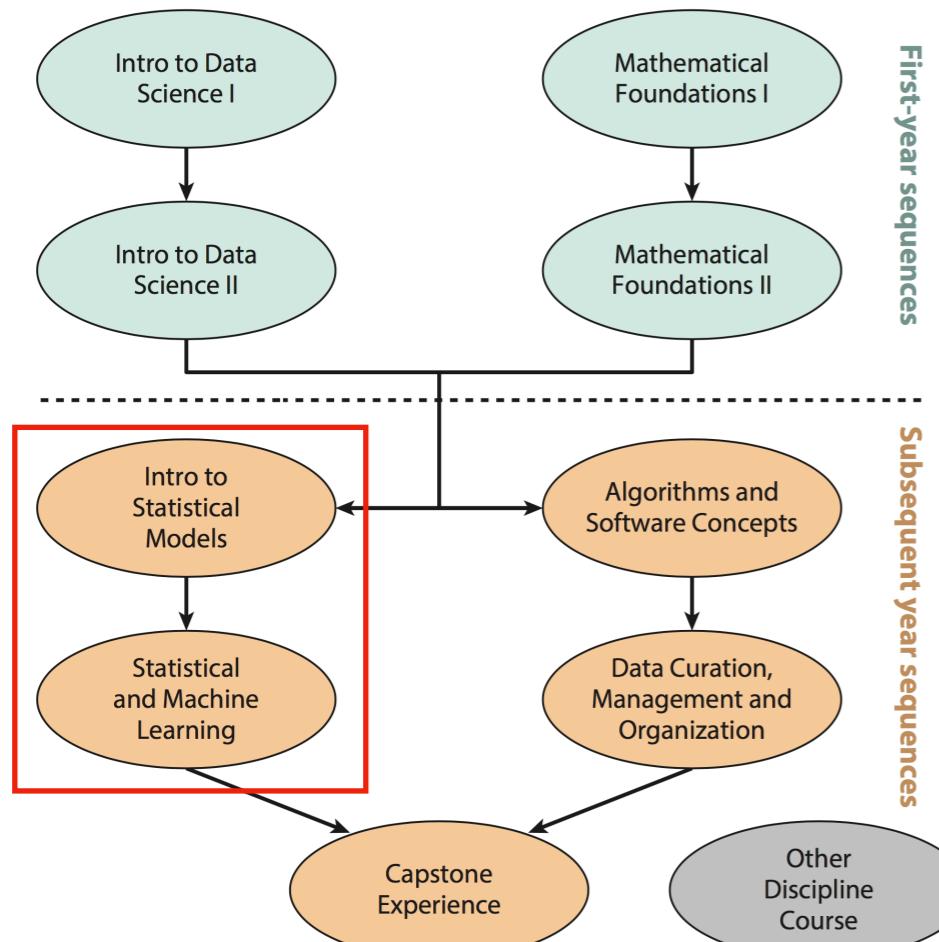
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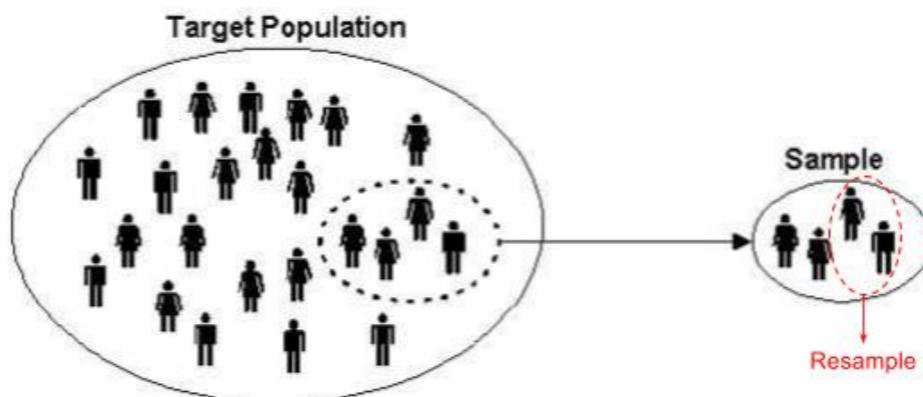
Modeling

