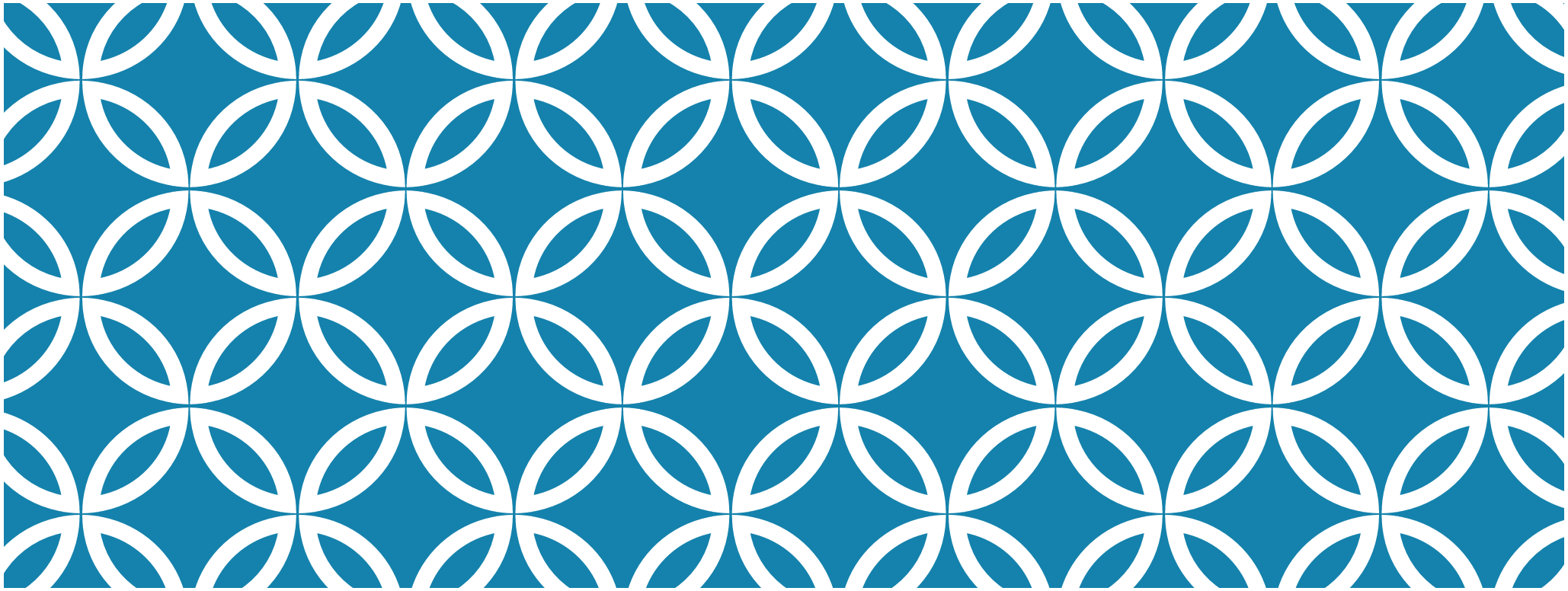


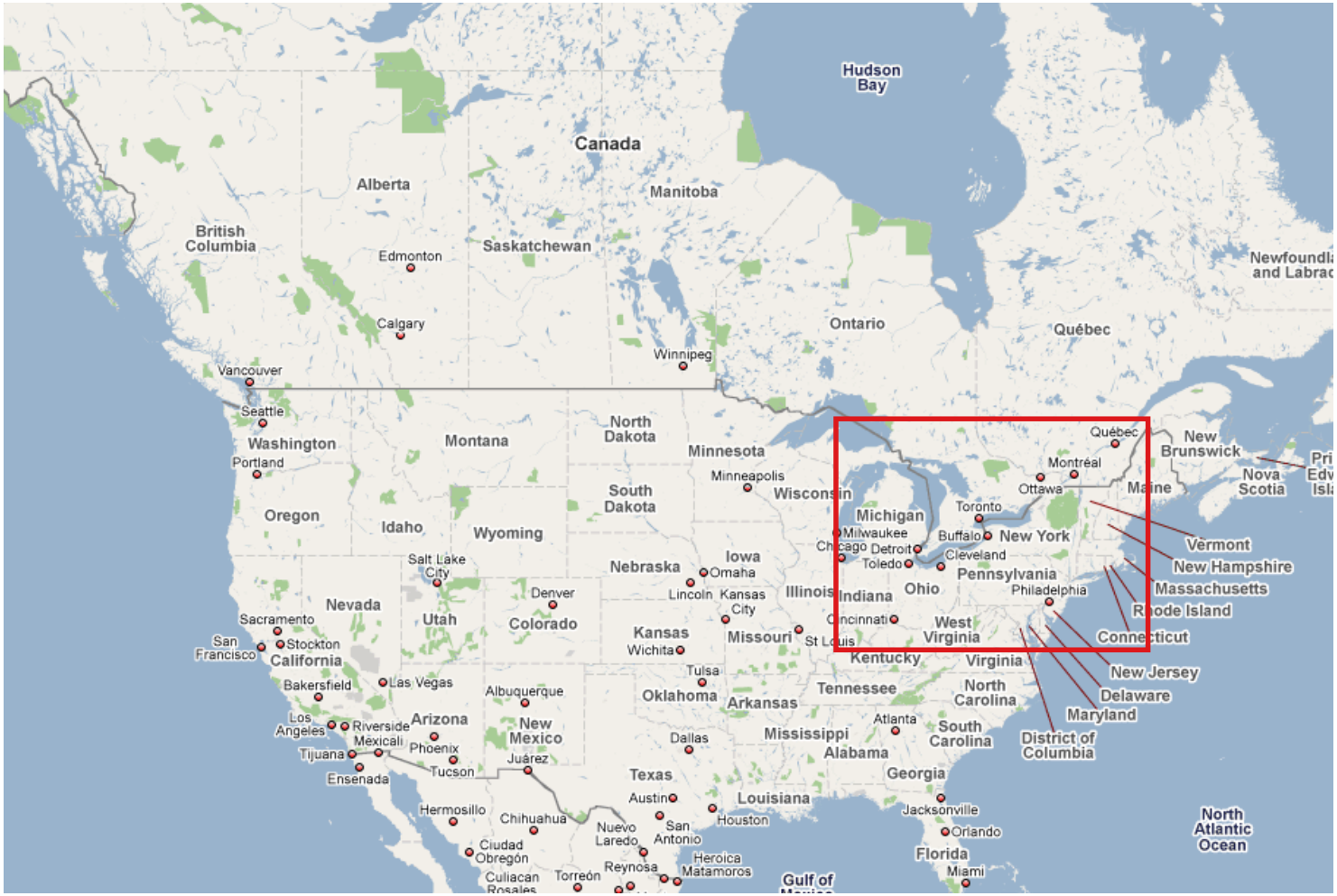
RESEARCH METHODS IN NETWORKS AND SYSTEMS

S. Keshav
School of Computer Science
University of Waterloo

August 14, 2018

WATERLOO?

