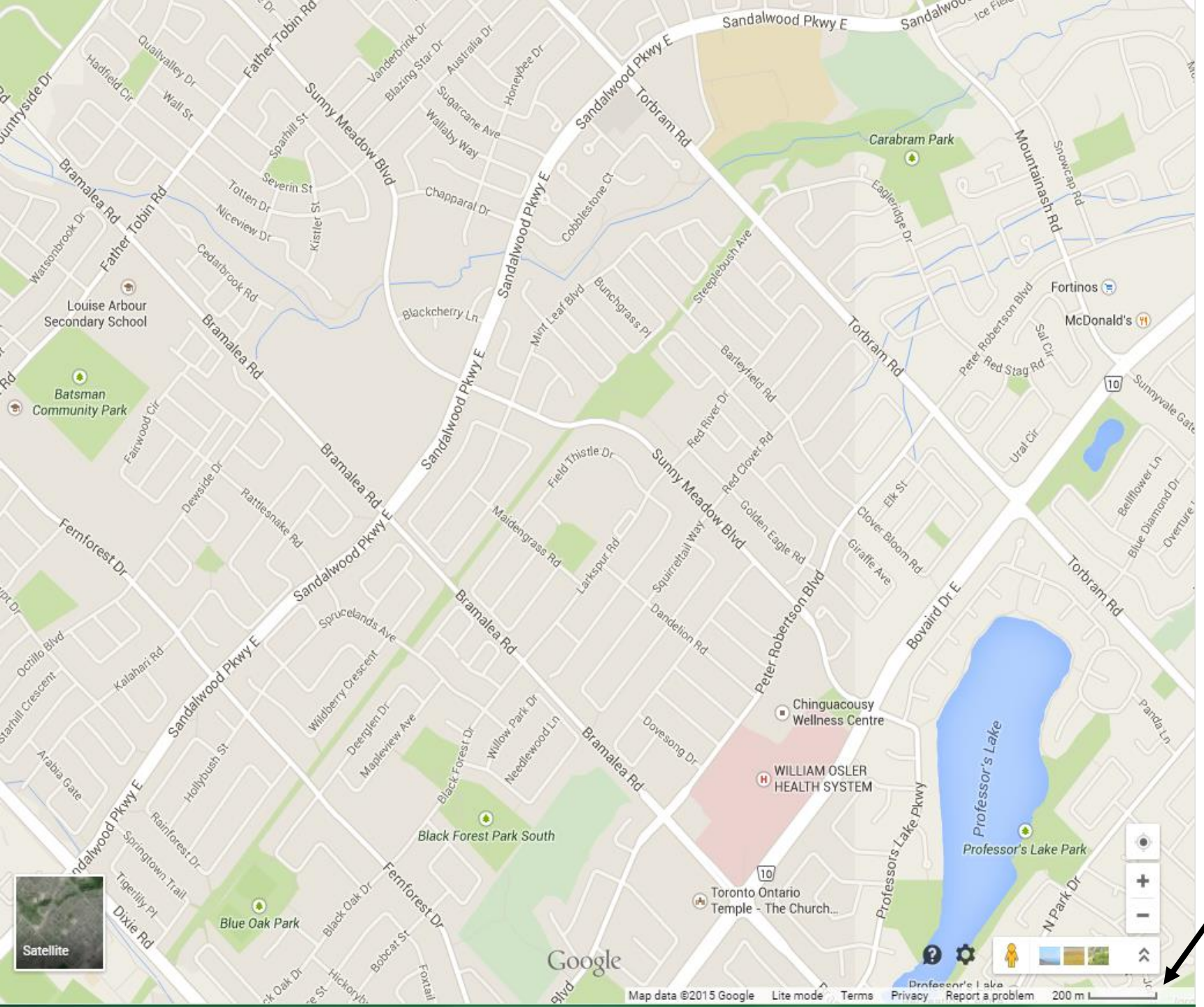
Kinematics

Thinking about how things move

Basic Concepts

1. Distance vs. Displacement
2. Vectors
3. Directions
4. Position
5. Speed & Average Speed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Fortinos
McDonald's
Fernforest Dr
Peter Robertson Blvd
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WILLIAM OSLER HEALTH SYSTEM
