PREPARING OUR STUDENTS FOR UNKNOWN CHALLENGES

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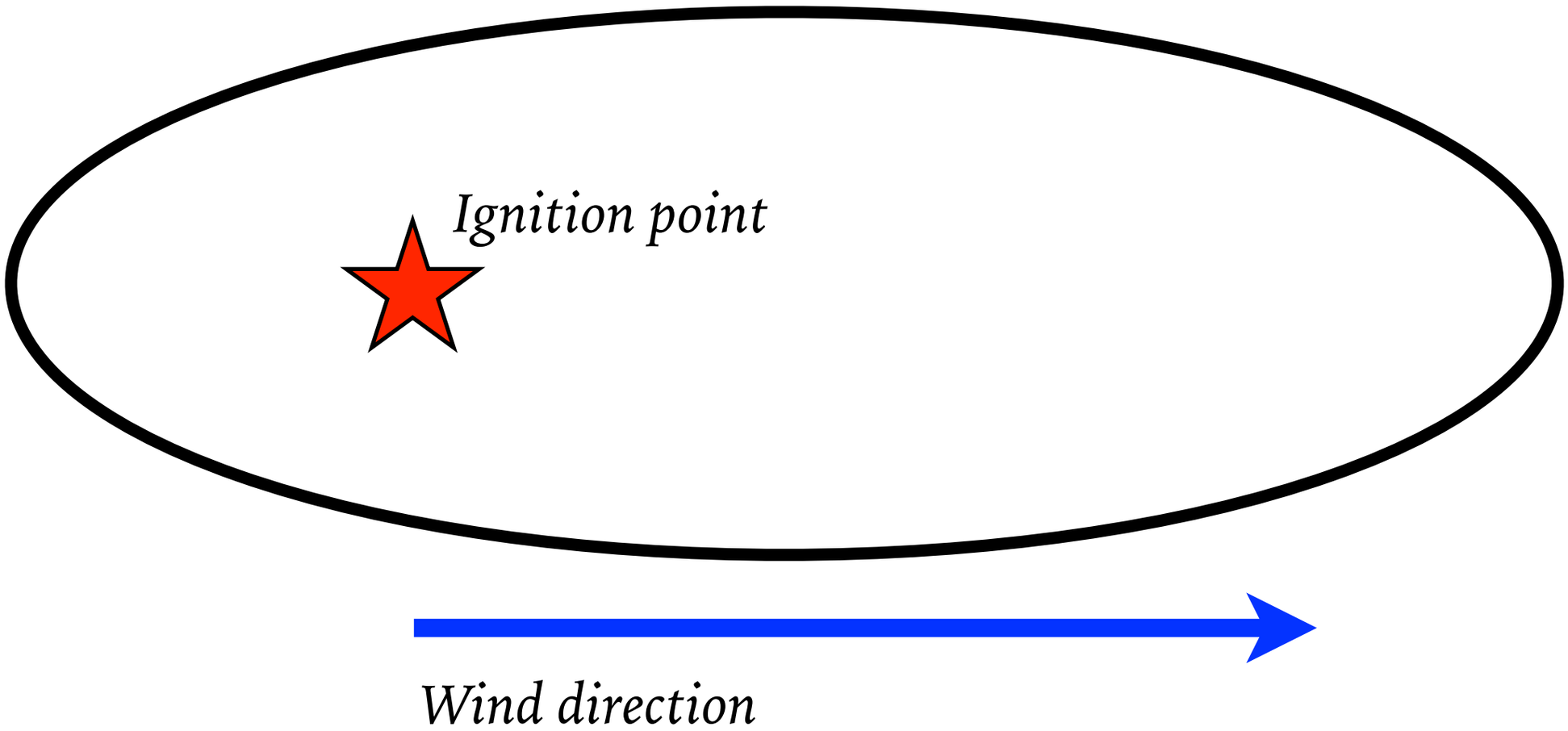
Fort McMurray, Alberta
2016
Canada
NUNAVUT
Northwestern Passages
Hudson Bay
YUKON TERRITORY
NORTHWEST TERRITORIES
ALBERTA
MANITOBA
BRITISH COLUMBIA
SASKATCHEWAN
ONTARIO
QUEBEC
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
OREGON
Ottawa
Montreal
Toronto
NB
PE
VT
Google

Where will the fire spread to be at a certain time?

Authorities used a model based on historical data, with inputs for weather, fuel, and topography.