Where is that?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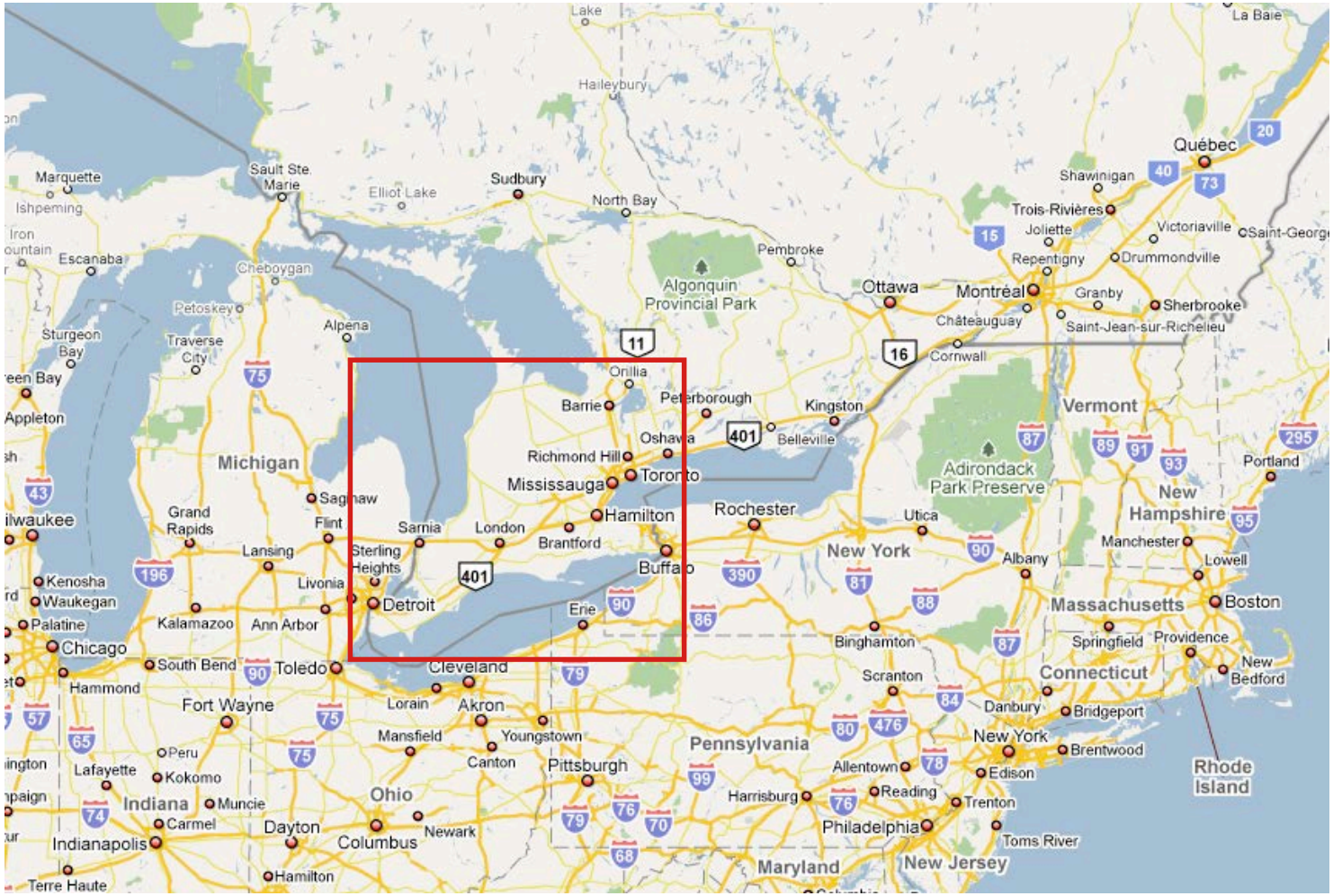
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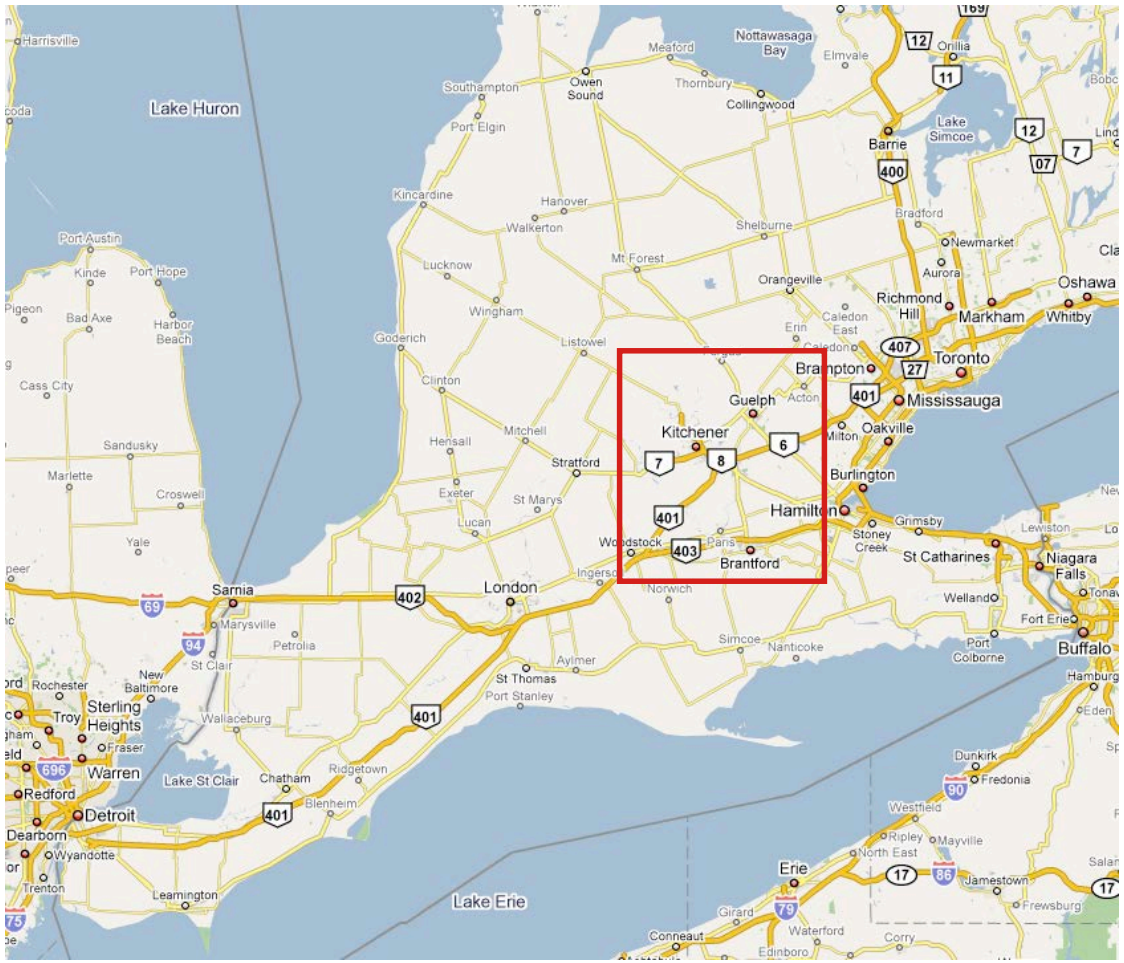
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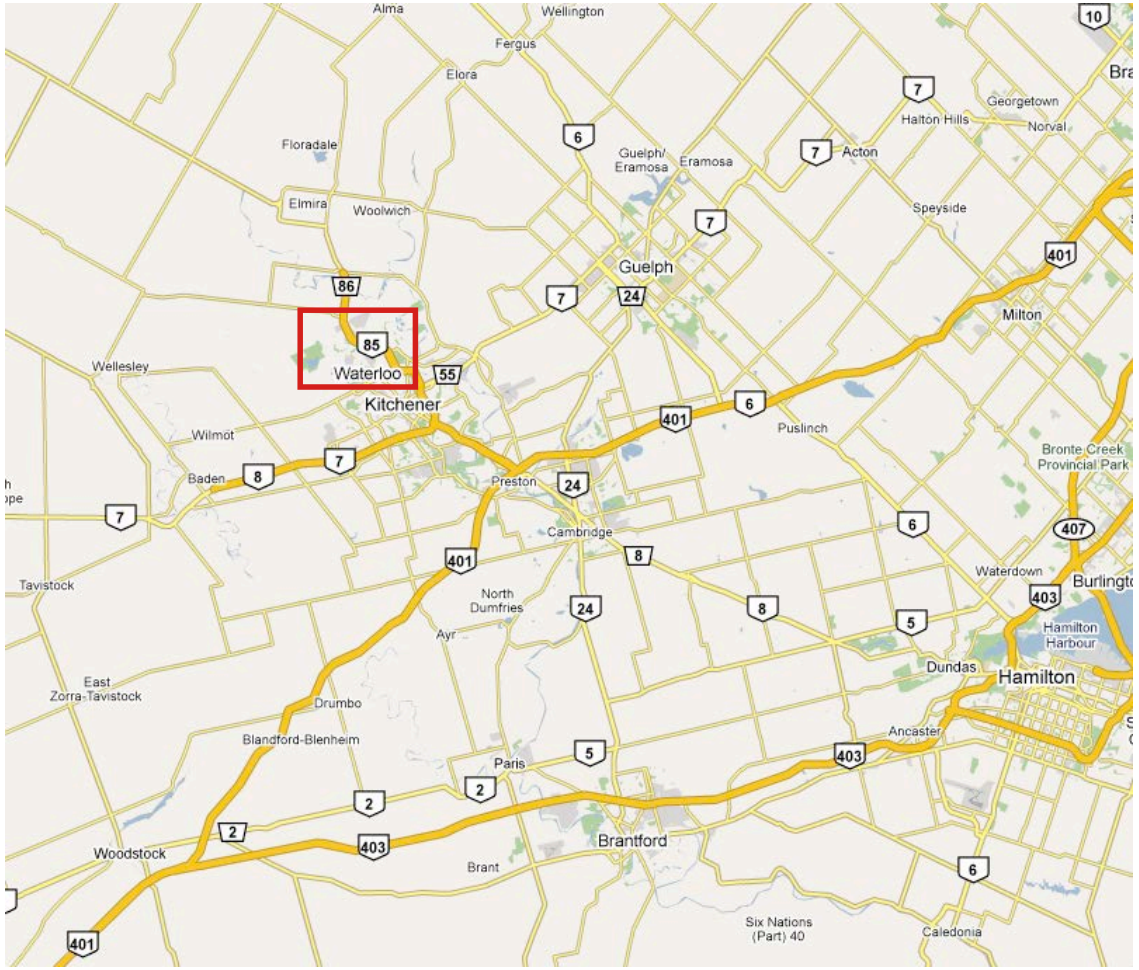
