Incorporating data science into undergraduate microbiology

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Data science

- extracting knowledge and meaning from (big) data
- statistics, mathematics, computer science

- Where do the data come from?

(James Montgomery Flagg)

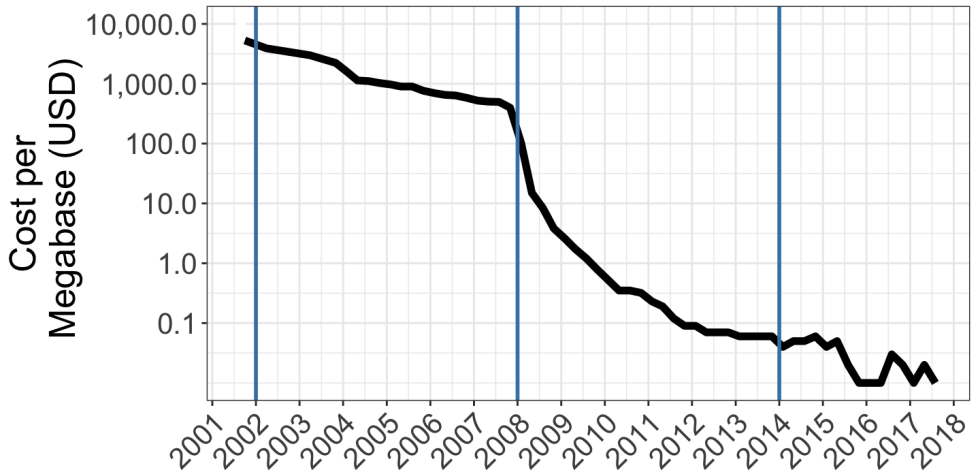
> 90% of researchers in the biological sciences work with or plan to work with big data

(Williams & Teal 2017)

Next-generation sequencing

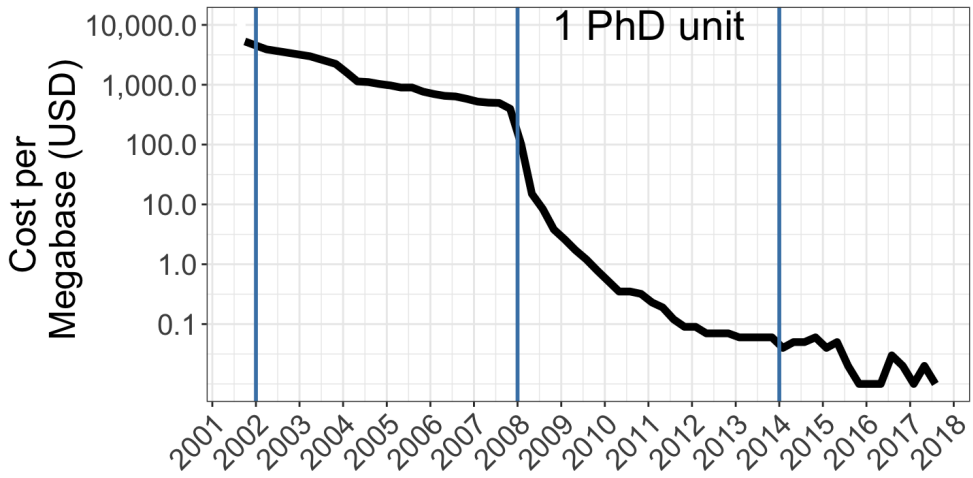
(NIH National Human Genome Research Institute)

Next-generation sequencing



(NIH National Human Genome Research Institute)