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

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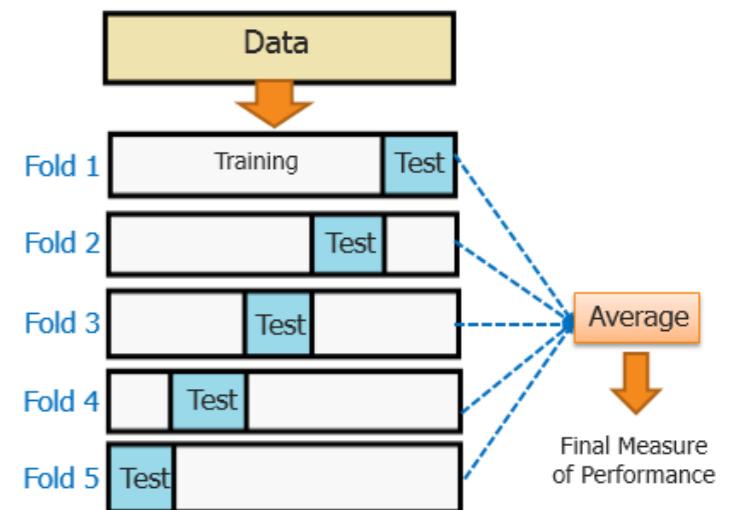
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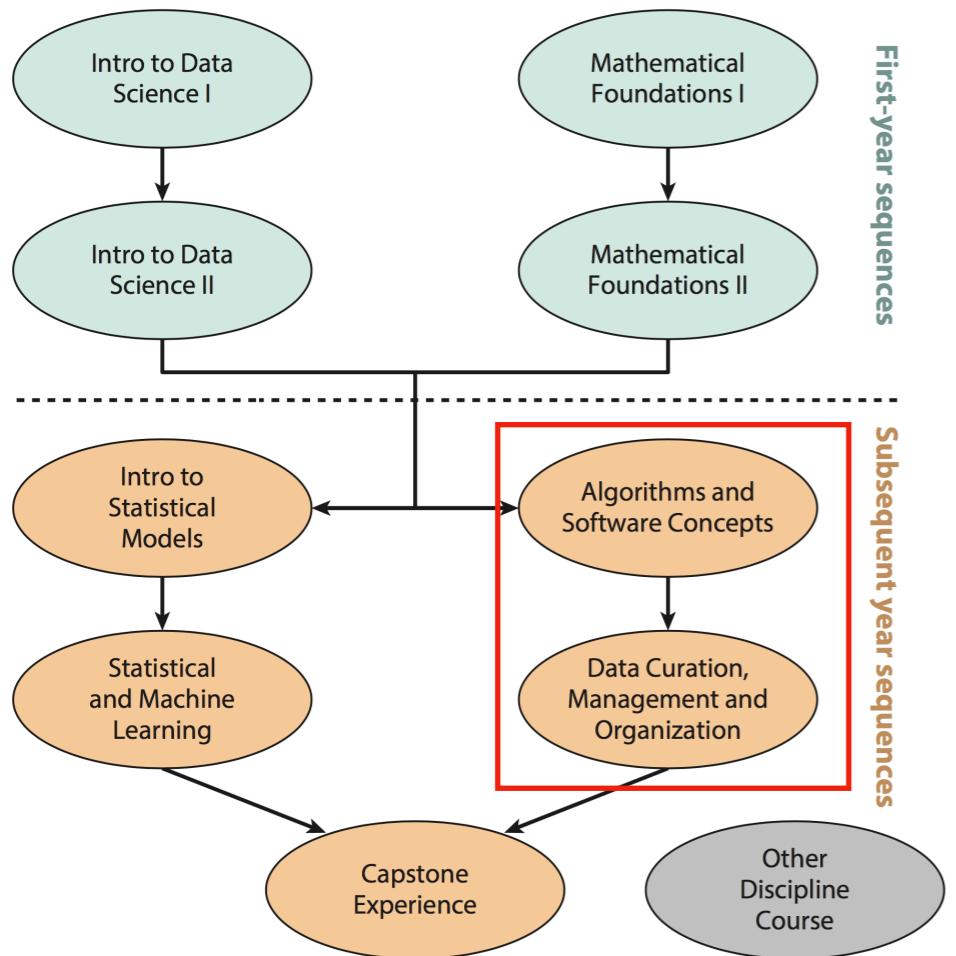
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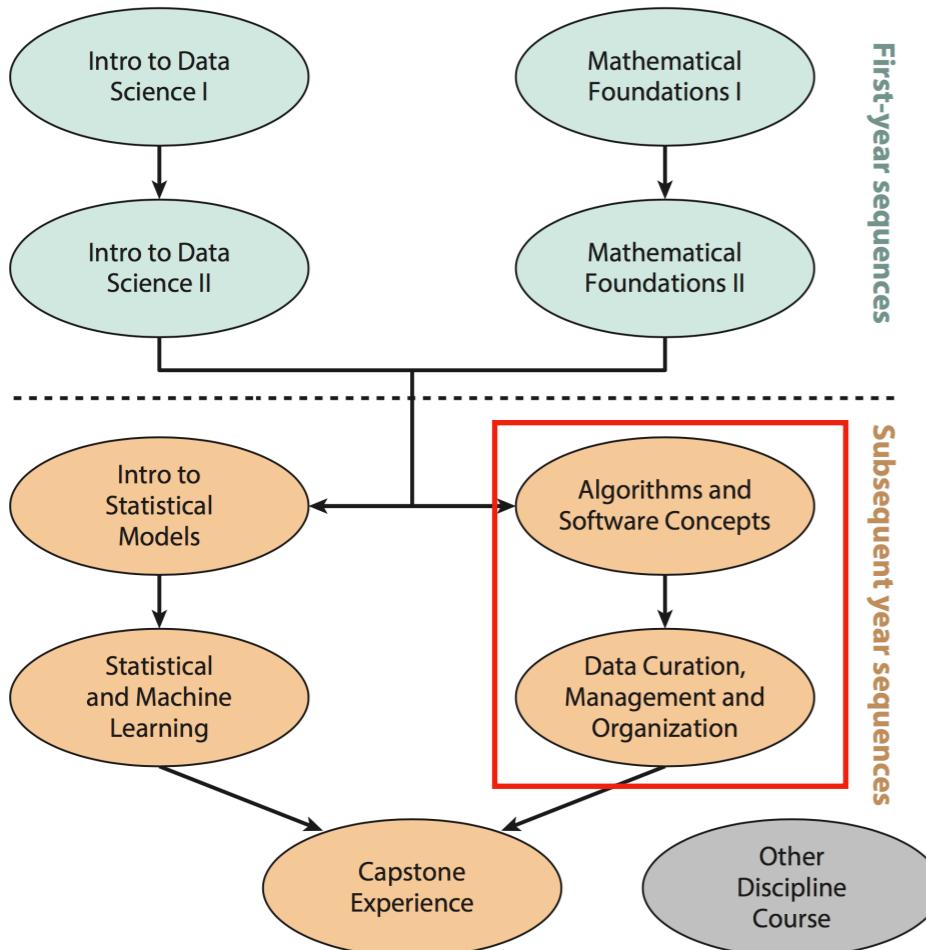
Machine Learning



À-la-carte: From the “CS” Menu:



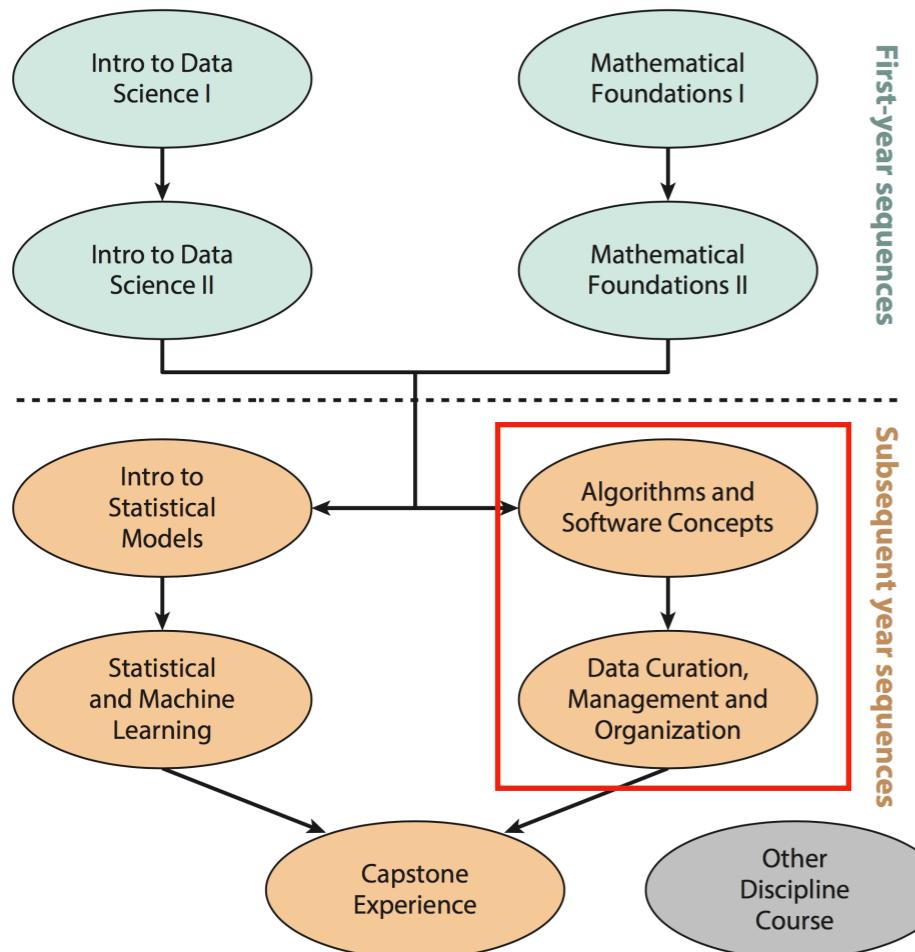
À-la-carte: From the “CS” Menu:



Coding as a skill



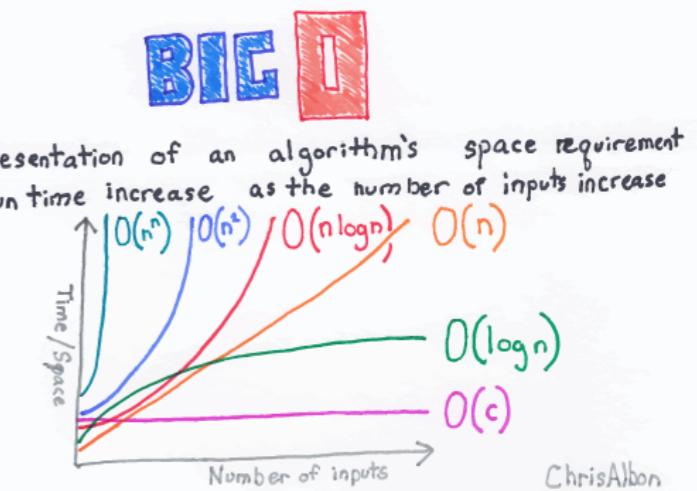
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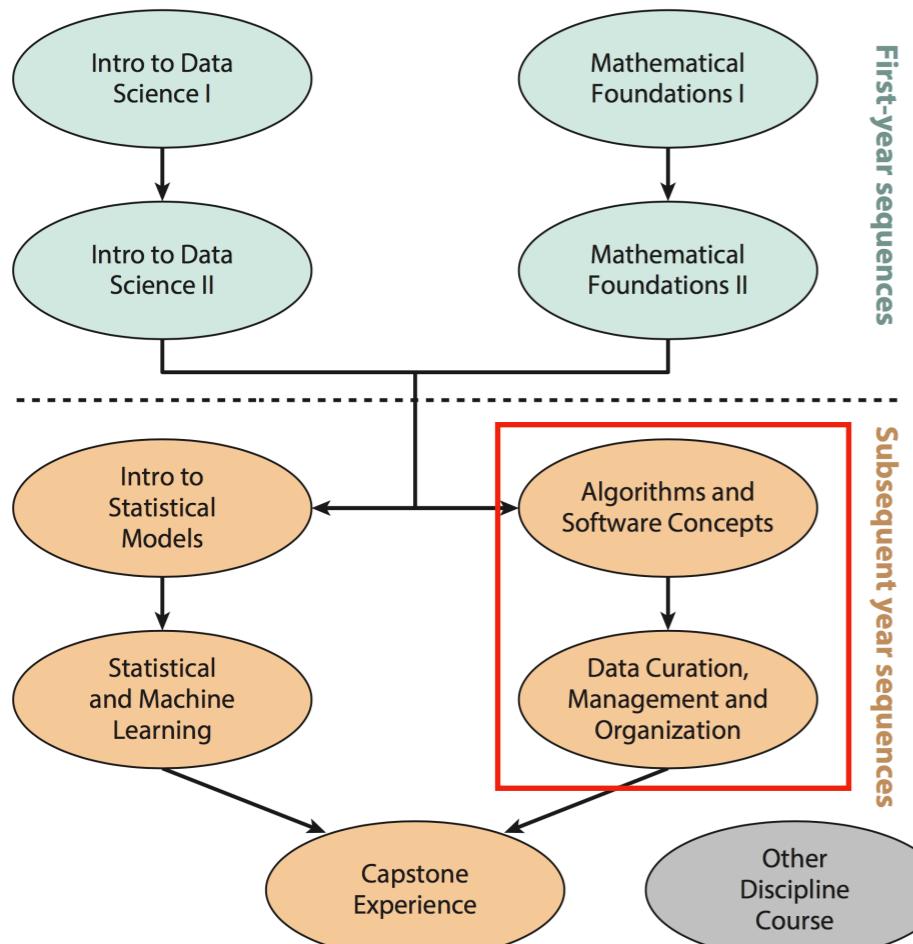
Coding as a skill