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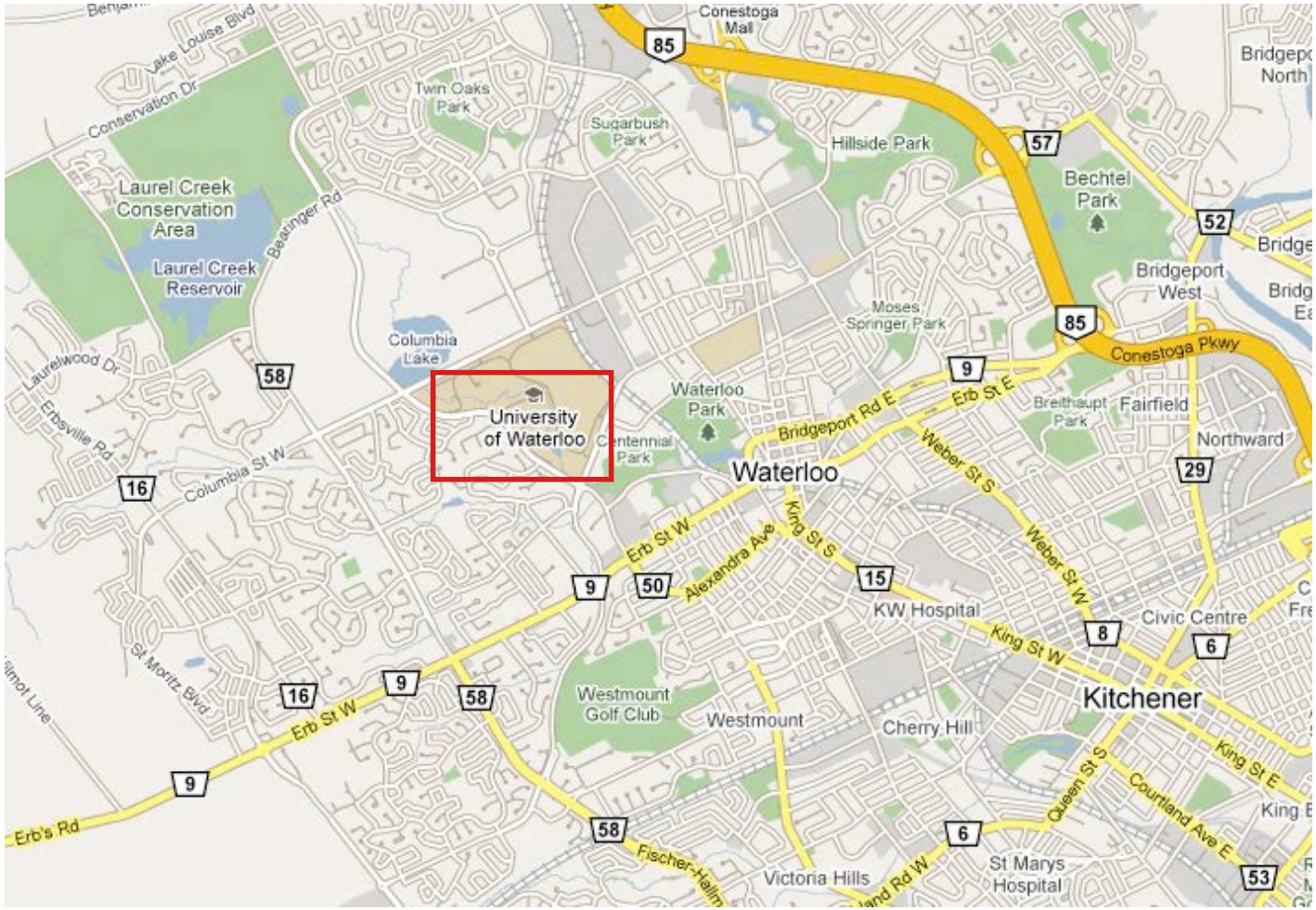
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University of Waterloo
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Breithaupt Park
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Civic Centre
Weber St W