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Professor's Lake Park
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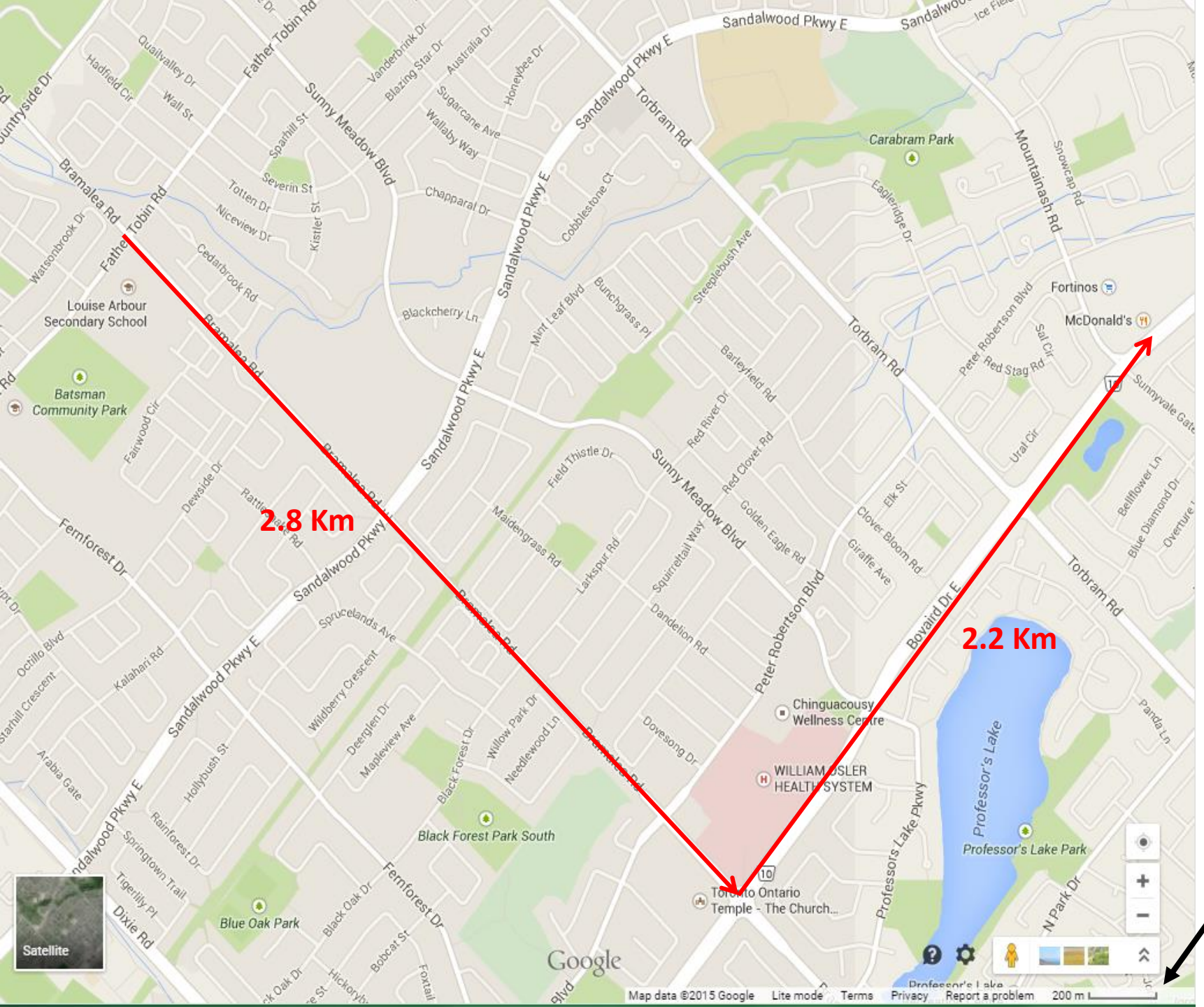
Map Scale

A Story in Motion

- After school, you and your friends went to the McDonalds at the Fortinos Plaza on Bovaird.
  1. Trace your path on the map.
  2. Calculate your distance travelled (using the scale on the map.)