Next-generation sequencing

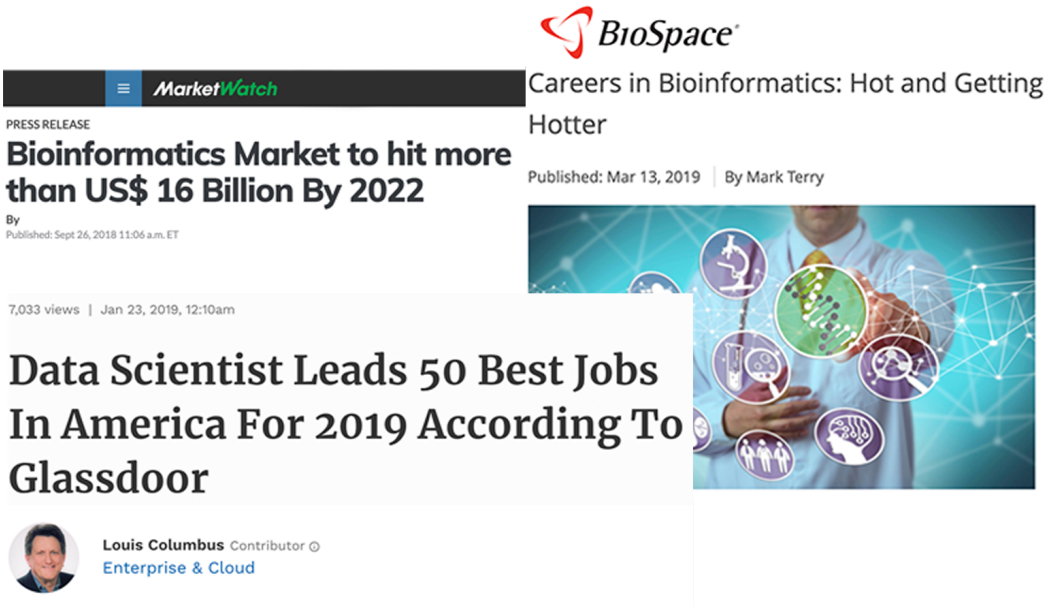


(NIH National Human Genome Research Institute)

> 60% of researchers in the biological sciences report a need for more training in data science

Meta-analysis 2013 - 2016
(Attwood *et al* 2017)

Not just academia



We need to teach data science in undergraduate life science curriculum.

Barriers to data science integration

1. Faculty training
2. Student interest
3. Student preparation in mathematics, statistics, and computer science
4. Already overly full curricula
5. Limited access to resources (hardware, software)

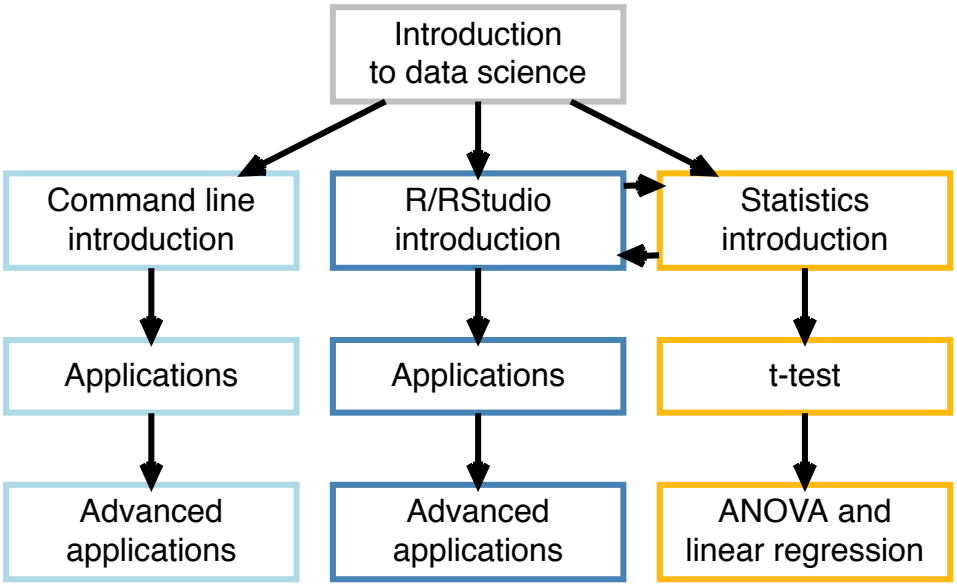
(Williams *et al* 2017)