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Westmount
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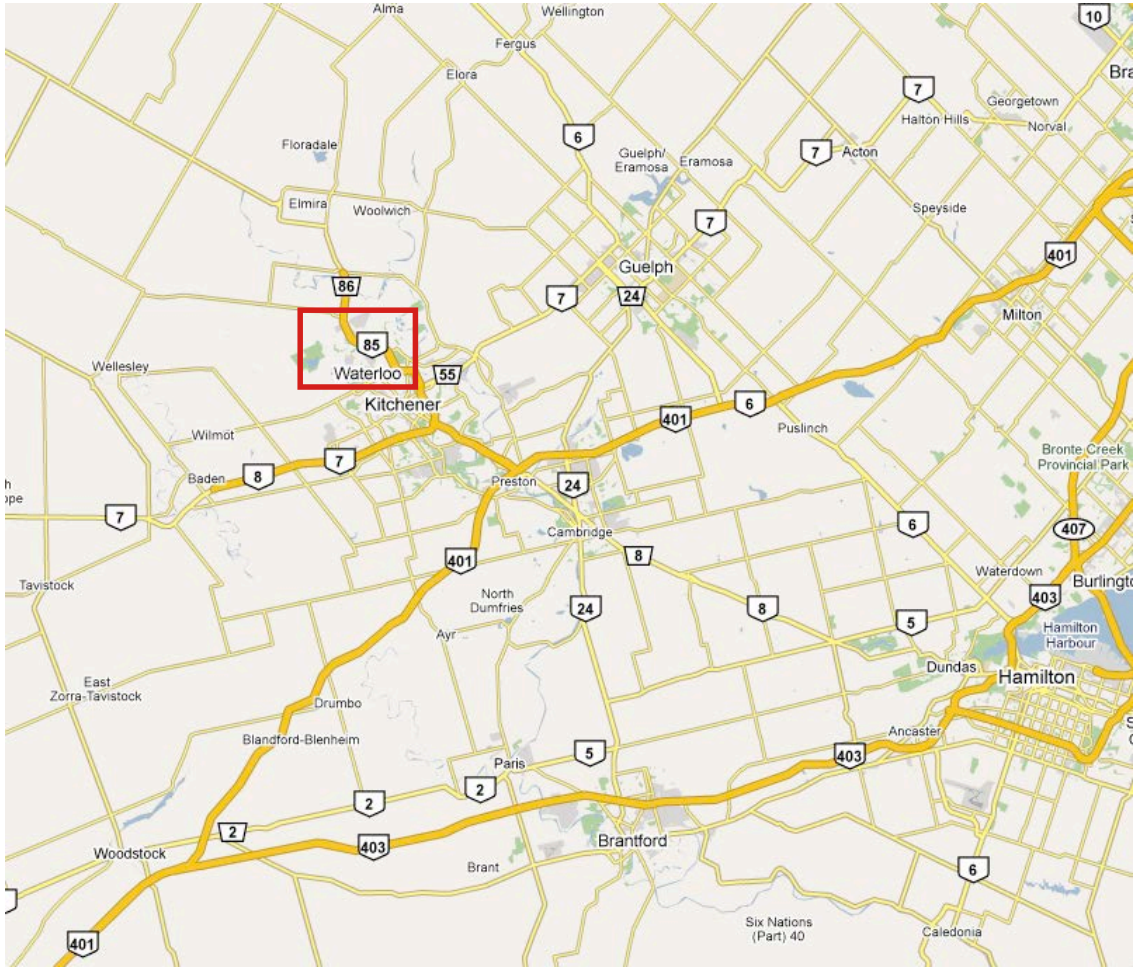
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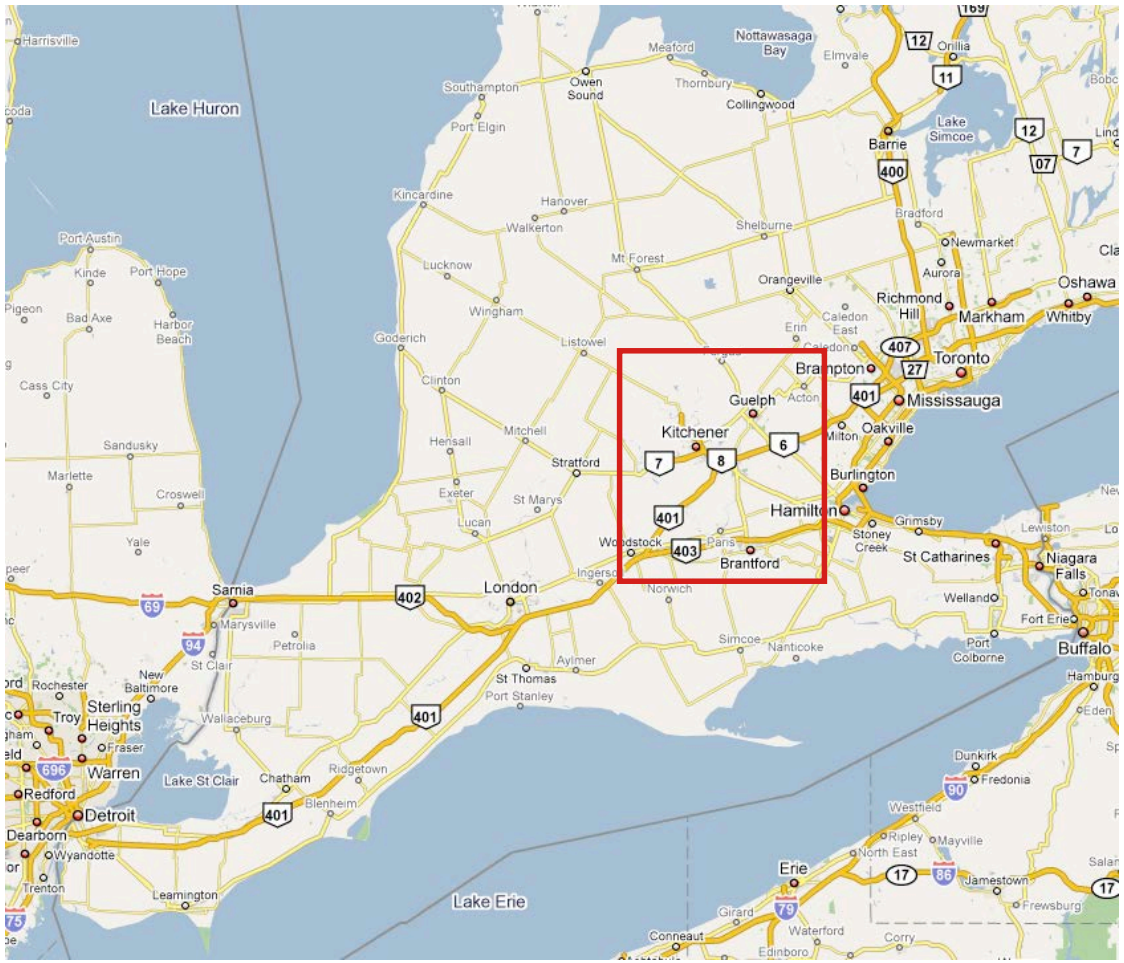
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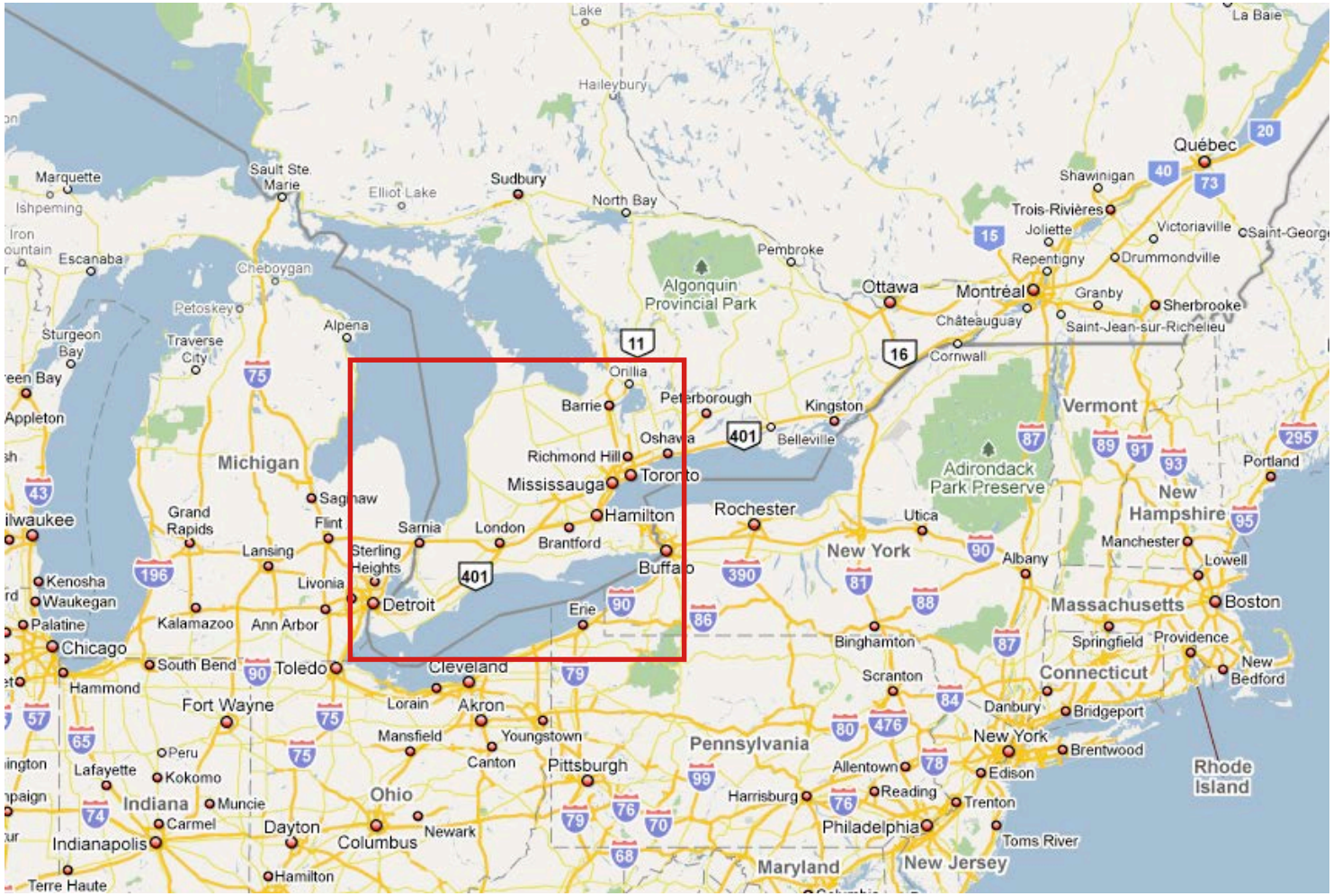