Algorithms



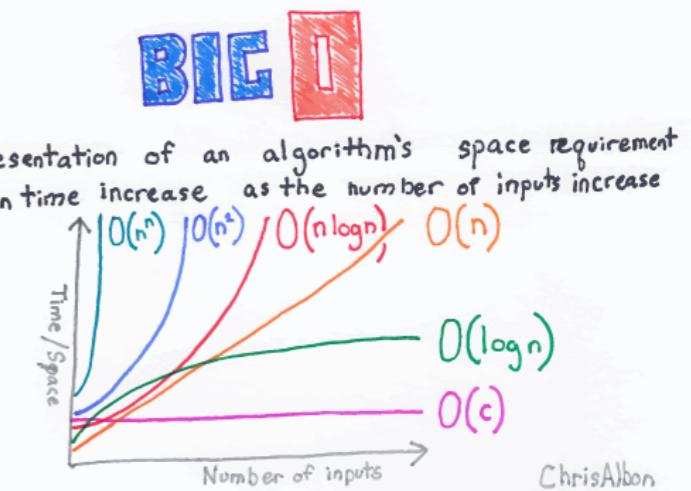
À-la-carte: From the “CS” Menu:



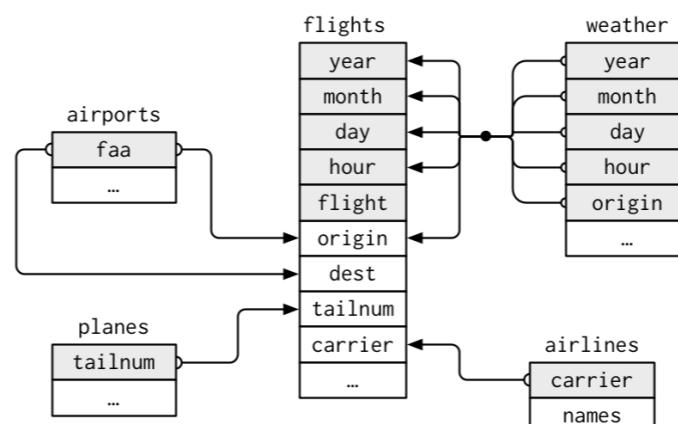
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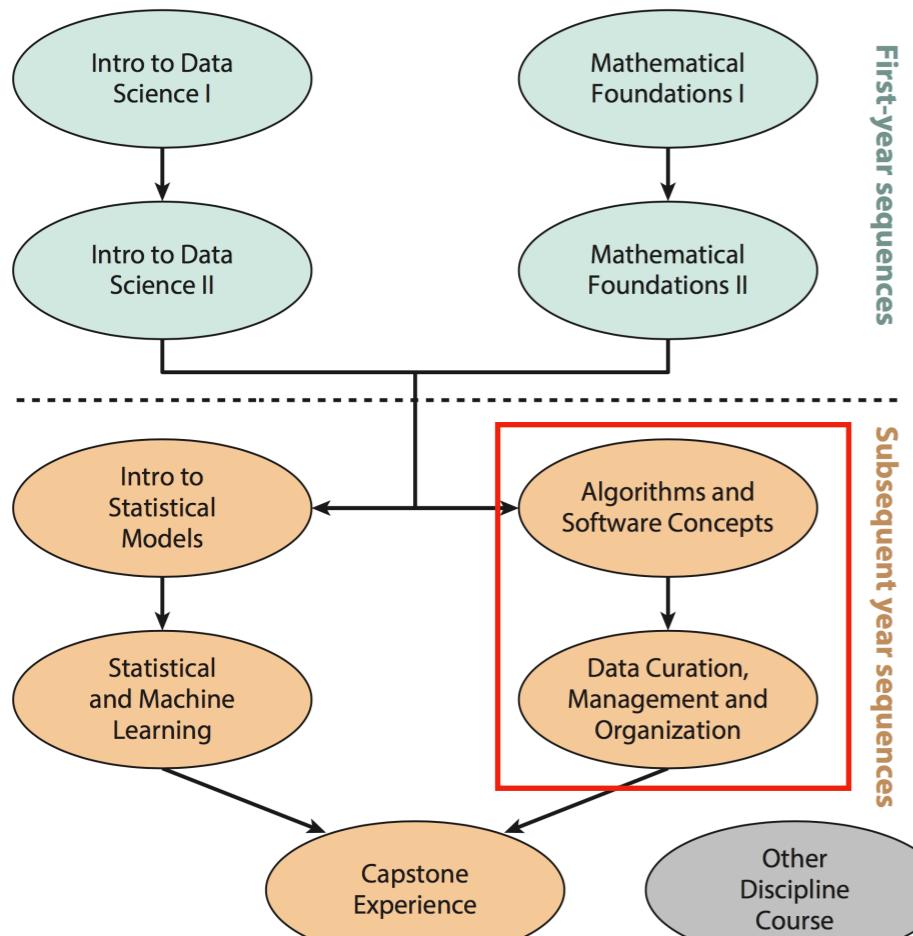
Algorithms



Data Representation



À-la-carte: From the “CS” Menu:



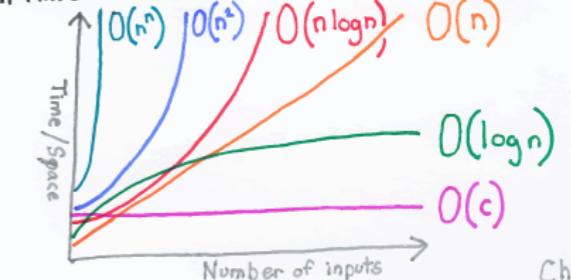
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Algorithms