Experiential
Data science for
Undergraduate
Cross-disciplinary
Education

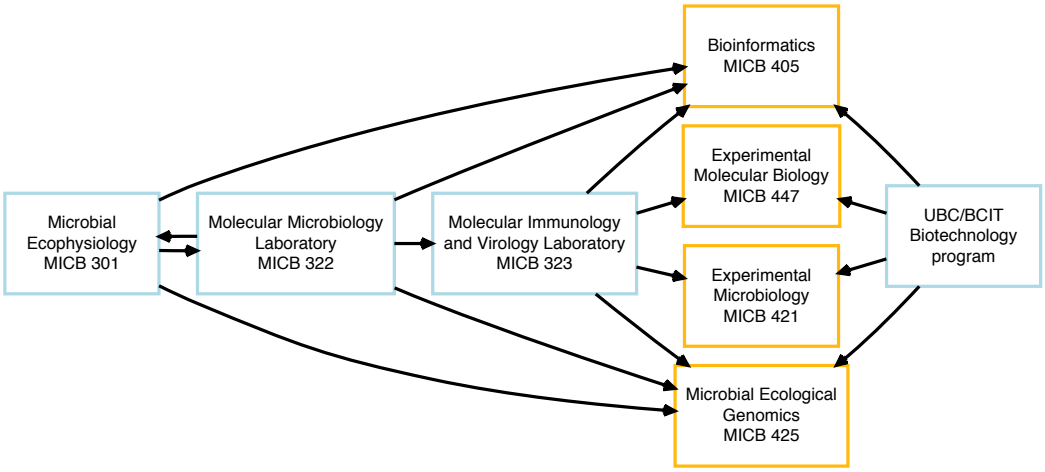
Our goal

Modular integration of
data science curriculum into
existing courses

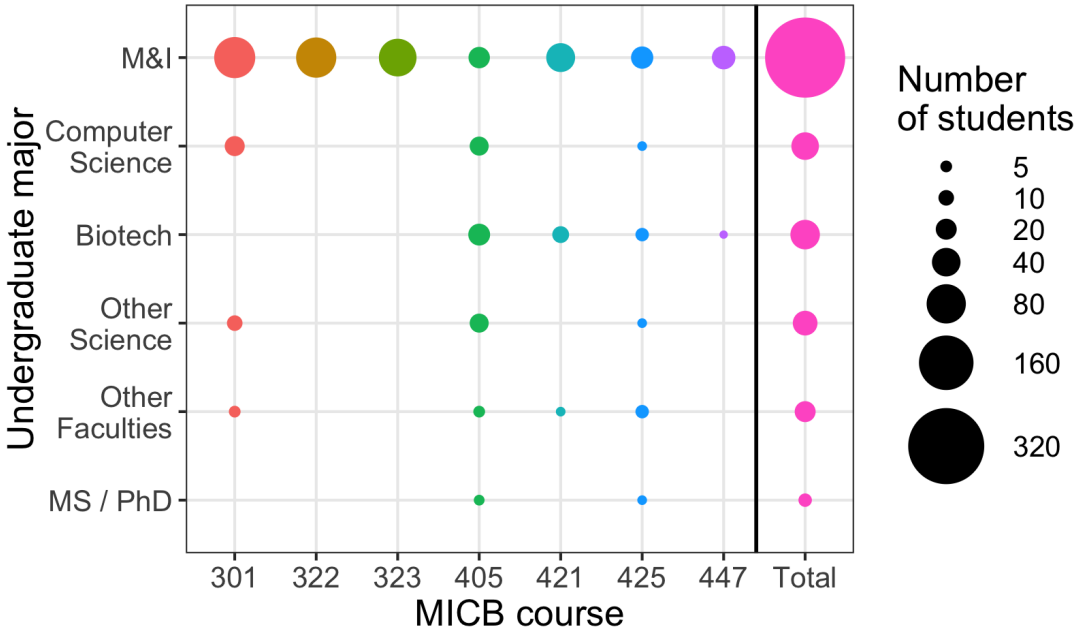
Content overview



Course overview

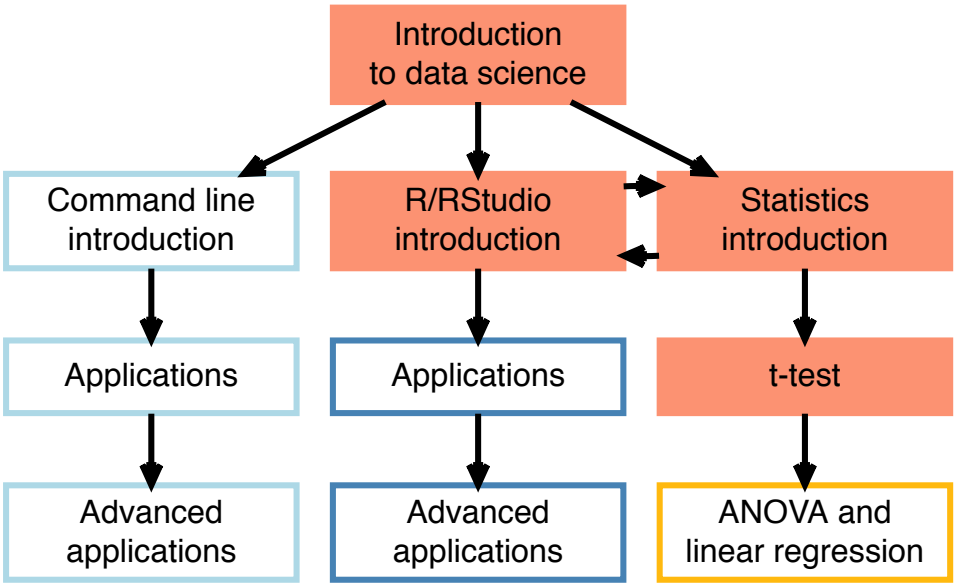


Students impacted per year

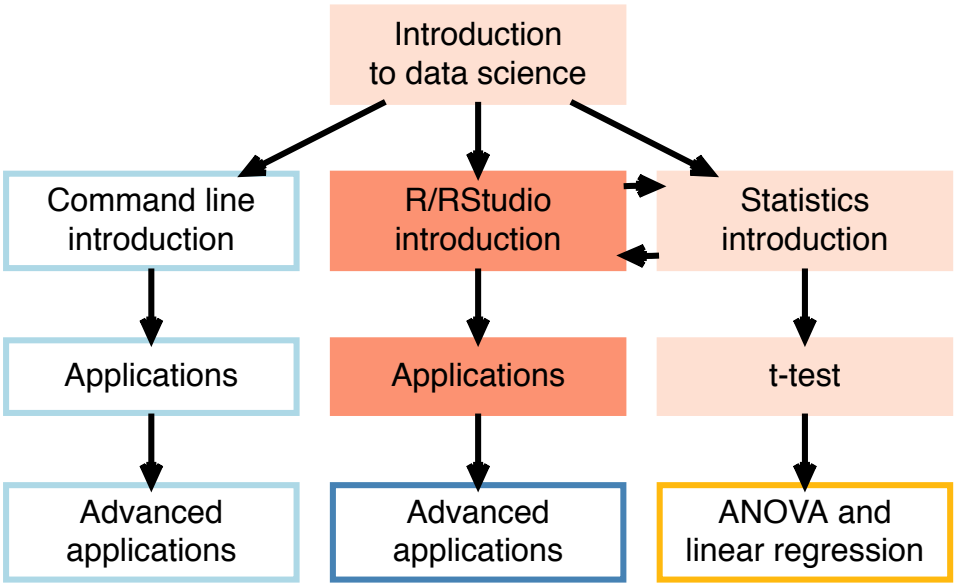


Example student

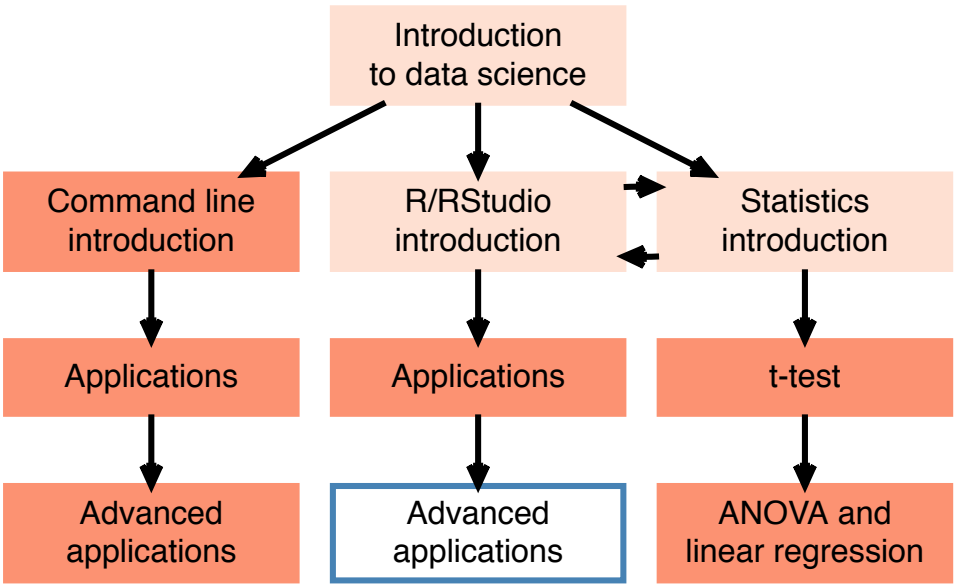
MICB 301



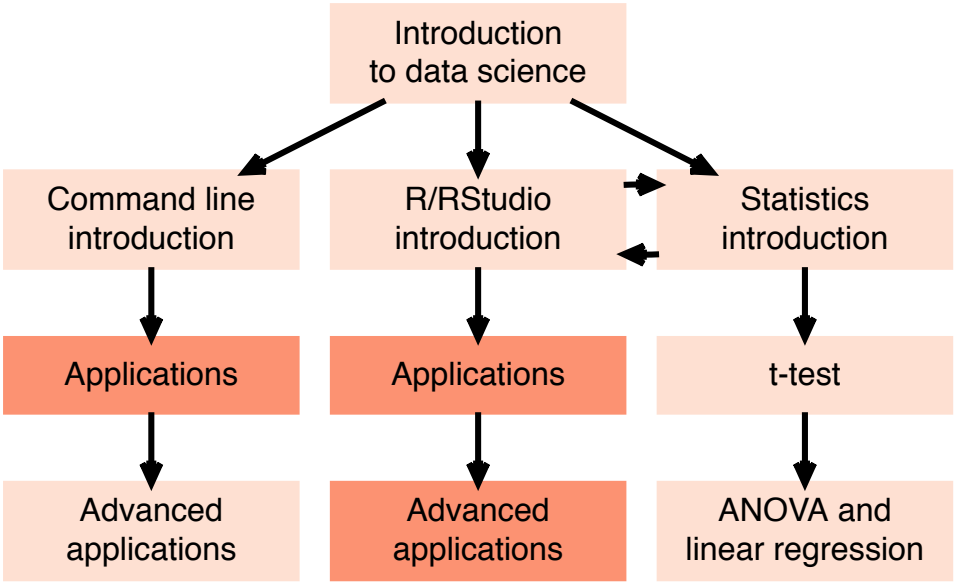
MICB 301 - 322