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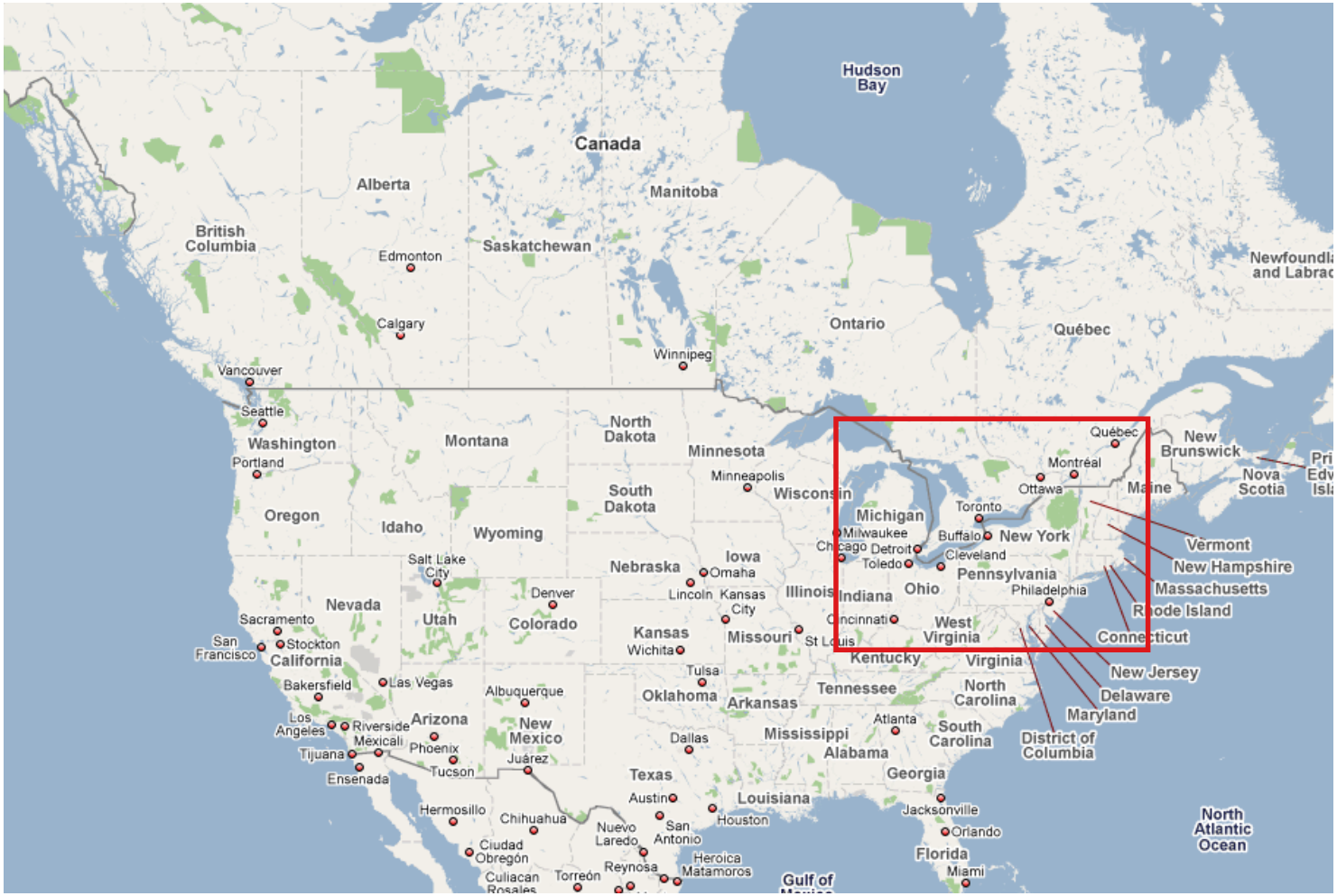
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RIM/Blackberry
Sybase/SAP
Maplesoft
Google, Square,
Clearpath, Vidyard, Thalmic + 1200 more startups
Perimeter Instititute for Theoretical Physics