BIG O

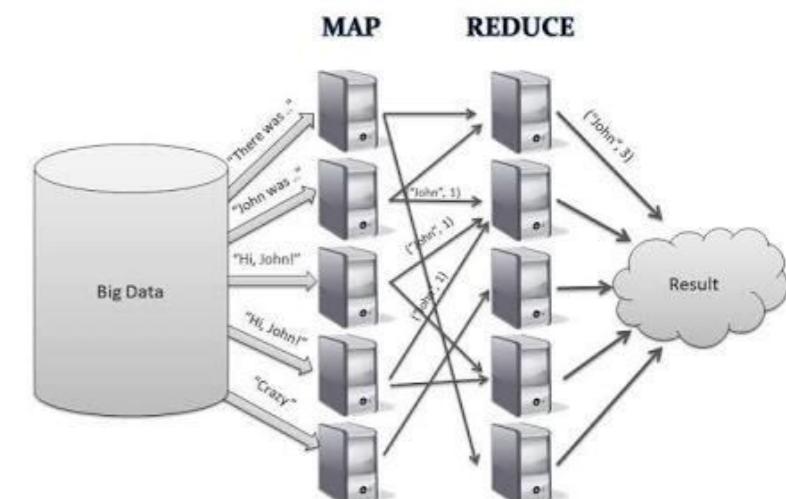
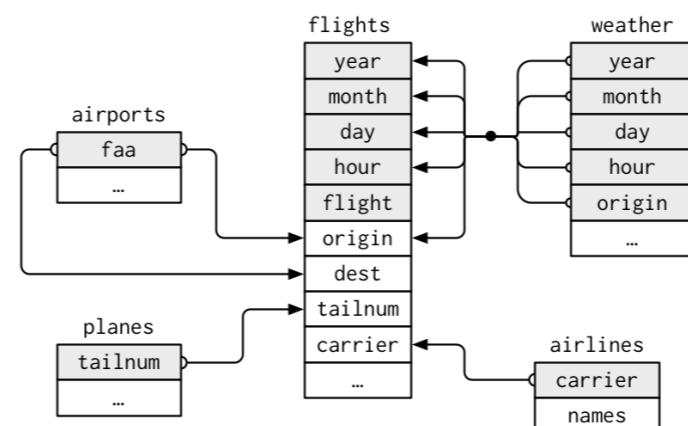
Representation of an algorithm's space requirement or run time increase as the number of inputs increase



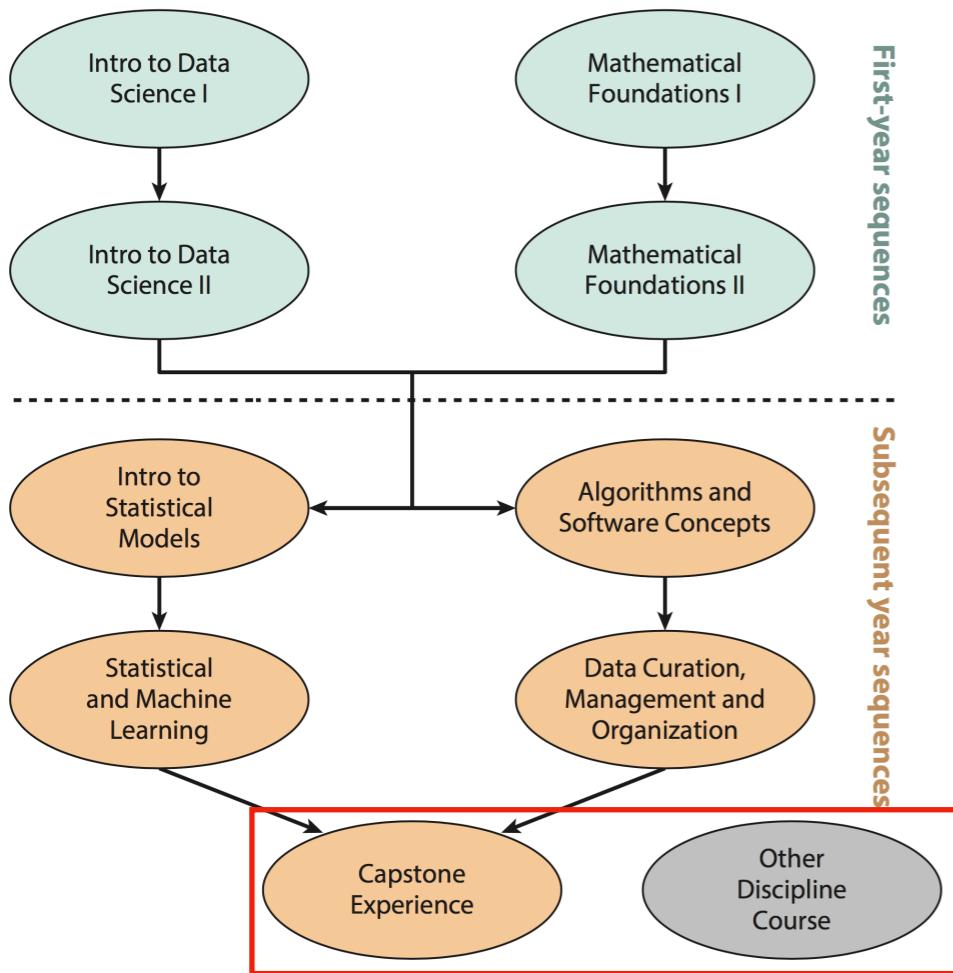
ChrisAlbon

“Big Data”