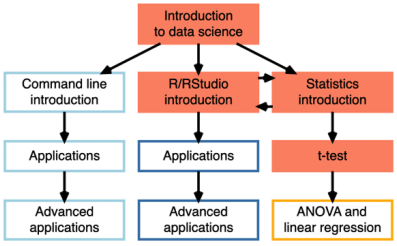
MICB 301 - 322 - 405



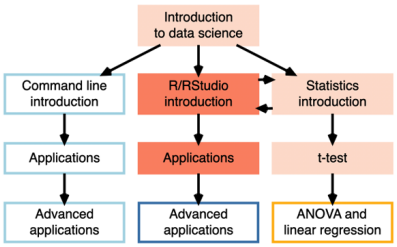
MICB 301 - 322 - 405 - 425



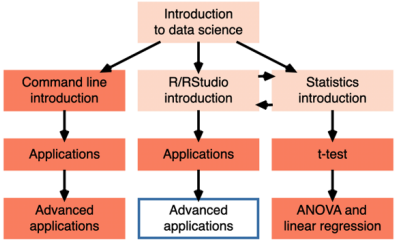
Example student



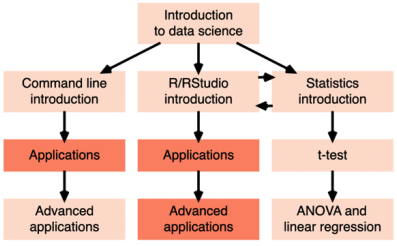
MICB 301



MICB 322



MICB 405



MICB 425

Solutions to integration

1. Faculty training

- *Dedicated Postdoctoral Teaching and Learning Fellow*
- *Cross-disciplinary TAs from multiple departments*

2. Student interest

- *Direct connections to other course curricula*
- *Hands-on, experiential learning*