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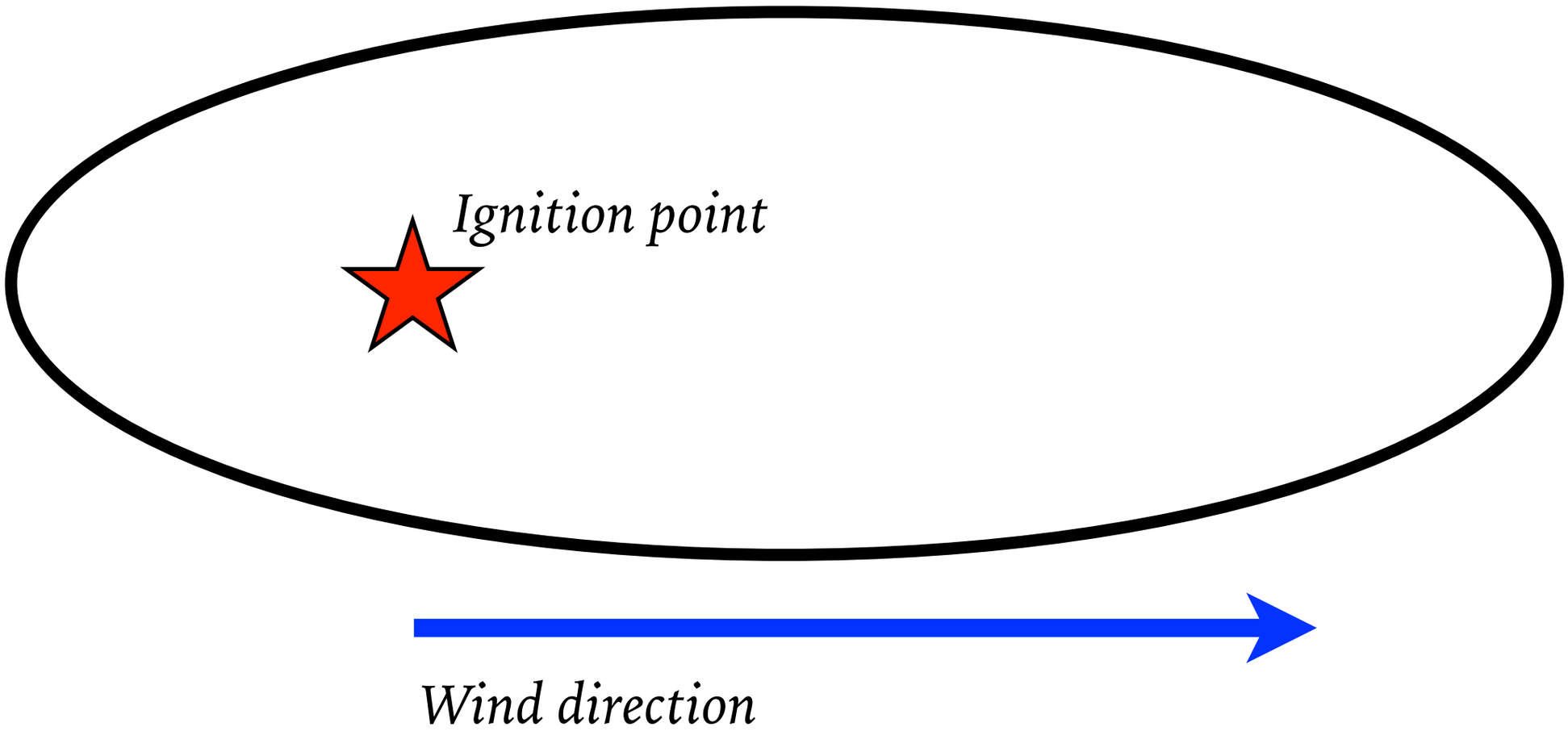


At noon, the model estimated that the fire would reach the town limits at 11pm.

Is it too early to divert resources to the evacuation?

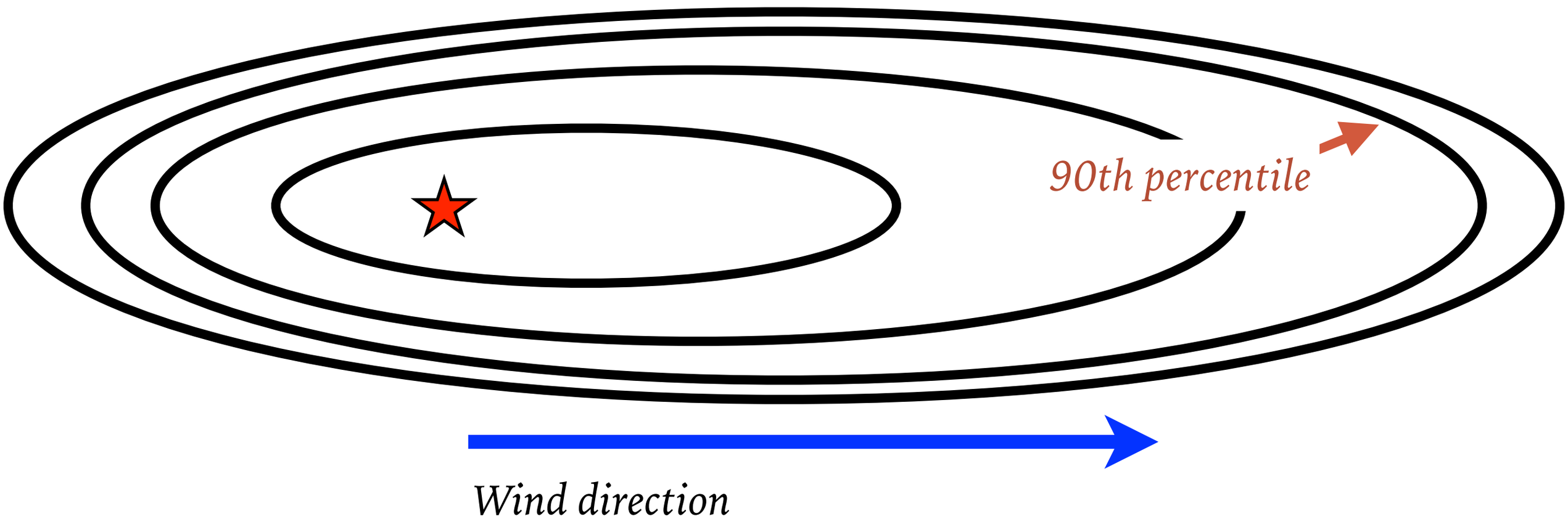
They had 11 hours. Was it too early to divert resources to the evacuation?