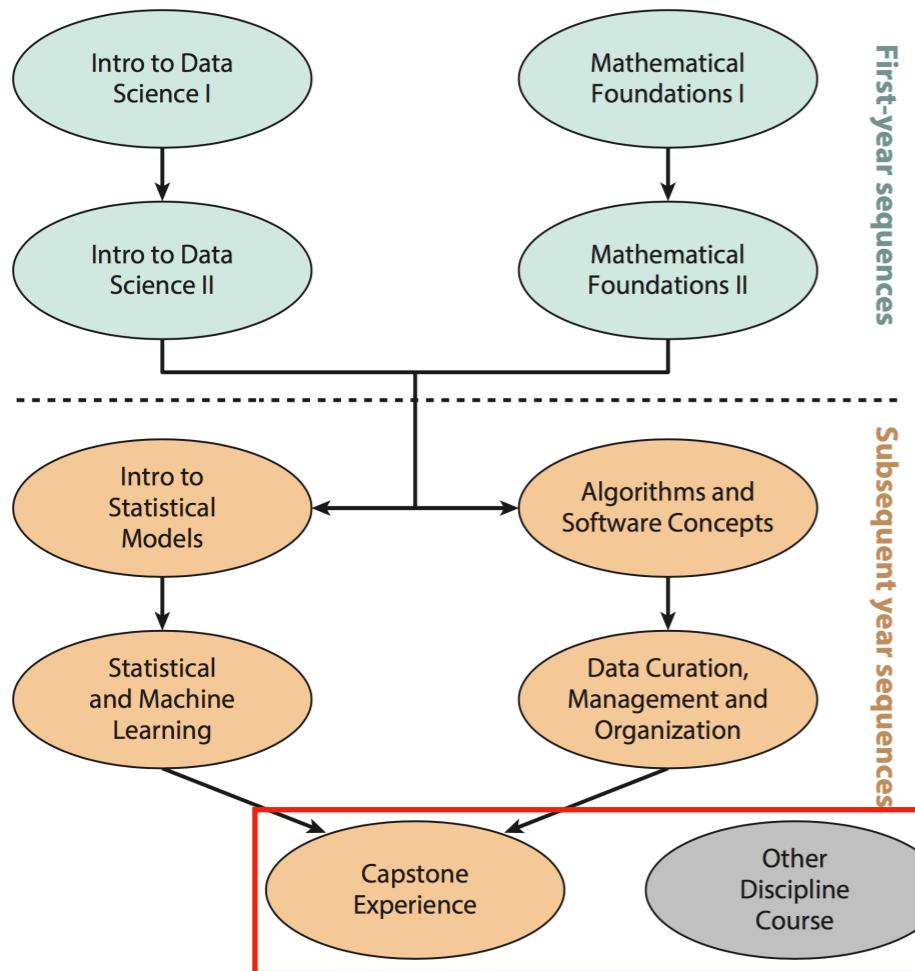
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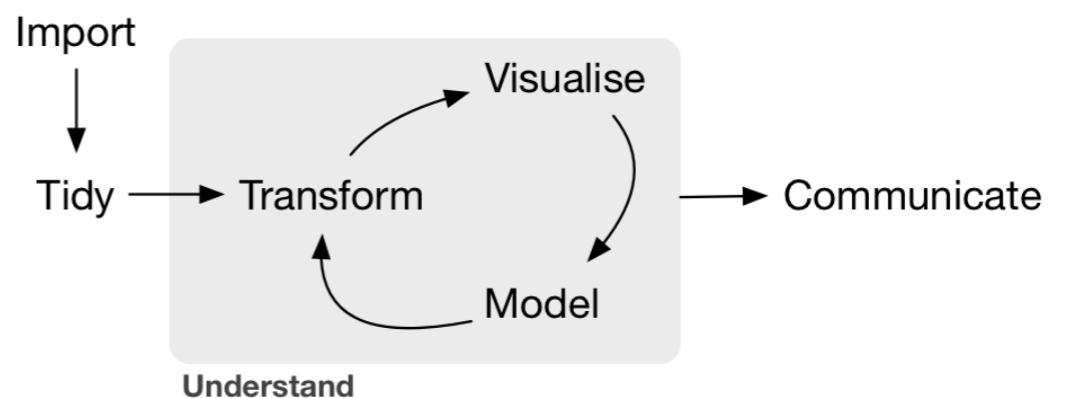
Capstone Experience & Domain Courses



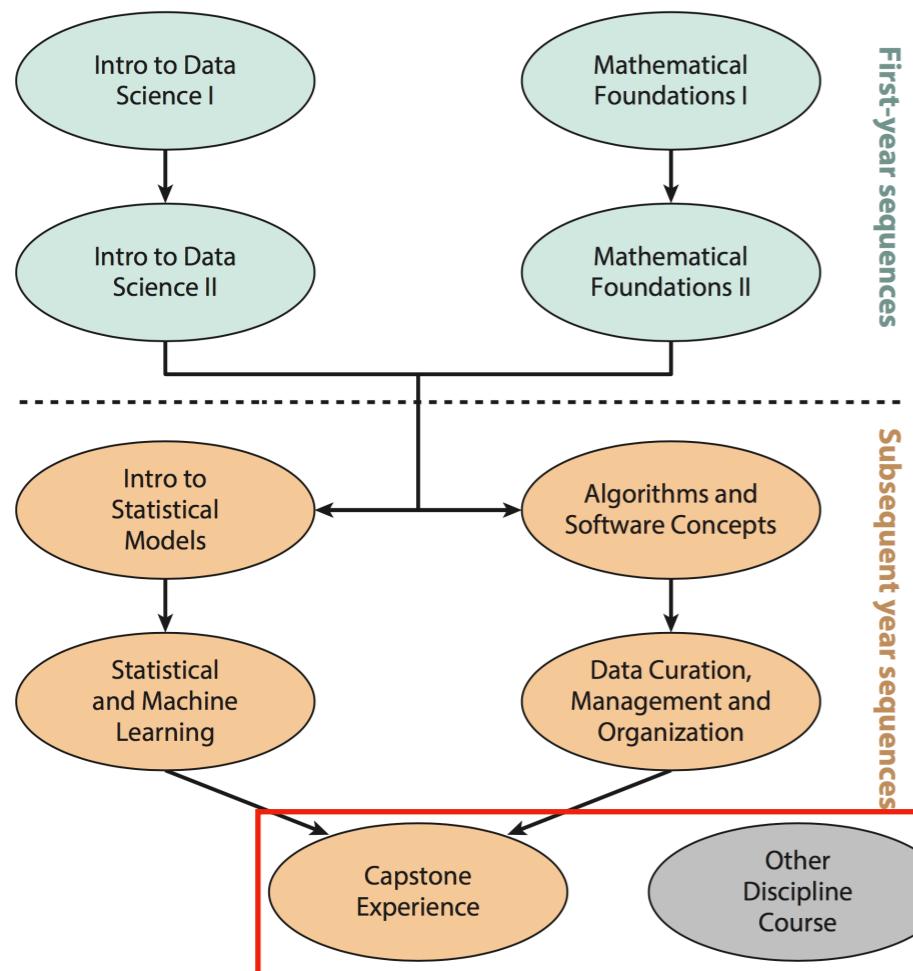
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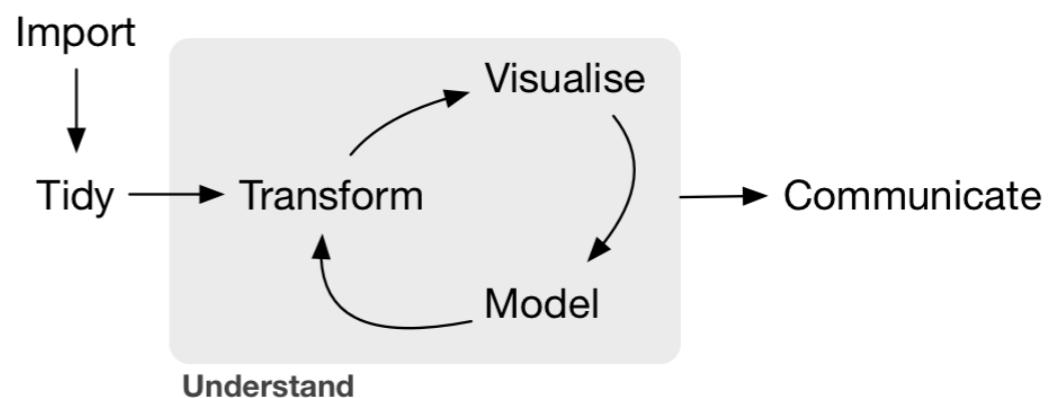
Capstone: Revisit entirety of pipeline