Solutions to integration

3. Student preparation

- *No prior knowledge assumed*

4. Already overly full curricula

- *No new courses required*

5. Limited access to resources

- *Stripped down datasets and use of cloud resources*
- *Open-source tools and curricula*

Does EDUCE effectively teach data science skills to M&I students?

MICB 301 as a case study

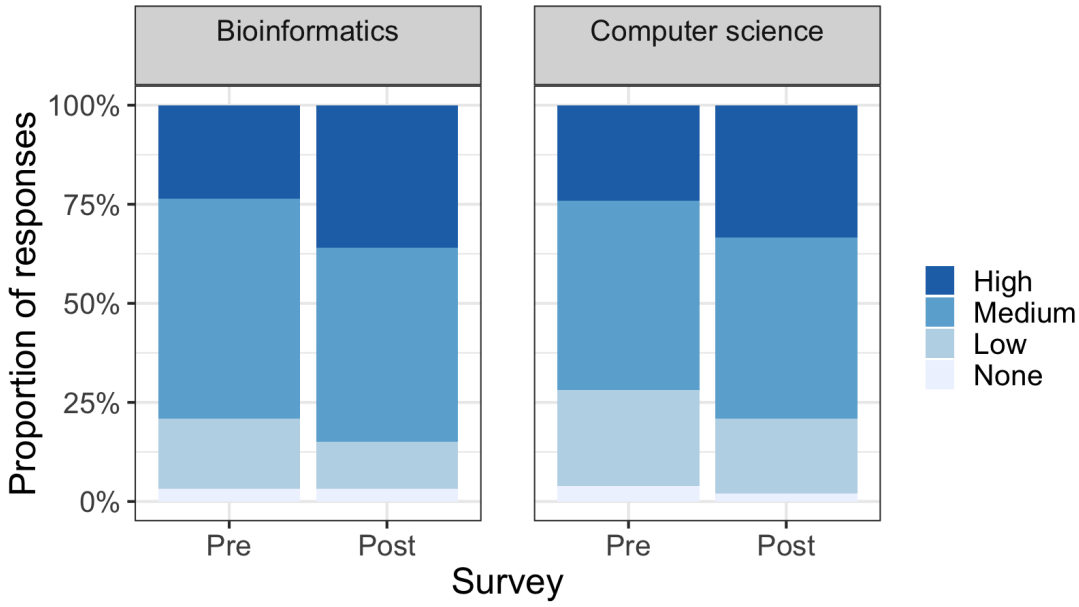
EDUCE in MICB 301

- 5 x 50 min class sessions across 5 weeks
- Weekly assignments and a final report