AGENDA

1. Hints for doing GREAT research
2. How to read a paper
3. How to do a literature survey
4. How to give a talk
5. Q&A

HINTS FOR DOING **GREAT** RESEARCH

GREAT RESEARCH

Grounded

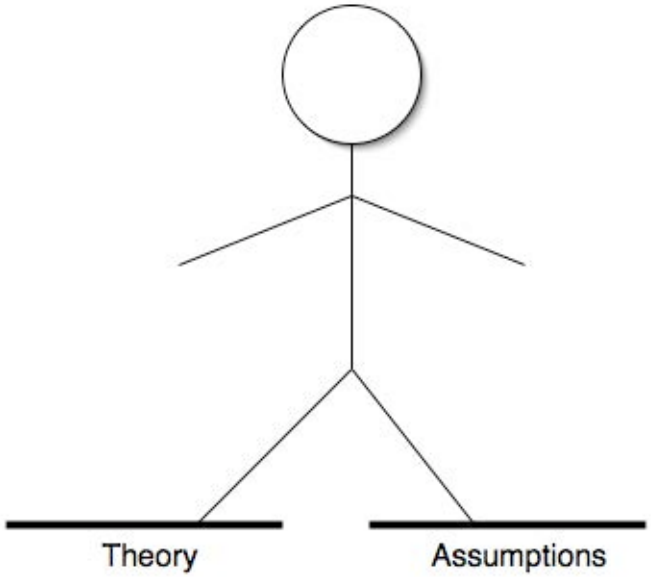
Risky

Ethical

Absorbing

Thorough

GROUNDED



GROUNDED

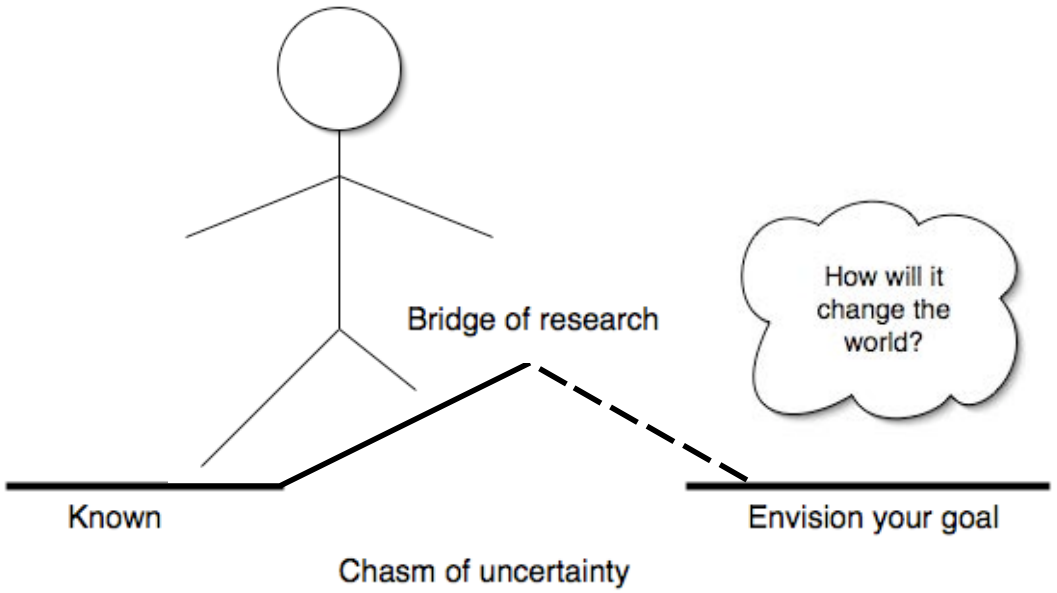
Look for gap between hype and reality

Use appropriate theory

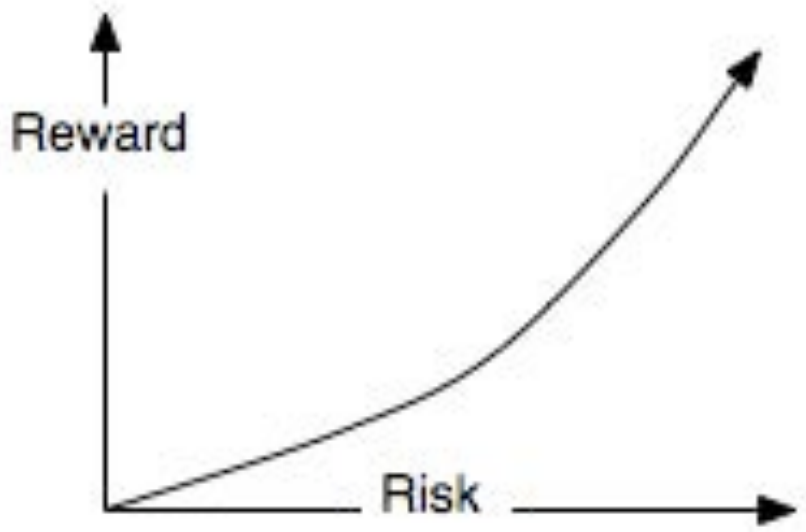
Assumptions are critical

- Be the harshest critic of your own work
- Prepare to move on

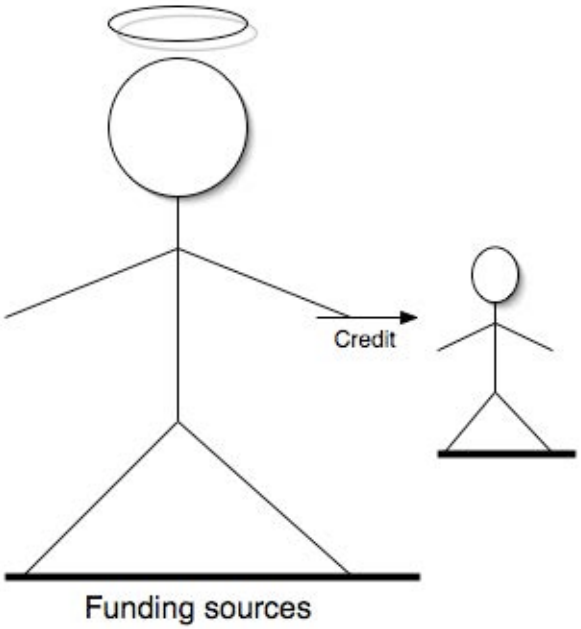
RISKY


Bridge of research
How will it change the world?
Known
Envision your goal
Chasm of uncertainty