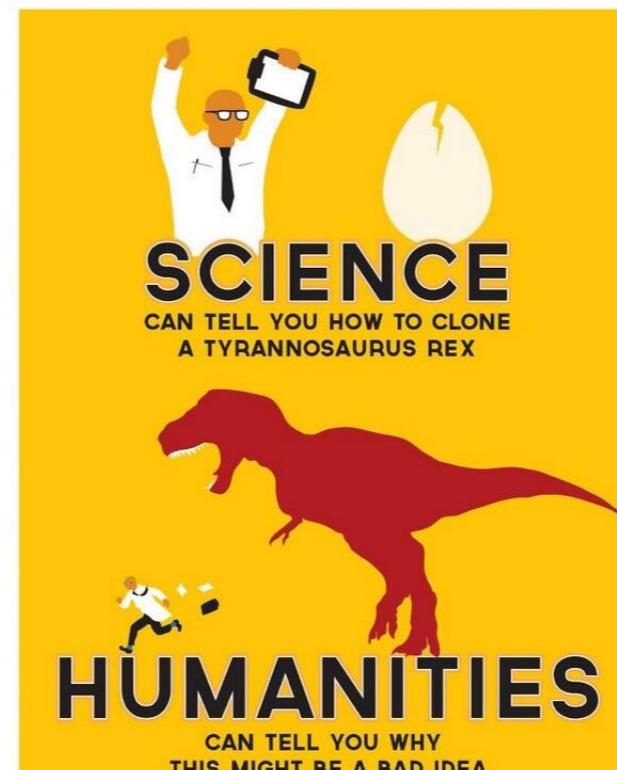
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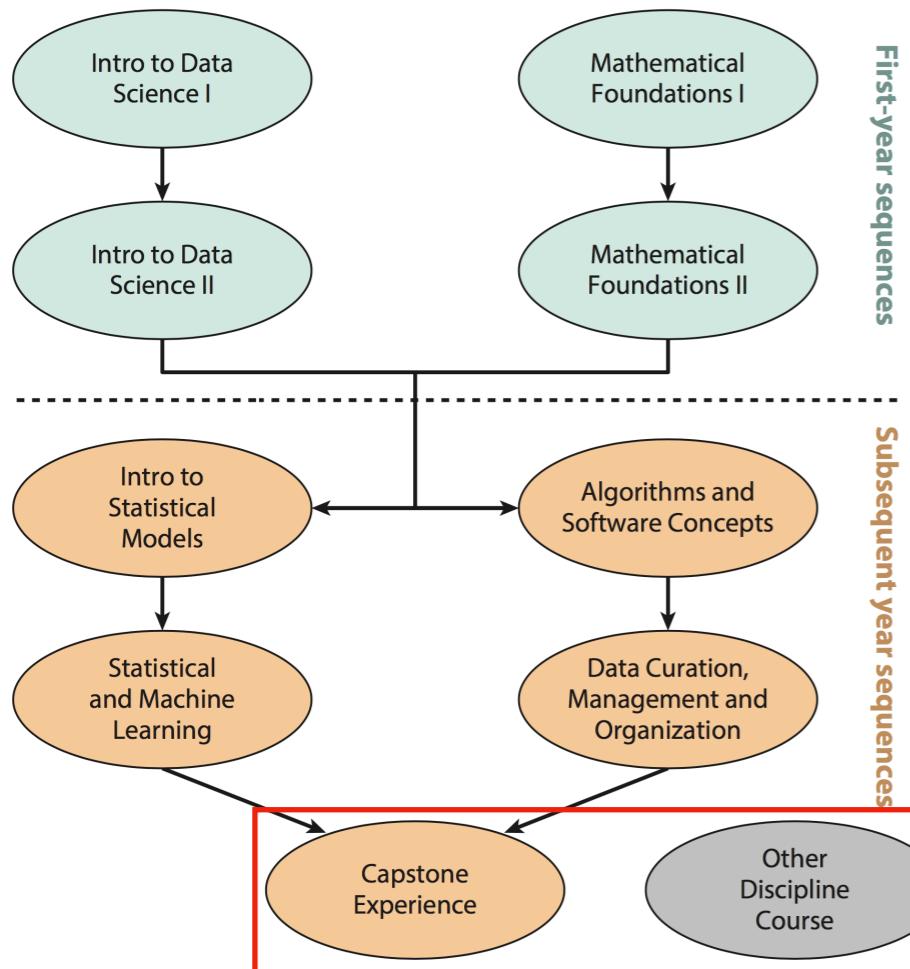
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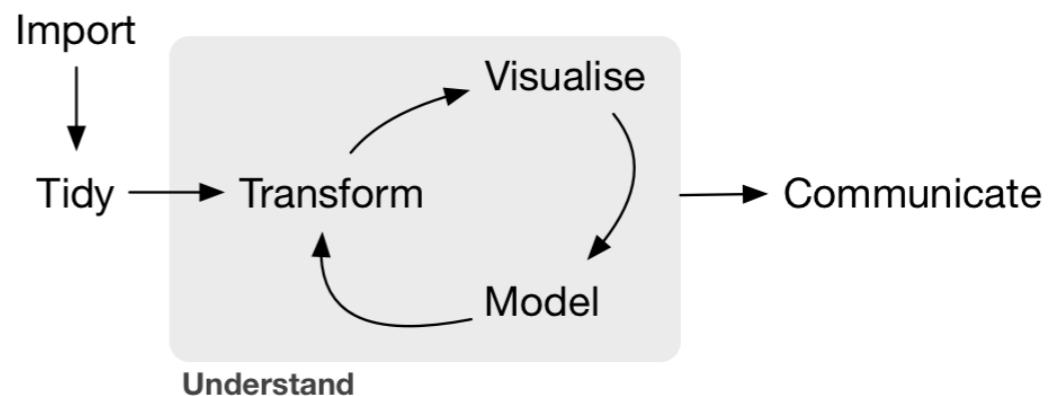
Ethics