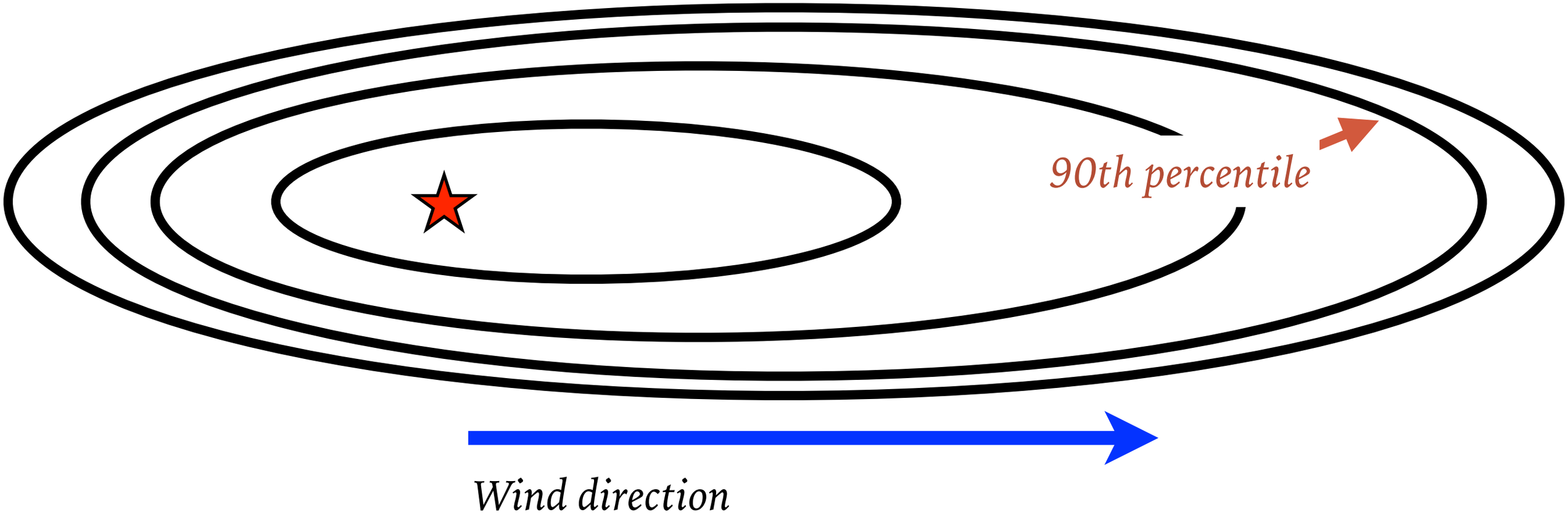
The fire reached the city limits in 6.5 hours.

The post-mortem analysis:

Add in some statistical thinking…

- The model relied on inputs they could explain: some are observable and some not observable.
- The statistician exploited the unexplained variation in the historical data to create a probability distribution of envelopes for the fire spread.





The 90th percentile of the distribution estimated the arrival of the fire in town within 20 minutes of its actual arrival time.

What did statistical thinking bring?
A focus on the data, skepticism of the estimate, and comfort with unexplained variation.

Think about both what you can explain and what you can’t

Miracle Cat Survives 20-Story Fall From Upper West Side Apartment Building

By Maurice DuBois July 13, 2011 at 11:45 pm **Filed Under:** Barry Myers, Gloucester, Manhattan, Maurice DuBois, miracle cat, New York City, Upper West Side

Who, What, Why: How do cats survive falls from great heights?

25 March 2012

Share

How cats can survive falling 32 stories high with limited injuries

Uma Sharma and Shira Polan Nov. 5, 2018, 9:00 AM

1987 study:

- 132 cats
- Fell from high-rise building
- Brought to a NYC emergency veterinary clinic
- 90% of treated cats survived
- Only 37% needed emergency treatment to keep them alive
- Cats who fell less than 6 stories had more serious injuries than cats who fell from higher stories

1987 study:

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- Fell from
- Brought t y clinic
- 90% of treated cats survived
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CATS ARE AMAZING!

1987 study:

- 132 cats
- Fell from
- Brought t y clinic
- 90% of treated cats survived
- Only 37% needed emergency treatment to keep them alive

These are the cats that were brought to the vet

Think about both what you observe and what you don’t

The Economist

Topics Current edition More

Regulating the internet giants

The world's most valuable resource is no longer oil, but data


PETER B. VAILL
Author of Managing as a Performing Art
LEARNING
AS A
WAY
OF
BEING
Strategies for Survival in a World of Permanent White Water

“

We must prepare our students for jobs that do not yet exist … and to take on roles for which they cannot ready themselves ahead of time.

-University of Toronto, Towards 2030 (2008)

“

Never become so much of an expert that you stop gaining expertise. View life as a continuous learning experience.

-Denis Waitley

AN ADAPTIVE EXPERT

AN EXPERT

- Has extensive knowledge
- Has skills to apply that knowledge quickly and efficiently
- In settings seen before

- Can transfer knowledge in novel or complex situations
- Can create new procedures in novel or complex situations
- Is flexible
- Able to innovate
- Continuous learner
- Seeks challenges
- Creative
- Has better developed meta-cognitive skills

AN ADAPTIVE EXPERT

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Prepared for future learning:

- Cautious in applying past knowledge
- Know how to use technology / networks of expertise to learn
- Thinks and judges with the background of previous knowledge, even if that knowledge can't be recalled on demand

(Schwartz, Bransford, Sears 2005)

DEVELOPING ADAPTIVE EXPERTISE

- To help our students develop from routine to adaptive experts, the adaptive learning literature suggests we need to spend more time on the following educational approaches

Learning that emphasizes understanding	Opportunities to explore, discover, and struggle	Experience with lots of variations on problems

Learning that emphasizes understanding

- Not just procedural knowledge (how)
- Also conceptual knowledge (why)
- How knowledge connects

Opportunities to explore, discover, and struggle

- Learning activities that promote
  - synthesis
  - analysis
  - building knowledge and formulating strategies
- Expose students to
  - struggle
  - risk-taking
  - confronting errors and exceptions
- Have students reflect on and articulate the process

Experience with lots of meaningful variations

- See concepts in multiple contexts
- Focus on differentiation
- More than a store of exemplars
- Recognize when previously practiced procedures don't apply

