

Evolving Statistics Education for a Data Science World



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Data Revolution

Machine
Learning

Analytics

Statistics

Data
Science

Data
Mining



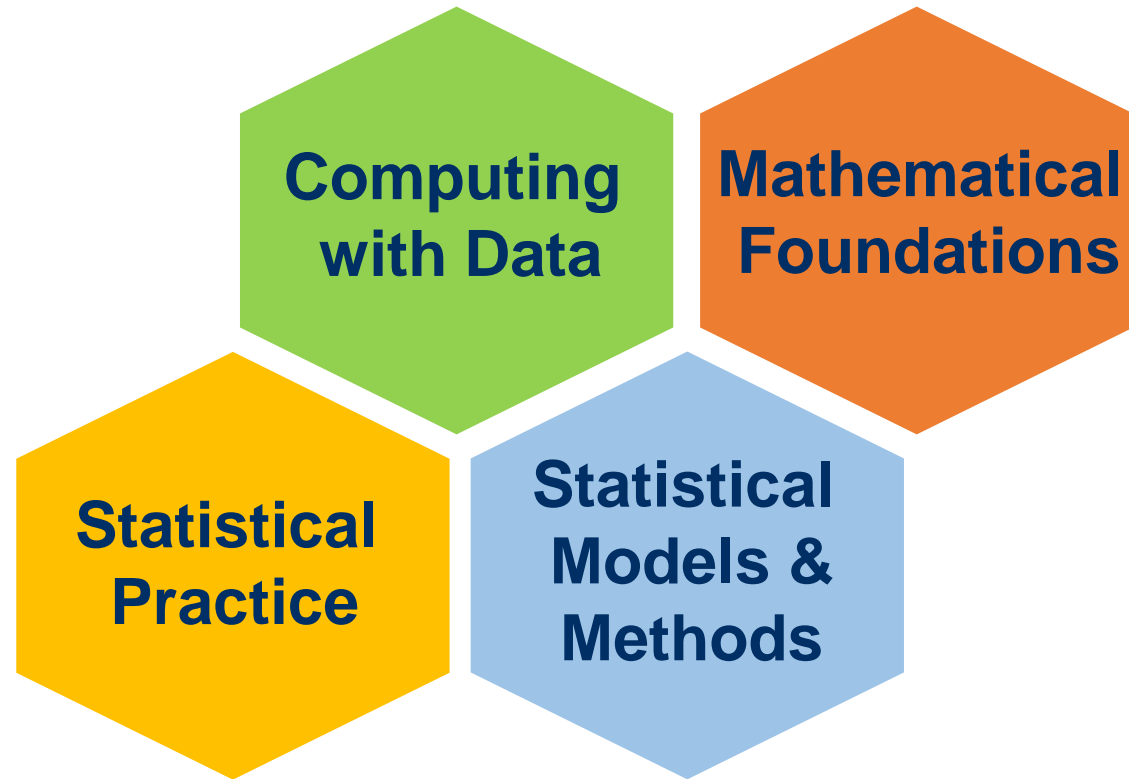
Role of Statistics

“Statisticians should engage with, learn from, teach, and work with other researchers in Data Management and Computation”

(ASA Statement on the Role of Statistics in Data Science, 2015)

Implications for Teaching Statistics

- Renewed emphasis on *Computation* and *Applications*
- *Integrated Approach*



(ASA Curriculum Guidelines, 2014)

Beyond Content

- Statistics experiencing “whitewater” conditions
- Updating content *not* enough
- Students must be able to *adapt* to changing conditions



Adaptive Expertise

Two types of expertise (Hatano & Inagaki 1984):

Routine Expertise

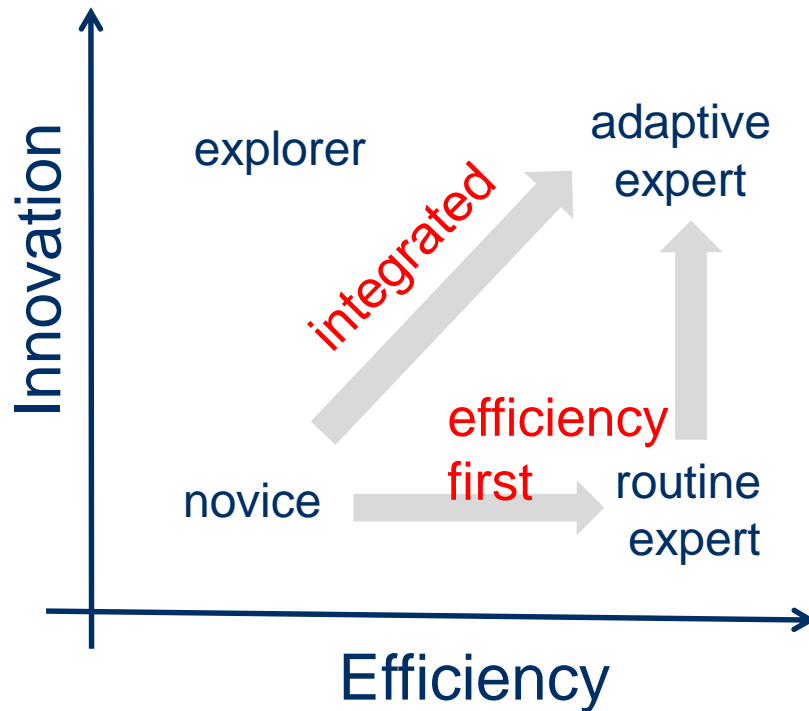
- Effectively *apply* skills & knowledge in *familiar settings*
- Extensive factual knowledge
- Experience with typical scenarios