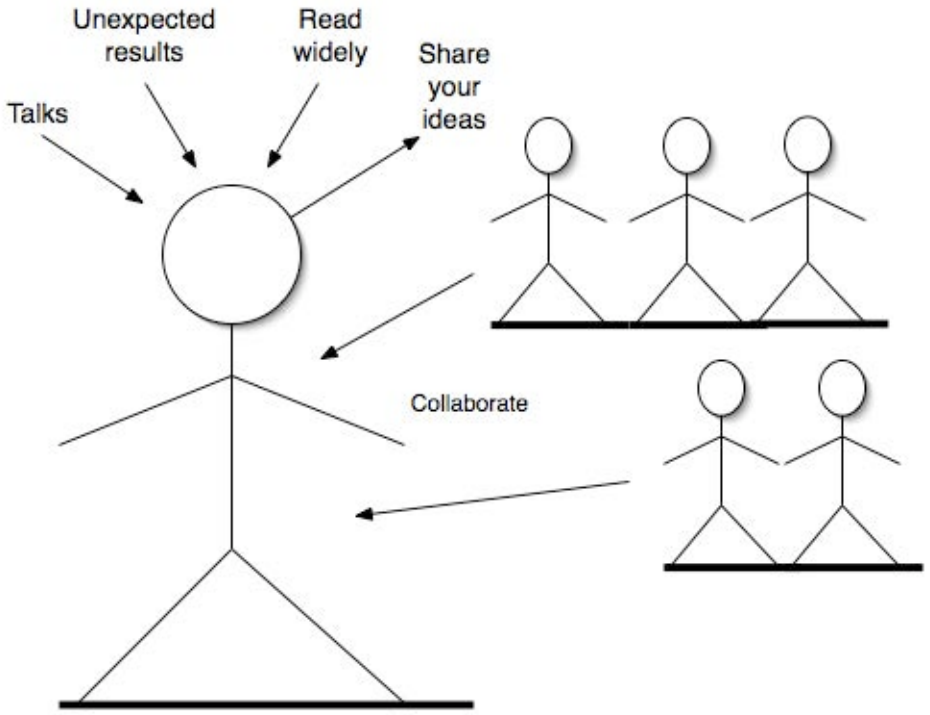
RISKY



ETHICAL



ABSORBING


Unexpected results
Read widely
Share your ideas
Talks
Collaborate

ABSORBING

Be passionate

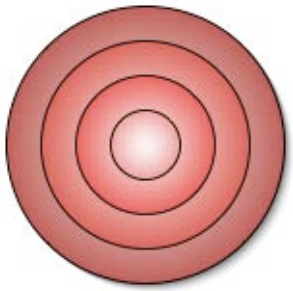
Read widely

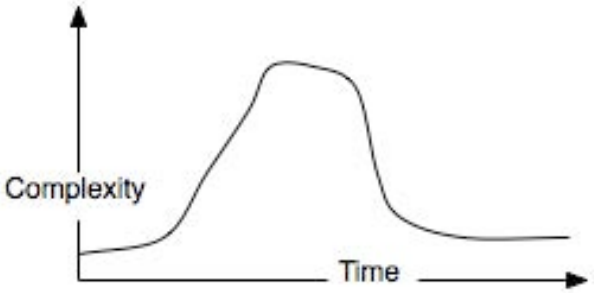
Attend diverse talks

Share your ideas

- Maintain a research site

THOROUGH





BEING THOROUGH

Always begin with a literature survey

Start with the simplest non-trivial instance

Learn as you go

Prepare to change

Crystallize solutions

Keep an eye open for the unexpected

Carry a notebook

ON WRITING PAPERS

Publish, but not at any cost

- Quality trumps quantity

Avoid gratuitous math

Fuzzy writing indicates fuzzy thinking

Use the one week rule

Hone your writing and thoughts

Rejection strengthens your work

ON ATTENDING TALKS

Take detailed notes

Ask questions

- It keeps you from sleeping

THE BOTTOM LINE

Have fun doing research!

- You're not going to make any money anyway

HOW TO READ A PAPER

KEY IDEA

Don't read linearly. Instead, make three passes:

- Pass 1: General idea
- Pass 2: Basic content, but not details
- Pass 3: In-depth understanding

FIRST PASS

- Bird's eye view : 5-10 minutes

1. Title, abstract, introduction
2. Section and subsection headings
3. Conclusions
4. Glance over references

AFTER THE FIRST PASS…

You should be able to answer the "five Cs":

1. Category: What type of paper?
2. Context: What other papers is it related to?
3. Correctness: Do assumptions seem valid?
4. Contributions: Main contributions?
5. Clarity: Well-written?

SECOND PASS

- Read carefully, but ignore details
  - proofs, for example
- ~ 1 hour
- Figures, diagrams, illustrations, graphs.
  - Properly labeled? Error bars? Etc…
- Mark relevant unread references
- After, should be able to summarize main thrust

THIRD PASS

"Virtually re-implement" the paper

- Identify and challenge assumptions
- ~ 1 – 5 hours

Jot down ideas for future work

After, be able to:

- Reconstruct entire structure of paper from memory
- Identify strong and weak points
- Pinpoint implicit assumptions, missing citations to related work, issues with experimental or analytical technique

HOW TO DO A LITERATURE SURVEY

FIRST…

Use Microsoft Academic or Google Scholar and well-chosen keywords to find 3-5 recent papers

- Do first pass read of each
- Read related work section of each
- Find a good survey in related work?

PHASE 2

- If you didn't find a good survey already:
  - Find shared citations, repeated author names
  - Download key papers, set aside
  - Go to websites of key researchers
    - Where have they published recently?
    - What are the top conferences?

PHASE 3

Go to web sites of top conferences

- Look through recent proceedings
- Identify recent, high-quality related work

Make 2nd pass through papers from these phases …

3rd pass on most promising

ITERATE . . .

HOW TO GIVE A RESEARCH TALK

OUTLINE

Preparation

Presentation

RULE 1: TELL A STORY

Background
- "Once upon a time, …"

Problem
- "The ogre ate all the apples, so the children went without…"

Solution
- "The anti-ogre fence…"

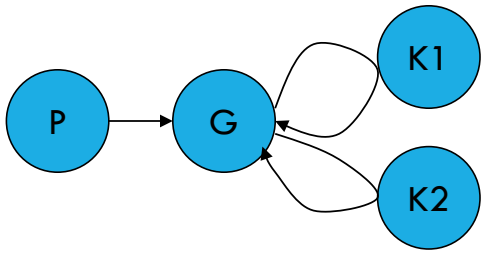
Evaluation
- "Ogre infestations declined 58% over 5 years…"

Conclusions
- "We recommend anti-ogre fences"

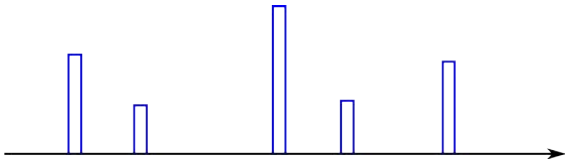
RULE 2: 1-2-3 RULE

One idea per slide

MICROBENCHMARKS



Traffic Model: Batched Poisson



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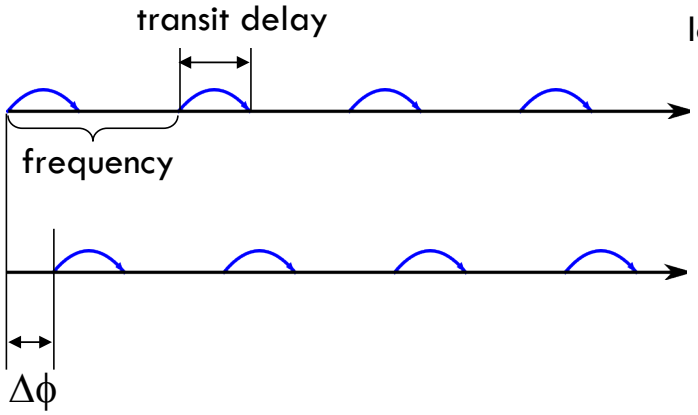

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Frequency	12 / day
Transit Delay	60 min
$\Delta\phi$	180°

RULE 2: 1-2-3 RULE

Two minutes per slide

30 minute talk: no more than 15 body slides

- unless very sparse
- like this talk!

RULE 2: 1-2-3 RULE

At most three topics

- figure them out first
- depends on the nature of the audience
- work backwards

RULE 3: USE OUTLINES

Outlines show connections

- as important as the details

Start with an outline

Repeat the outline or section title for each section

- 'roadmap'

RULE 4: USE FEW WORDS

"Words on presentation slides are a very good idea, but only when the audience is deaf."

- Prof. W. Cowan, University of Waterloo

FOR EXAMPLE…

A lush green valley in the Himalayas, looking down a thousand meters to stepped rice fields by a rushing river

RULE 5: USE FRIENDLY THEMES, FONTS AND COLOURS

KioskNet Architecture

Downlink Scheduling

- *Problem Definition*
- *Existing Approaches*
- *Our Solution*
- *Simulation*

Implementing the KioskNet System

Especially for graphs

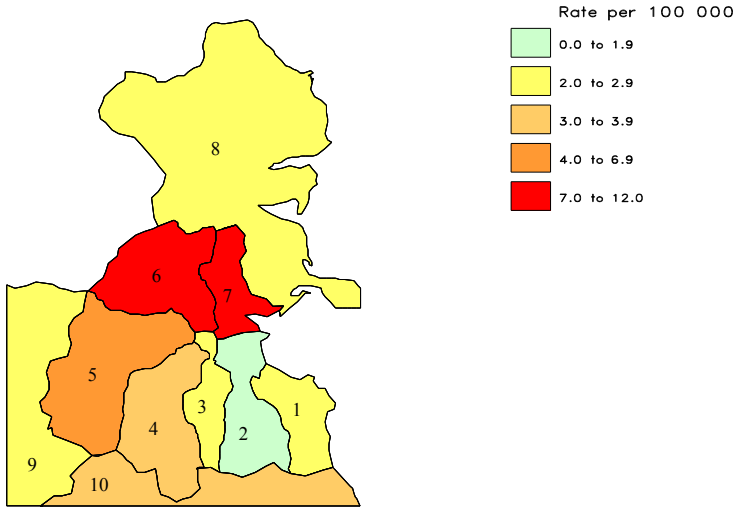
RULE 6: NEVER SHOW TABLES WHEN YOU CAN SHOW GRAPHS

Table 4. Cases of meningococcal disease in Dublin 1998 by area of residence

Area	Cases	
	n	%
1	2	5
2	1	3
3	2	5
4	2	5
5	8	22
6	7	19
7	10	27
8	2	5
9	2	5
10	1	3
Total	37	100

FROM EPINORTH.ORG

THE AREA MAP



From epinorth.org

RULE 7: TYPOS RELFECT PORELY ON YURE COMPTENCE

RULE 8: USE EXAMPLES

As in this talk!