- Introduction to
  - data science
  - R/RStudio
  - statistics
- Simple plots and running a *t*-test in R

Increased interest in data science

How would you rate your interest in…



Increased interest in data science

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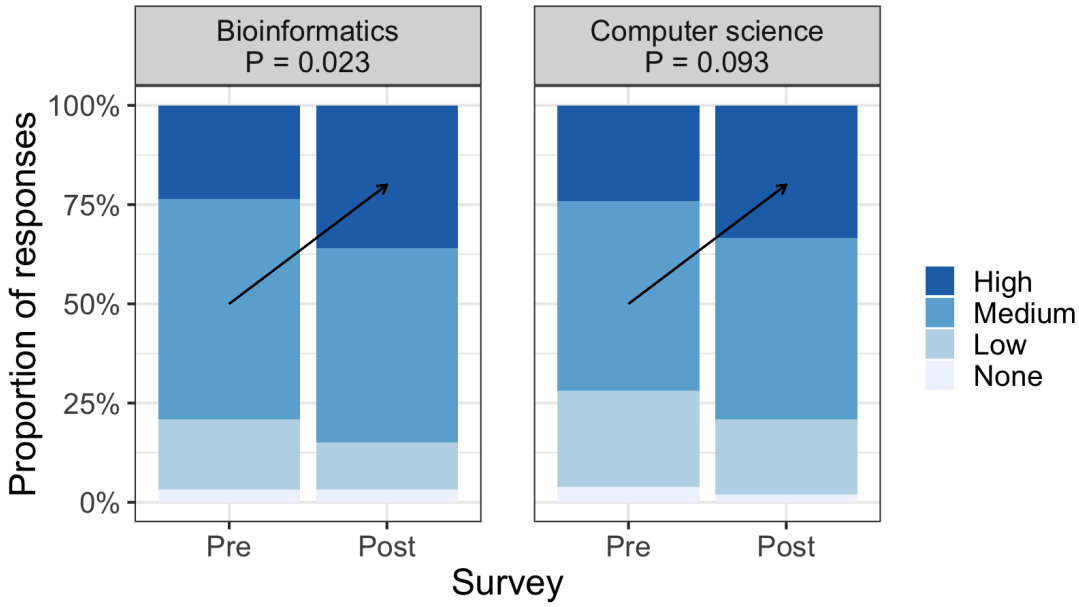
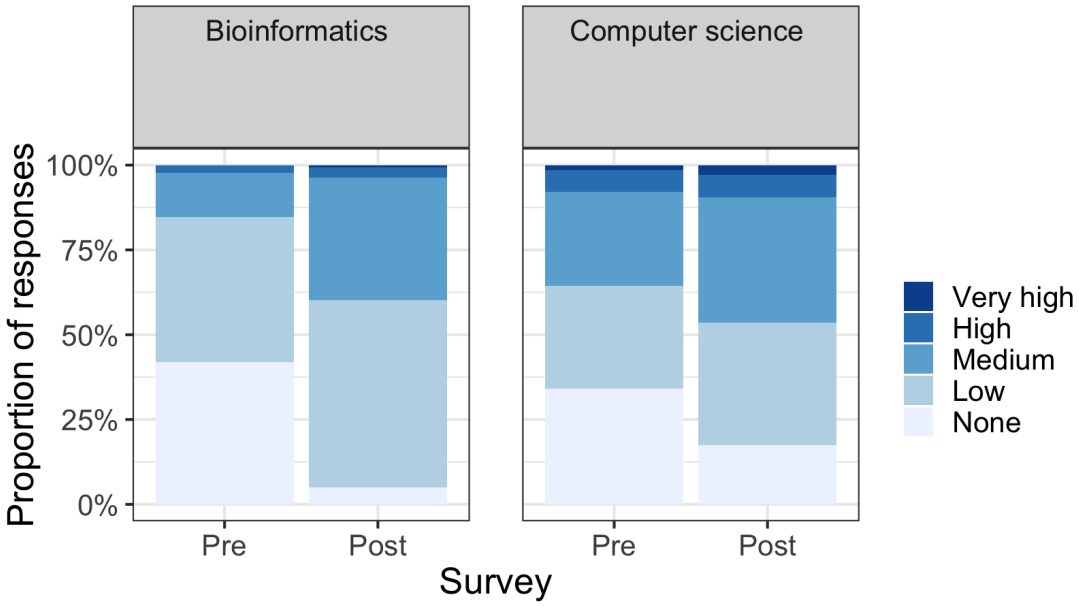