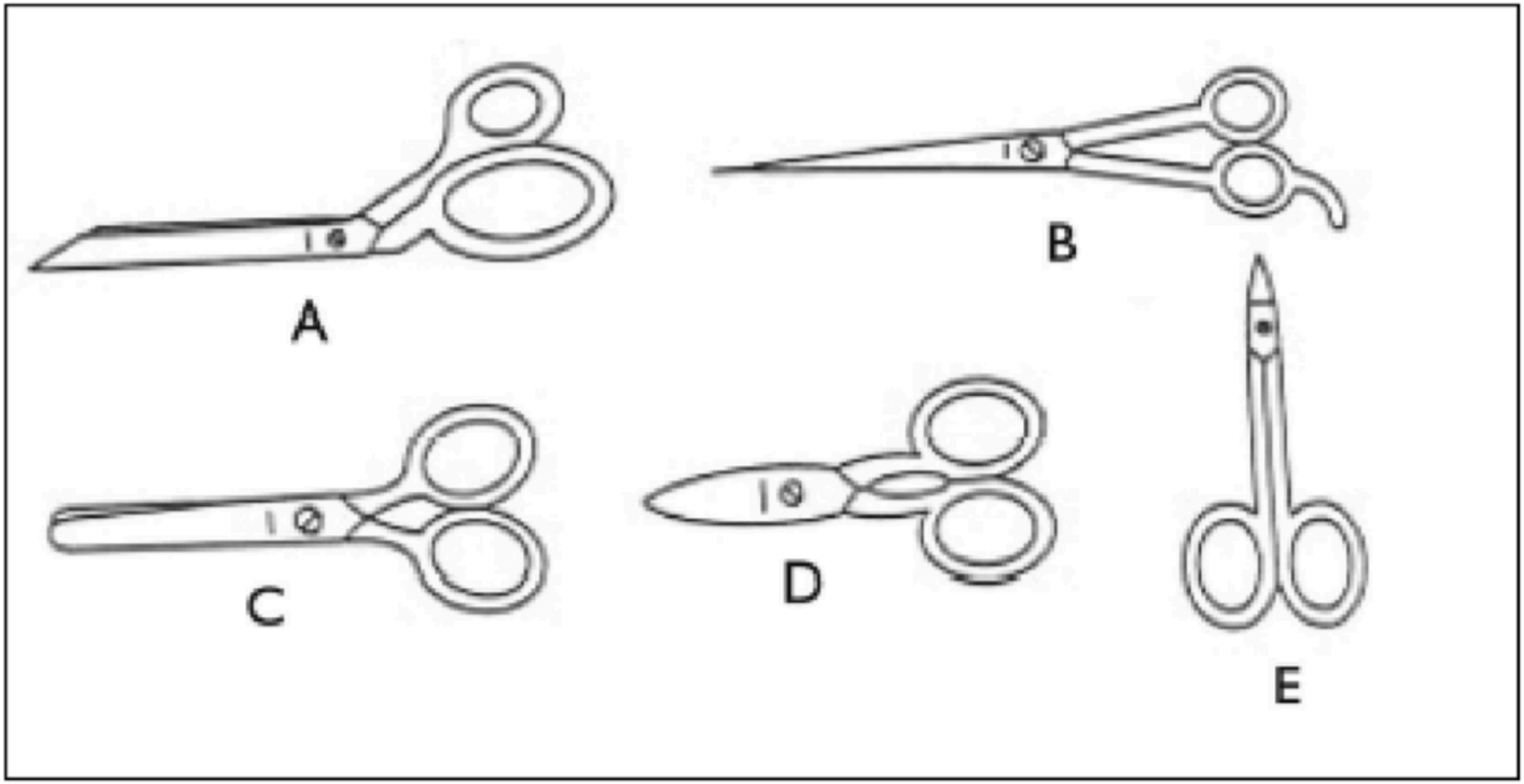


Figure 1.1. Noticing function–structure relations in scissors (Bransford & McCarrel, 1974).

Which pair of scissors is best for a new task?

DEVELOPING ADAPTIVE EXPERTISE

- To help our students develop from routine to adaptive experts, the adaptive learning literature suggests we need to spend more time on the following educational approaches

Learning that emphasizes understanding	Opportunities to explore, discover, and struggle	Experience with lots of meaningful variations