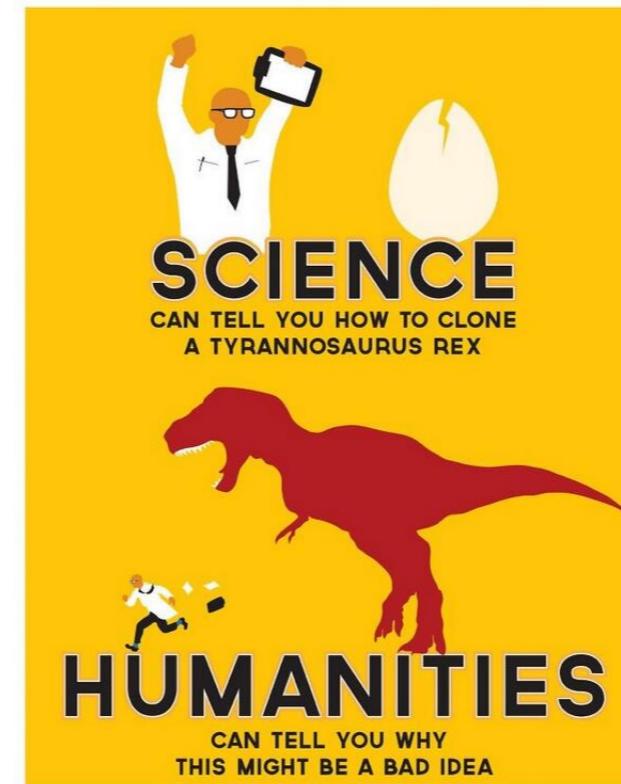
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Capstone: Revisit entirety of pipeline



Ethics



Other Disciplines:

“Numbers are numbers, but data has context”

Summary Points of Proposal

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1. Data science is a **fast evolving** discipline centered on the acquisition, curation, and analysis of data.

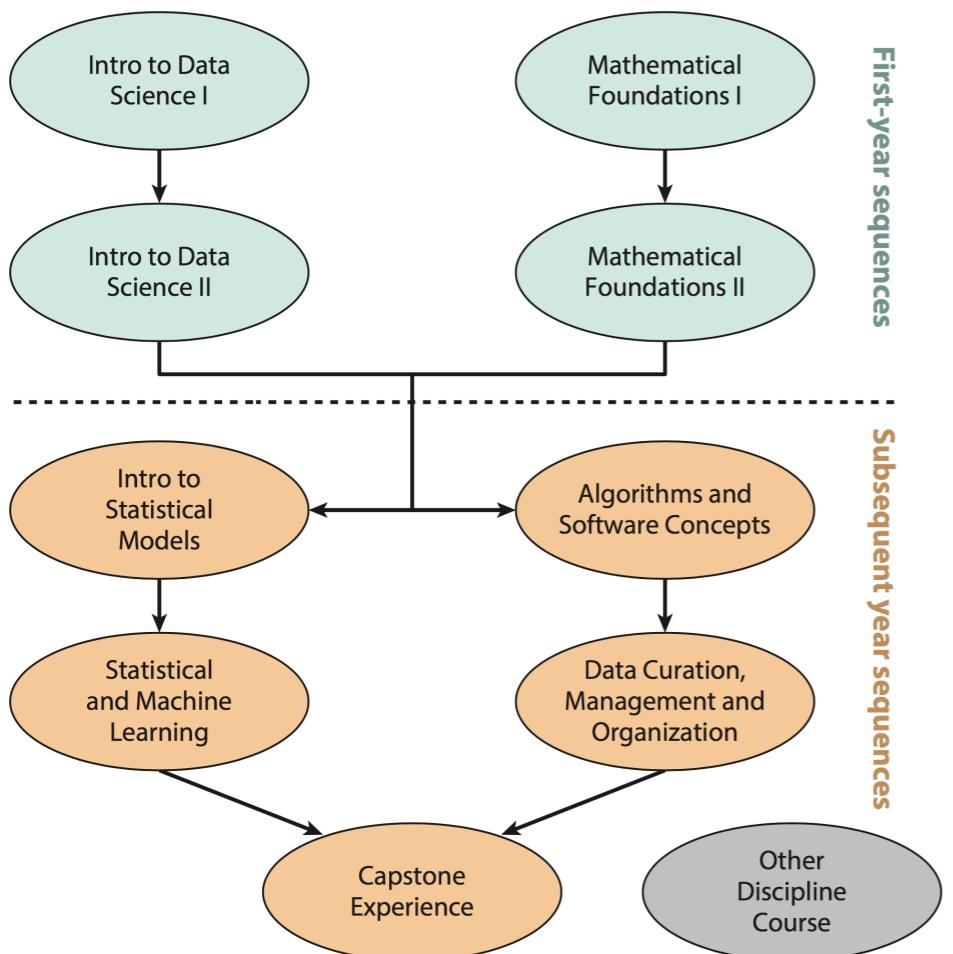
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2. Courses from the traditional disciplines of mathematics, statistics, and computer science **provide the basic infrastructure** for the major at present.
3. A **redesign of the curriculum**, integrating the elements of mathematical foundations and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