Except…

No significant changes in interest in statistics

Increased experience in data science

What level of experience do you have in …



Increased experience in data science

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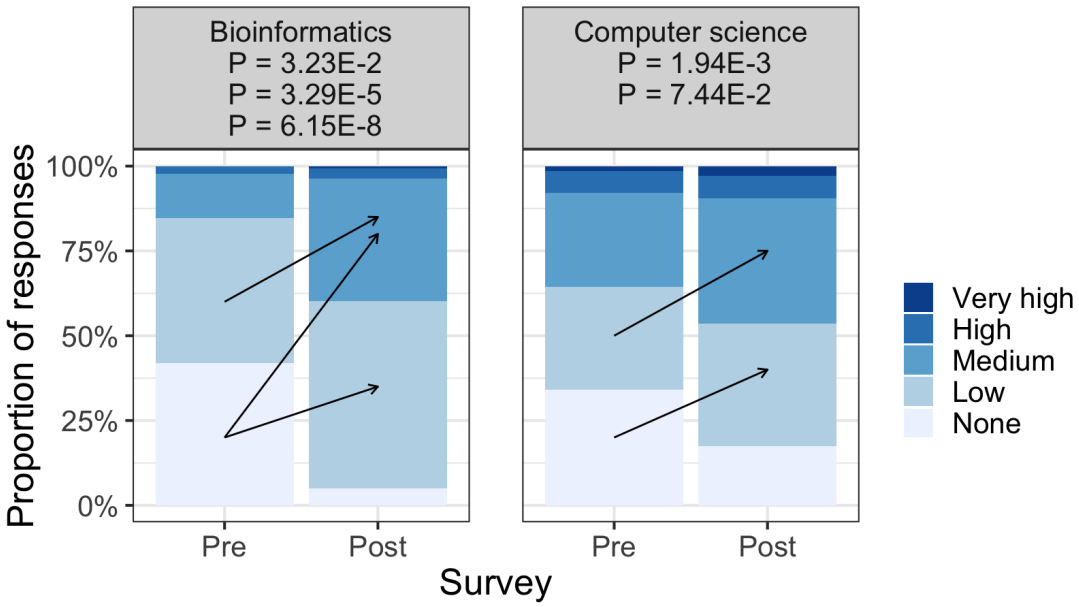

Except…

No significant changes in experience in statistics

Conclusions

- Data science literacy is needed in the life sciences
- EDUCE provides a flexible, modular approach for integrating data science into undergraduate curriculum
- Even minimal exposure (5 hours) can increase student self-reported interest and experience in data science areas

The future

- A wealth of survey data to mine
- Repetition across 3 years for statistical analyses
- More courses? Other departments?
- Faculty of Science Data Science Committee

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Course instructors

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Opportunities at UBC

Postdoctoral Teaching and Learning Fellow

- EDUCE
  http://ecoscope.ubc.ca/program-structure/educe/educe-postdoctoral-application

- Master of Data Science
  https://www.stat.ubc.ca/postdoctoral-teaching-and-learning-fellow-ubc-master-data-science-program-0

References

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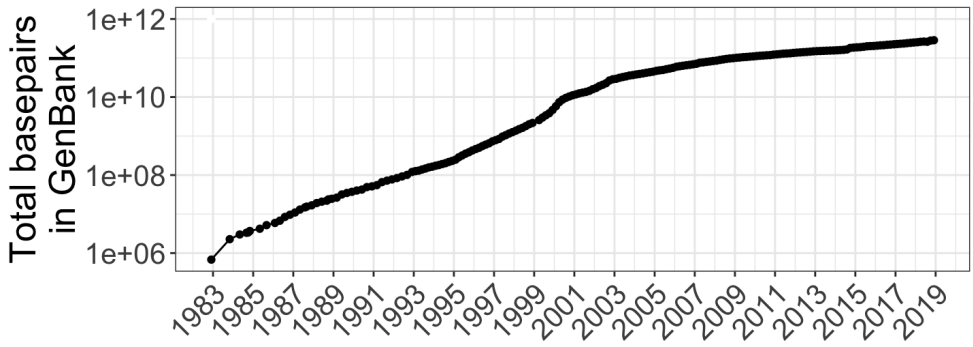
Williams JJ *et al* 2017. *Barriers to integration of bioinformatics into undergraduate life sciences education.* BioRxiv. doi: 10.1101/204420

Williams JJ & Teal TK. 2017. *A vision for collaborative training infrastructure for bioinformatics.* Ann N Y Acad Sci. 1387(1):54-60_ doi: 10.1111/nyas.13207

GenBank sequences



Undergraduate programs

BSc in Bioinformatics

- U. of Montreal
- U. Saskatchewan
- U. Calgary
- Carleton U.