- Grounded in core knowledge
- Socially significant contexts

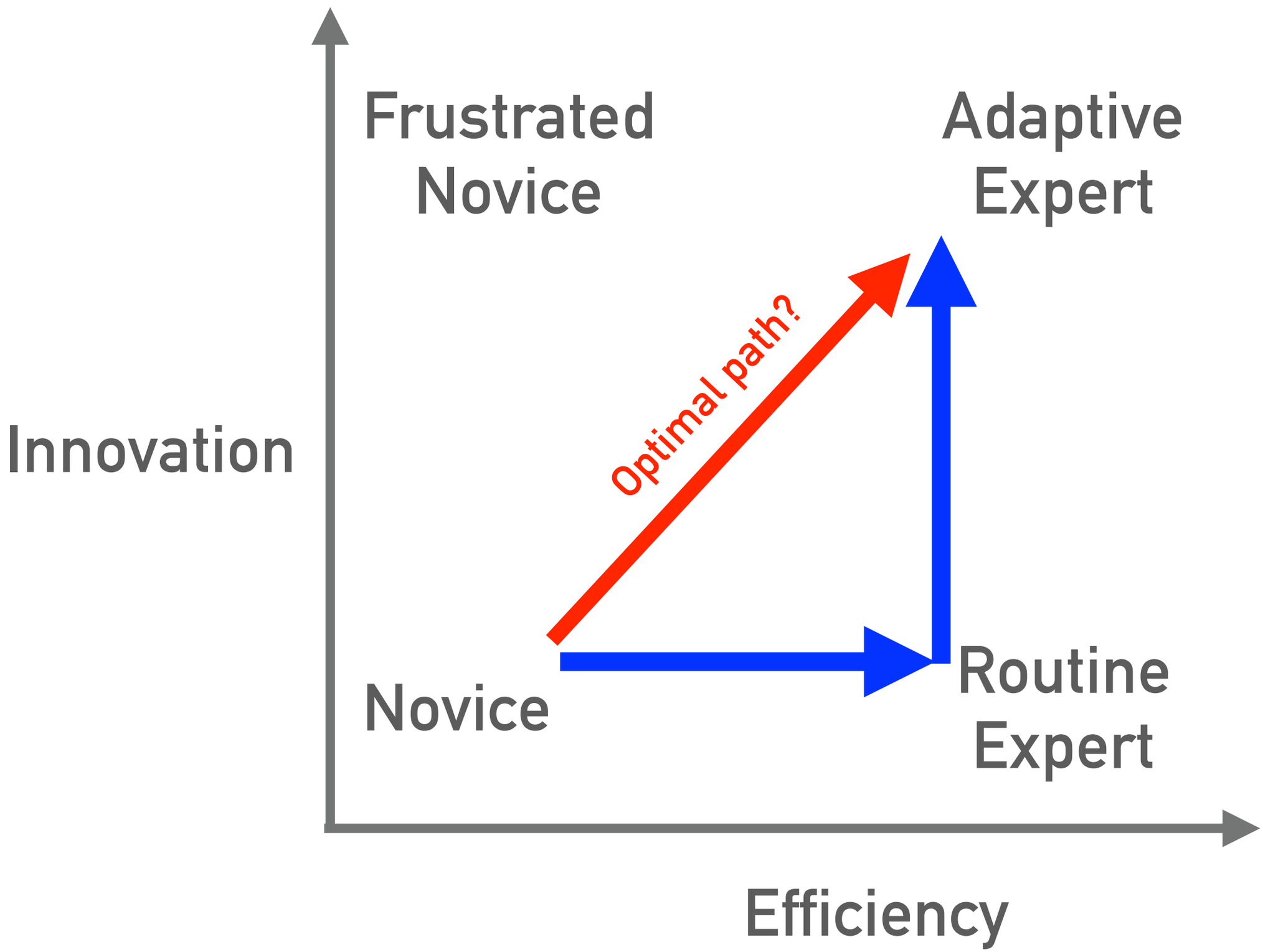
DEVELOPING ADAPTIVE EXPERTISE

- To help our students develop from routine to adaptive experts, the adaptive learning literature suggests we need to spend more time on the following educational approaches

Learning that emphasizes understanding	Opportunities to explore, discover, and struggle	Experience with lots of meaningful variations

- In an environment that:
  - is open to new ideas
  - tolerates mistakes
  - has high expectations

A PATH TO ADAPTIVE EXPERTISE



Develop efficiency and innovation starting in the first course

A FIRST COURSE: OUR CHOICES

- audience?

  majors

- survey of discipline or build foundations?

  survey

THE CONTEXT

- First year course

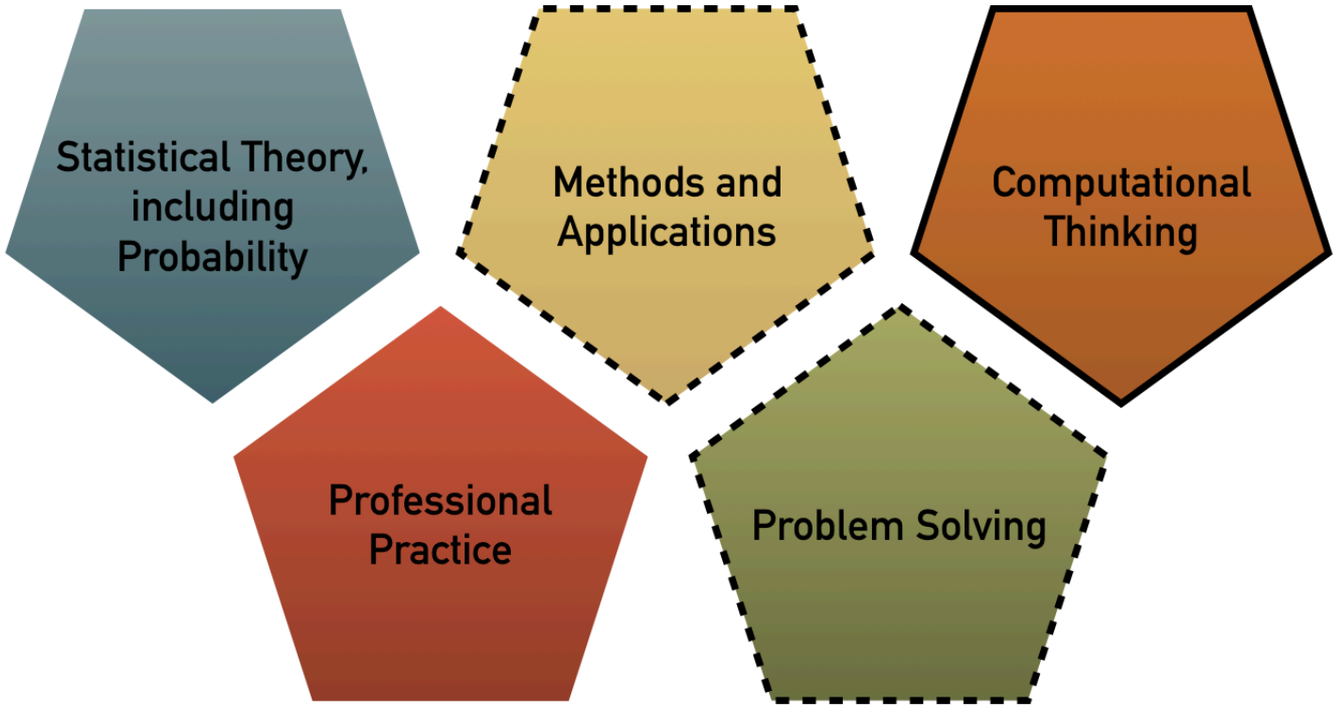
  STA130:

  Introduction to Statistical Reasoning and Data Science

  ~1000 students per year

A FIRST COURSE: A SURVEY COURSE

- Inculcation of the discipline, its core ways of thinking, types of arguments used, vocabulary
- Content can be varied, as long as all of the program learning outcome themes are introduced



A course goal:

By the end of the course, we want our students to be able to do something creative with data, while demonstrating appropriate statistical thinking

and be able to talk about it.

WHERE WE WANT STUDENTS TO BE AT END OF FIRST YEAR

<< Home

New Study: Be Alert to Moose Car Crash Risk

August 14, 2018

Author: Geotab, Data and Analytics Team

Like 9 Tweet G+ Share

A 2018 study by University of Toronto students using Geotab's Intelligence Data highlights the importance of being aware of hazardous driving areas, and particularly moose habitats. The risk of a moose car crash is no joke, especially considering the consequences. A collision with the animal which stands about 6 ft and weighing up to 1,500 lb could result in serious damage to a vehicle,

Headline:

"New Study: Be Alert to Moose Car Crash Risk"

WHERE WE WANT STUDENTS TO BE: AT END OF FIRST YEAR

<< Home

New Study: Be Alert to Moose Car Crash Risk

"Students from the first-year Statistical Reasoning and Data Science course were asked to conduct a statistical analysis based on Geotab's Intelligence Data from data.geotab.com and present their findings at a poster fair.

"Hazardous Driving Areas in Canada" was selected by the Geotab Data & Analytics team as the top presentation. Ruei-Hung Chen, Xuechun Qian, Zhenyu Xuan and Ziyang Li collaborated on this project looking at the severity of hazardous driving conditions in Canada.

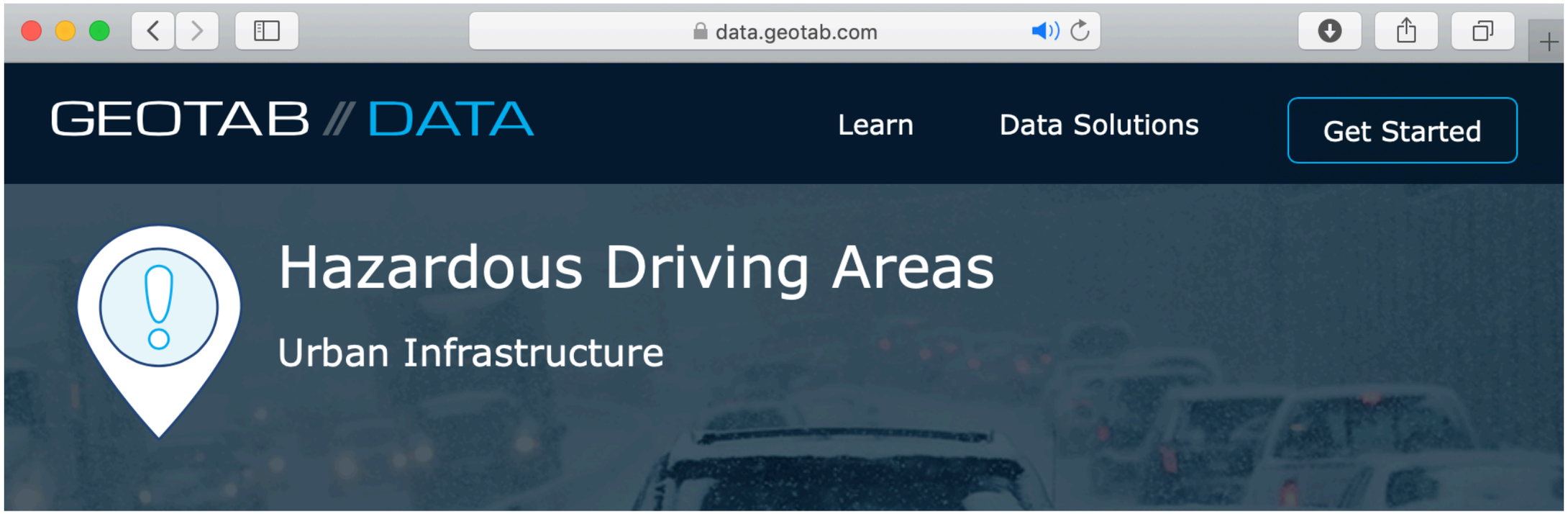
The study, carried out in early 2018, compares the severity score of each province in Canada and found that Newfoundland and Labrador was the most hazardous province for driving. The province with the lowest median was Manitoba.

The students found that Newfoundland and Labrador's median severity score was indeed the highest and statistically significantly different than the other provinces' median severity scores.

They pointed to the prevalence of highway accidents in Newfoundland and the high number of moose vehicle accidents reported as a possible explanation for the higher severity of hazardous driving."

importance of being aware of hazardous driving areas, and particularly moose habitats. The risk of a moose car crash is no joke, especially considering the consequences. A collision with the animal which stands about 6 ft and weighing up to 1,500 lb could result in serious damage to a vehicle,

FIRST YEAR COURSE: FINAL PROJECT DATA 2018



- Areas Of Idling
- Cell Coverage Dark Spots
- Hazardous Driving Areas
- Intersection Metrics
- Road Impediments
- Searching For Parking

Description

This dataset identifies hazardous areas for driving according to harsh braking and accident level events within a specific area. Each month a new set of dangerous driving areas is produced and encapsulates one year of rolling data (i.e. from the previous month back 1 year).