Adaptive Expertise

- Effectively *transfer* skills & knowledge in *novel situations*
- Extensive conceptual knowledge & metacognition
- Creativity and innovation

Developing Adaptive Expertise

- Paths through *Innovation* – *Efficiency* space



(Schwartz, Bransford & Sears, 2005)

- Principles for Innovation

Introduce
Variation

Encourage
Experimentation

Emphasize
Understanding

(Hatano and Inagaki, 1986)

An Adaptive Statistical Mindset

- Traits of adaptive *statistical* experts

Inquisitiveness

Spirit of Inquiry

**Motivated to
explore &
discover**

Statistical
Thinking

**Approach to
problem solving**

**Encompass
entire analysis
process**

Extroversion

**Collaboration &
Communication**

**Interact at
different levels &
contexts**

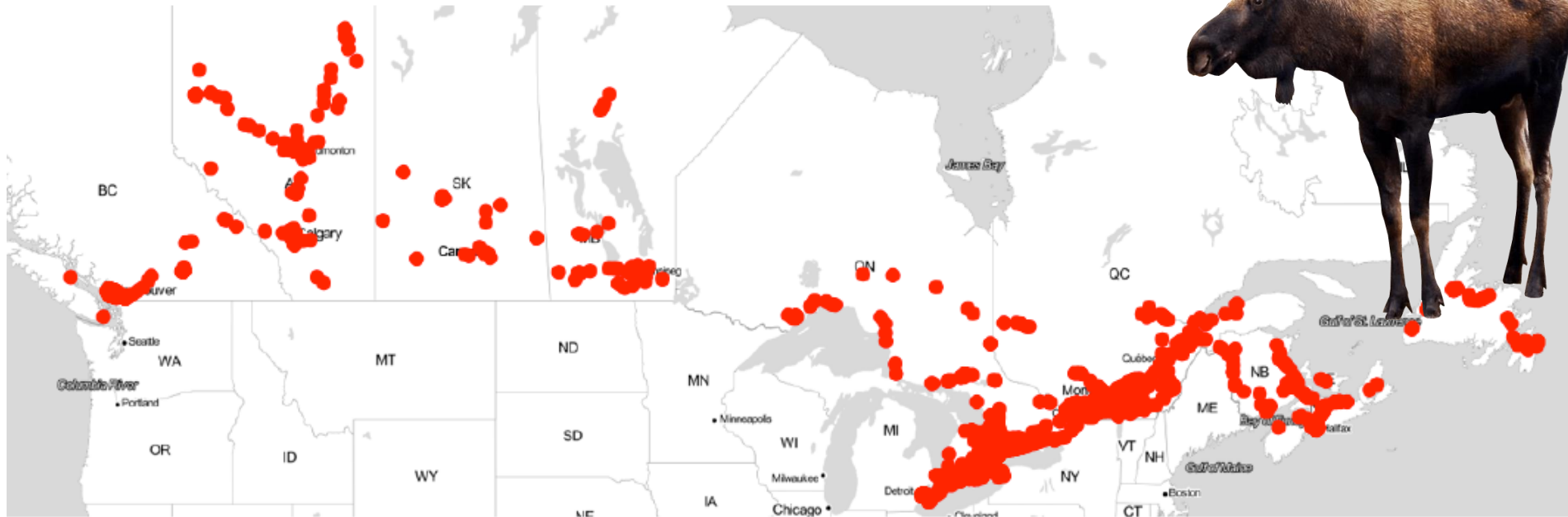
UofT Experience

- First year survey courses*: inculcation of the discipline & its core ways of thinking
- Introduce tools and methods for exploring data, statistical estimation & inference, and predictive modeling
- Main goal: by end of course, *students should be able to creatively address a problem using data, while demonstrating appropriate statistical thinking, and sharing their results*

(* STA130 Intro to Stats Reasoning & DS @ UofT
STAA57 Intro to DS @ UofT Scarborough)

Open Ended Investigations

- Students given road accident data
- Asked to define hazardous driving



Complex Real-World Data

- Students asked "is university education worth it?"
- Approach question with their own choice of data



CENSUS • RECENSEMENT



Statistics
Canada

Student Financial Survey
National Graduates Survey
Labour Force Survey
Canadian Income Survey



Collaborative Work

- Student collaboration in weekly labs & course project
- Emphasis on documenting and sharing results



Facilitated Problem Solving

- Students complete worksheets with help of TAs/Instructors
- Explore what-if type questions in low-stakes setting



Authentic Assessment

- Computer-based exams; students asked to analyse unknown data on the spot



Strategies for an Adaptive Statistical Mindset

Qualities	Inquisitiveness	Statistical Thinking	Extroversion
Open-ended Investigations	✓	✓	✓
Complex, real-world data	✓	✓	
Collaborative Work			✓
Facilitated Problem Solving		✓	✓
Authentic Assessment	✓	✓	

Thank You!

References

- van Dyk, D., Fuentes, M., Jordan, M., Newton, M., Ray, B.K., Temple Lang, D. & Wickham, H. (2015). ASA Statement on the Role of Statistics in Data Science. *AmStat News*, October 2015.
- American Statistical Association (ASA) Undergraduate Guidelines Workgroup. (2014). 2014 Curriculum Guidelines for Undergraduate Programs in Statistical Science. Alexandria, VA: American Statistical Association.
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- Schwartz, D.L., Bransford, J.D., & Sears D. (2005). Efficiency and Innovation in Transfer. In *Transfer of Learning in a Modern Multidisciplinary Perspective* (pp. 1-51), Information Age Publishing.

University of Toronto courses

- <http://sta130.utstat.utoronto.ca>
- <http://www.utsc.utoronto.ca/~sdamouras/STAA57>