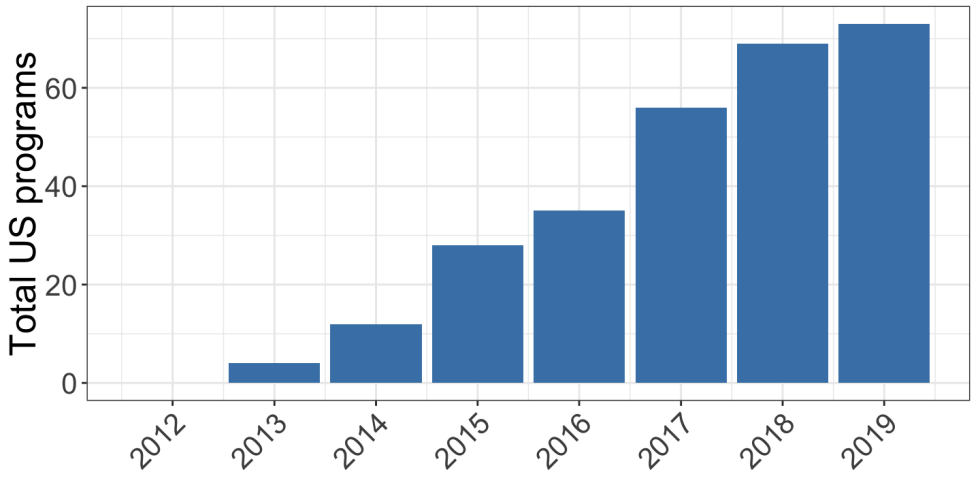
Joint BSc degrees

- Simon Fraser U.
- U. of British Columbia

Specializations / minors

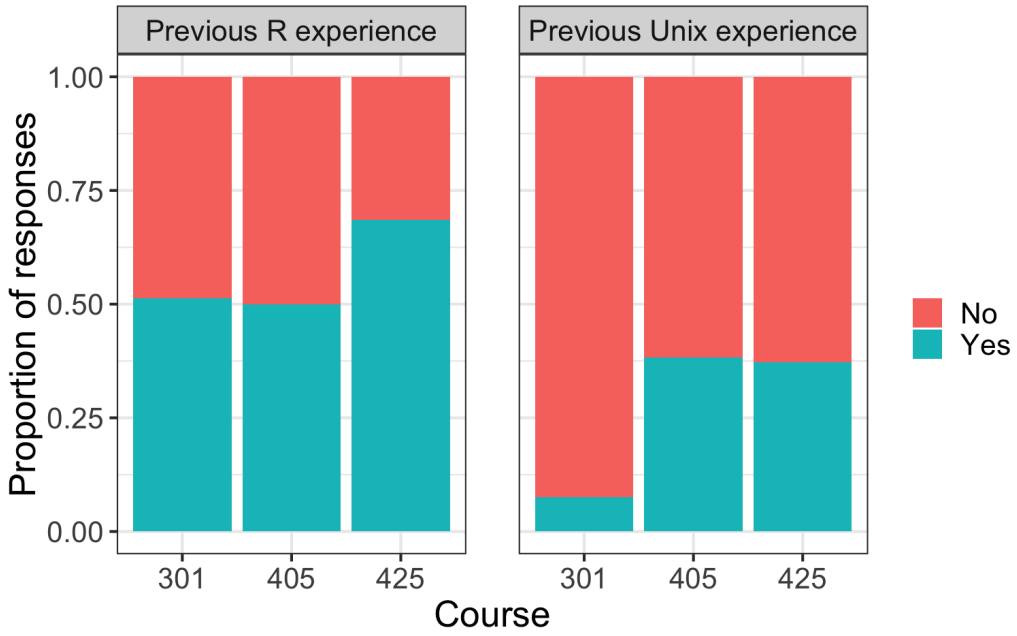
- Dalhousie U.
- McGill U.
- U. of Toronto
- U. of Victoria
- U. of Waterloo
- U. of Western Ontario

MDS programs



(Michael Rappa, NC State University)

Some prior experience



Minimal prior knowledge

Have you heard the term 'data science'?