Associated with each area is a severity score that is based on the frequency of occurrences in the area and the severity of said occurrences.

Real-Time and Historical Incident Data for Accidents and Near-Miss Events

Around the world, over one million people die every year as a result of road traffic crashes, according to a study conducted by the World Health Organization (WHO). This number does not include the massive amount of non-fatal injuries and vehicle damage.

FIRST YEAR COURSE FINAL PROJECT 2018: HAZARDOUS DRIVING INCIDENTS

Given harsh braking, accident incidents, and an index measuring severity, location characteristics:

- What is hazardous driving?
- Where is there more hazardous driving?

Opportunity to creatively explore data, develop their own questions, in a context that is socially significant

FIRST YEAR COURSE FINAL PROJECT 2018: HAZARDOUS DRIVING INCIDENTS

Given harsh braking, accident incidents, and an index measuring severity, location characteristics:

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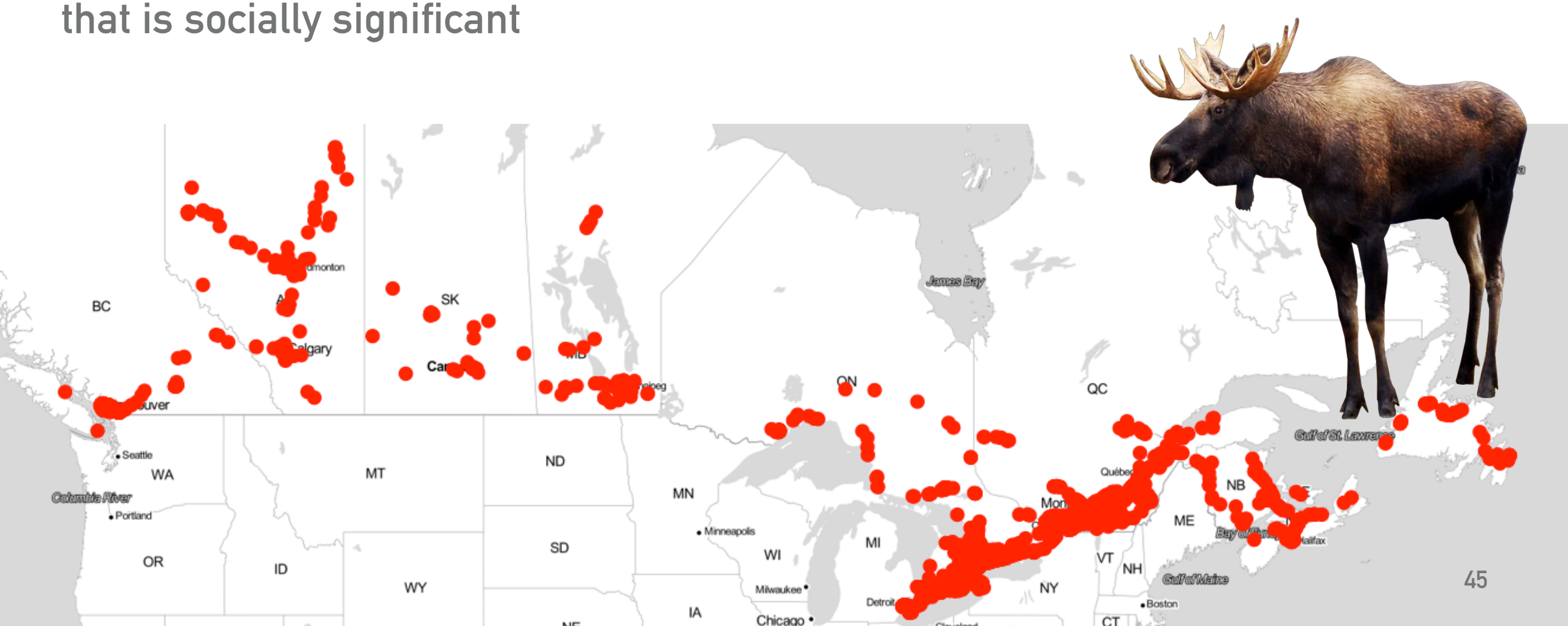
Opportunity to creatively explore data, develop their own questions, in a context that is socially significant



A FIRST COURSE: STRUCTURE

Mondays

- Large lecture sections
- Data stories
- A new idea or method each week

- Practice problems
- One solution brought to tutorial for grading and discussion

Fridays

- Small group tutorials
- Random group assignments each week
- Oral or written communication exercise each week

Project

A FIRST COURSE: DEVELOPING ADAPTIVE EXPERTISE

Mondays

- Large lecture sections
- Data stories
- A new idea or method each week

- Socially significant contexts in data stories
- Introduction to statistical methods for
  - summarizing
  - testing
  - estimation
  - prediction
- Encourages developing understanding of the similarities and differences in statistical thinking in these approaches and the related data stories

A FIRST COURSE: DEVELOPING ADAPTIVE EXPERTISE

Mondays

- Large lecture
- Data s
- A new
  method each
  week

- Socially significant contexts in data stories
- Introduction to statistical methods for

DEVELOPMENT OF ADAPTIVE EXPERTISE:

- **the ideas that connect diverse approaches**

encourages developing understanding of the similarities and differences in statistical thinking in these approaches and the related data stories

A FIRST COURSE: DEVELOPING ADAPTIVE EXPERTISE

- Practice problems

- One solution brought to tutorial for grading and discussion

Practice problems

- ask students to extend what was done in lecture (for example, categorical predictor variables with 3 levels vs 2) and see variations on it
- collect results from simulations; results discussed in tutorial