RULE 9: AVOID COLLOQUIALISMS

It's like, duh

RULE 10: DESCRIBE RELATED AND PAST WORK

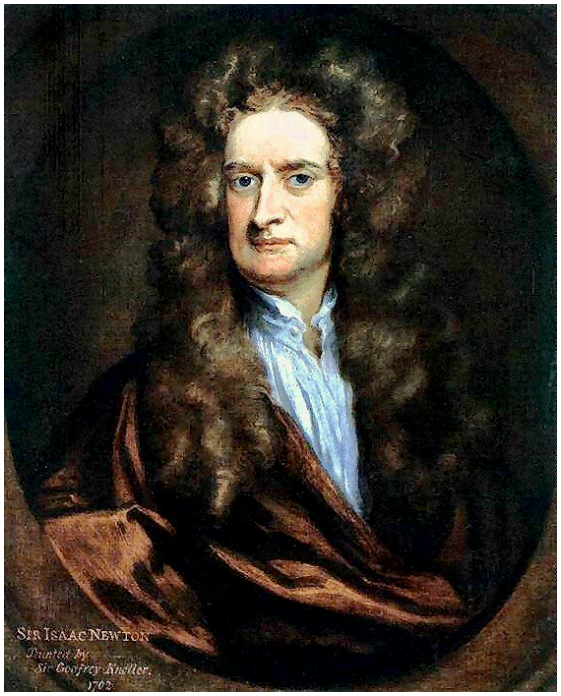
"If I have seen further it is only by standing on the shoulders of Giants."

Isaac Newton

RULE 4 &10: DESCRIBE RELATED AND PAST WORK

"If I have seen further it is only by standing on the shoulders of Giants."

Isaac Newton



RULE 11: TALK ABOUT YOUR CONTRIBUTIONS

Don't make the audience guess what they are

RULE 12: HIGHLIGHT INSIGHTS

The story behind the work is what audiences come to talks for

- What didn't work? Why?
- What would you do differently next time?

RULE 13: END WITH A SUMMARY SLIDE

Leave it up on the screen when you stop for questions

OUTLINE

Preparation

Presentation

RULE 1: TALK TO THE AUDIENCE, NOT THE SCREEN

Scan the audience, see if they are understanding

Pace your talk

RULE 2: NEVER READ FROM NOTES

Expand from ‘headlines’

RULE 3: WALK AUDIENCES THROUGH FORMULAE

$$\log N^*(t) = \log\left(\prod_{i=1}^{n} N^i\left(\frac{t}{\sigma}\right)\right) = \sum_{i=1}^{n} \log\left(N^i\left(\frac{t}{\sigma}\right)\right) \approx \sum_{i=1}^{n} \log\left(1 + \frac{(\sigma^i)^2}{2}\left(\frac{t}{\sigma}\right)^2\right) \quad \textbf{(EQ 14)}$$

It is easily shown by the Taylor series expansion that when h is small (so that h^2 and higher powers of h can be ignored) $\log(1+h)$ can be approximated by h. So, when n is large, and σ is large, we can further approximate

$$\sum_{i=1}^{n} \log\left(1 + \frac{(\sigma^i)^2}{2}\left(\frac{t}{\sigma}\right)^2\right) \approx \sum_{i=1}^{n} \frac{(\sigma^i)^2}{2}\left(\frac{t}{\sigma}\right)^2 = \frac{1}{2}\left(\frac{t}{\sigma}\right)^2 \sum_{i=1}^{n} (\sigma^i)^2 = \frac{1}{2}t^2 \quad \textbf{(EQ 15)}$$

where, for the last simplification, we used Equation 10. Thus, $\log N^*(t)$ is approximately $1/2\ t^2$, which means that

$$N^*(t) \approx e^{\frac{t^2}{2}} \quad \textbf{(EQ 16)}$$

RULE 4: ALWAYS INTRODUCE GRAPH AXES

RULE 5: SPEAK SLOWLY AND CLEARLY

Especially if you are not a native English speaker

and even if you are!

RULE 6: RESPECT QUESTIONERS

Hear questions fully

Defer them if needed

Remember the cry of distress: “Let’s take it offline”

RULE 7: PRACTICE MAKES PERFECT

Practice a talk at least three times

Talk in front of a mirror

Have it recorded, if possible

RULE 8: ARRIVE EARLY

Test your laptop or better yet, borrow one

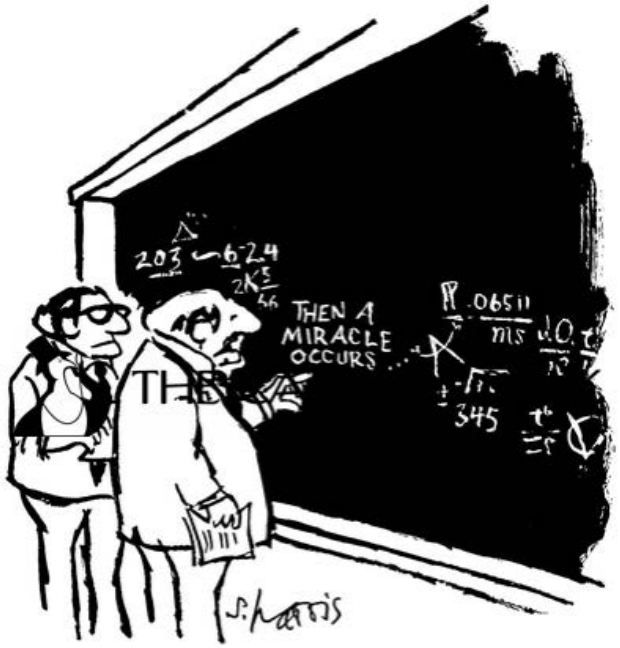
Bring a memory stick

Do the talk on a white/black board if necessary

RULE 9: BRING A POINTER

Laser, stick, or pen

RULE 10: A LITTLE HUMOUR GOES A LONG WAY



"I think you should be more explicit here in step two."

From *The New Yorker*

RULE 11: END ON TIME

Keep track of the time

SUMMARY

Rule 1: Tell a story

Rule 2: 1-2-3 rule

Rule 3: Use outlines

Rule 4: Use few words

Rule 5: Use friendly themes, fonts and colours

Rule 6: Never show tables when you can show graphs

Rule7: Typos relfect porely on ur comptence

Rule 8: Use examples

Rule 9: Avoid colloquialisms

Rule 10: Describe related and past work

Rule 11: Talk about your contributions

Rule 12: Highlight insights

Rule 13: End with a summary slide

Rule 1: Talk to the audience, not the screen

Rule 2: Never read from notes

Rule 3: Walk audiences through formulae

Rule 4: Always introduce graph axes

Rule 5: Speak slowly and clearly

Rule 6: Respect questioners

Rule 7: Practice makes perfect

Rule 8: Arrive early

Rule 9: Bring a pointer

Rule 10: A little humour goes a long way

Rule 11: End on time