A FIRST COURSE: DEVELOPING ADAPTIVE EXPERTISE

DEVELOPMENT OF ADAPTIVE EXPERTISE:

- **confronting variations**

for grading and
discussion

Practice problems

- ask students to extend what was done in lecture (for example, categorical predictor variables with 3 levels vs 2) and see variations on it
- collect results from simulations; results discussed in tutorial

A FIRST COURSE: DEVELOPING ADAPTIVE EXPERTISE

- In small groups, students reflect and articulate on concepts (for example, comparing, combining results from simulations)
- Prompt questions are often “why?” or “what if?”
- Environment where discussion and new ideas are encouraged and mistakes are welcomed as learning opportunities (assessment criteria has high weight on participation and communication)

Fridays

- Small group tutorials
- Random group assignments each week
- Oral or written communication exercise each week

A FIRST COURSE: DEVELOPING ADAPTIVE EXPERTISE

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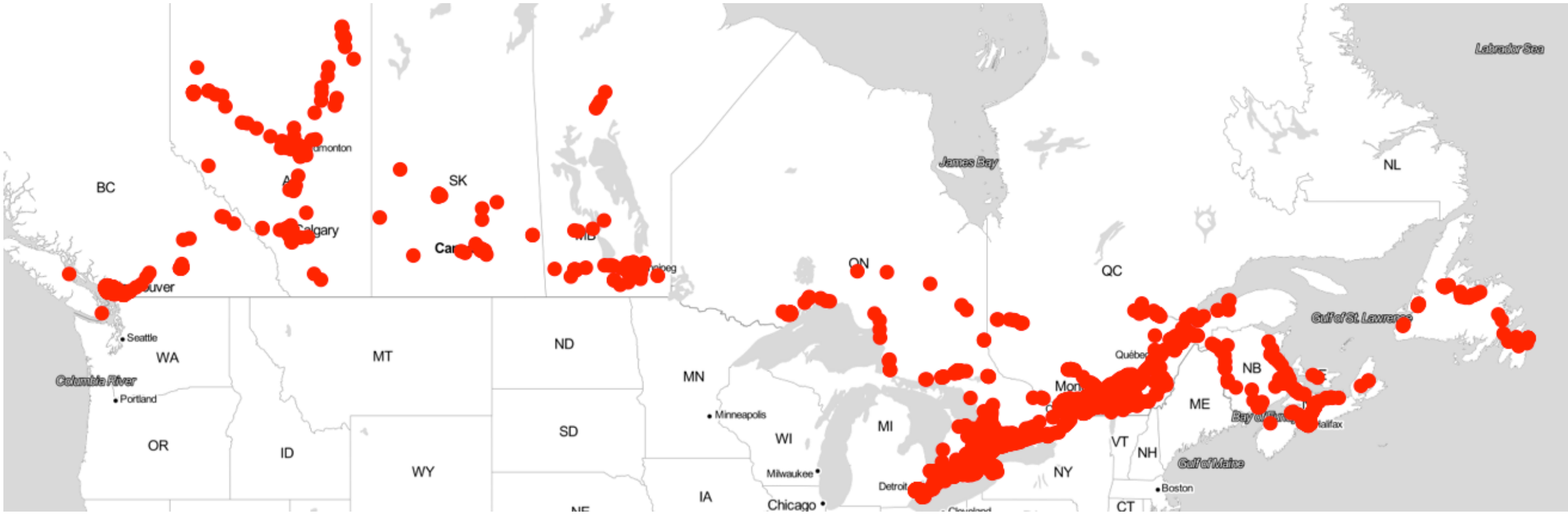
DEVELOPMENT OF ADAPTIVE EXPERTISE:

- mistakes are tolerated
- struggling through misconceptions is encouraged
- "why?"
- reflect on and articulate the process

A FIRST COURSE: DEVELOPING ADAPTIVE EXPERTISE



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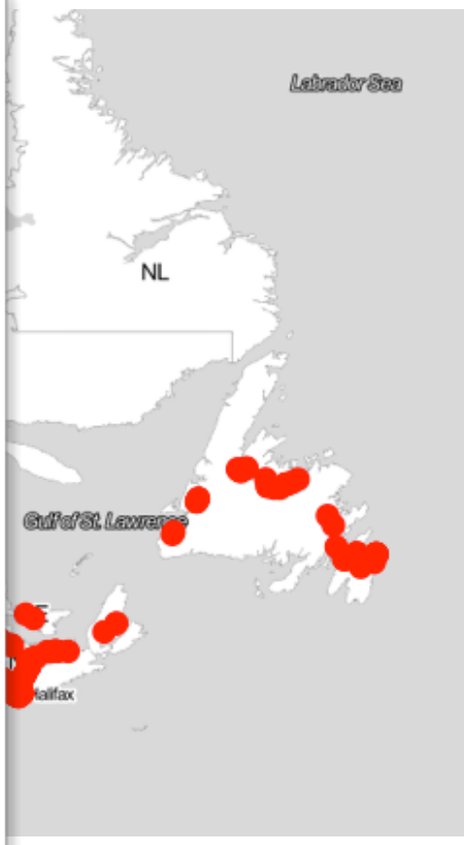
Project

A FIRST COURSE: DEVELOPING ADAPTIVE EXPERTISE



DEVELOPMENT OF ADAPTIVE EXPERTISE:

- socially significant context
- novel situation
- formulate multiple strategies
- synthesis of course concepts
- exploration & innovation encouraged
- high expectations

Given harsh b … erity, location characteristic

- What is ha
- Where is there more hazardous driving?

Project

ASSESSING ADAPTIVE EXPERTISE

How would you design an assessment to capture development of adaptive expertise?

… at scale …

“

You must continue to gain expertise, but avoid thinking like a *[routine]* expert.

-Denis Waitley

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