How far did you go?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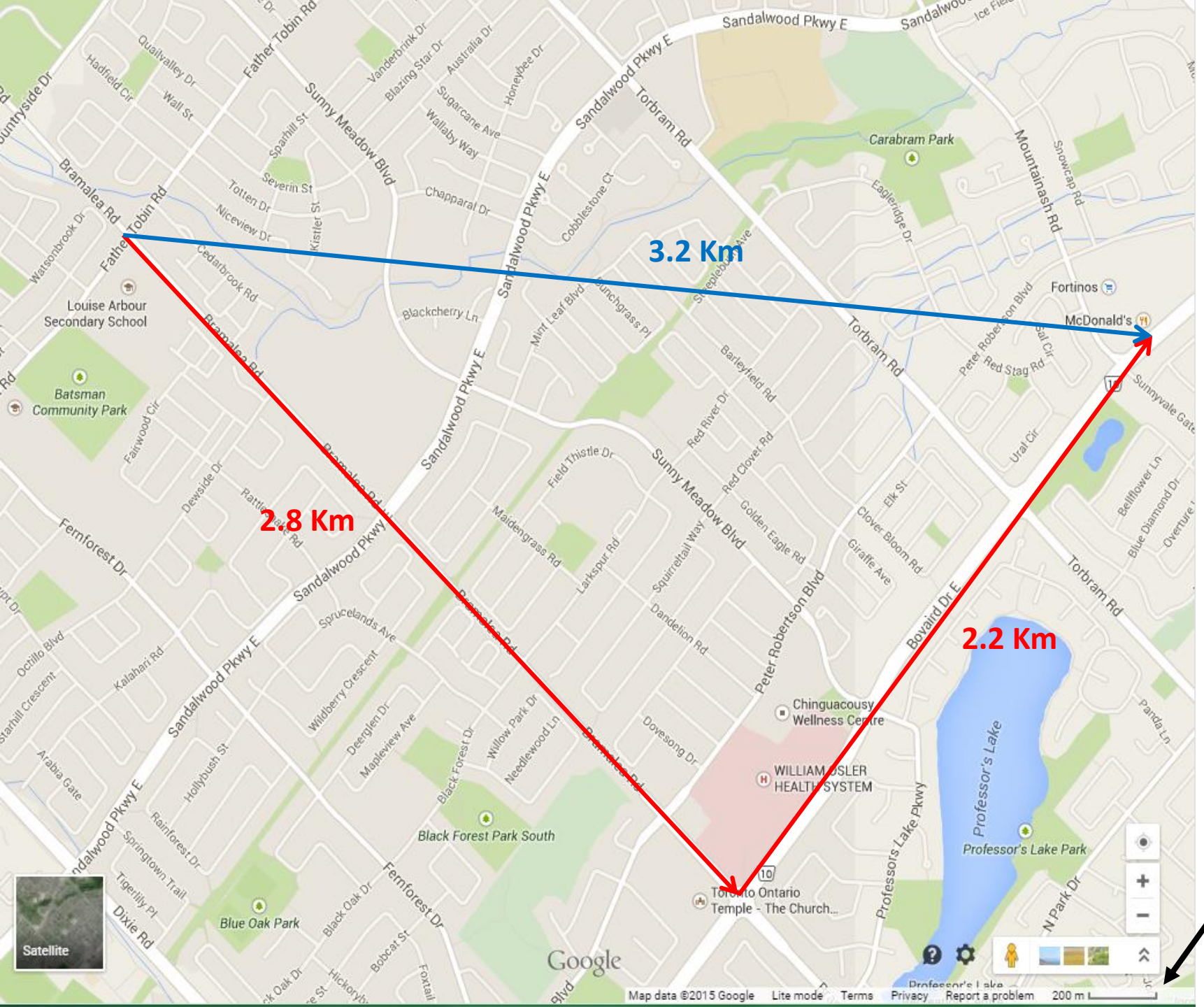
Map Scale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Map Scale

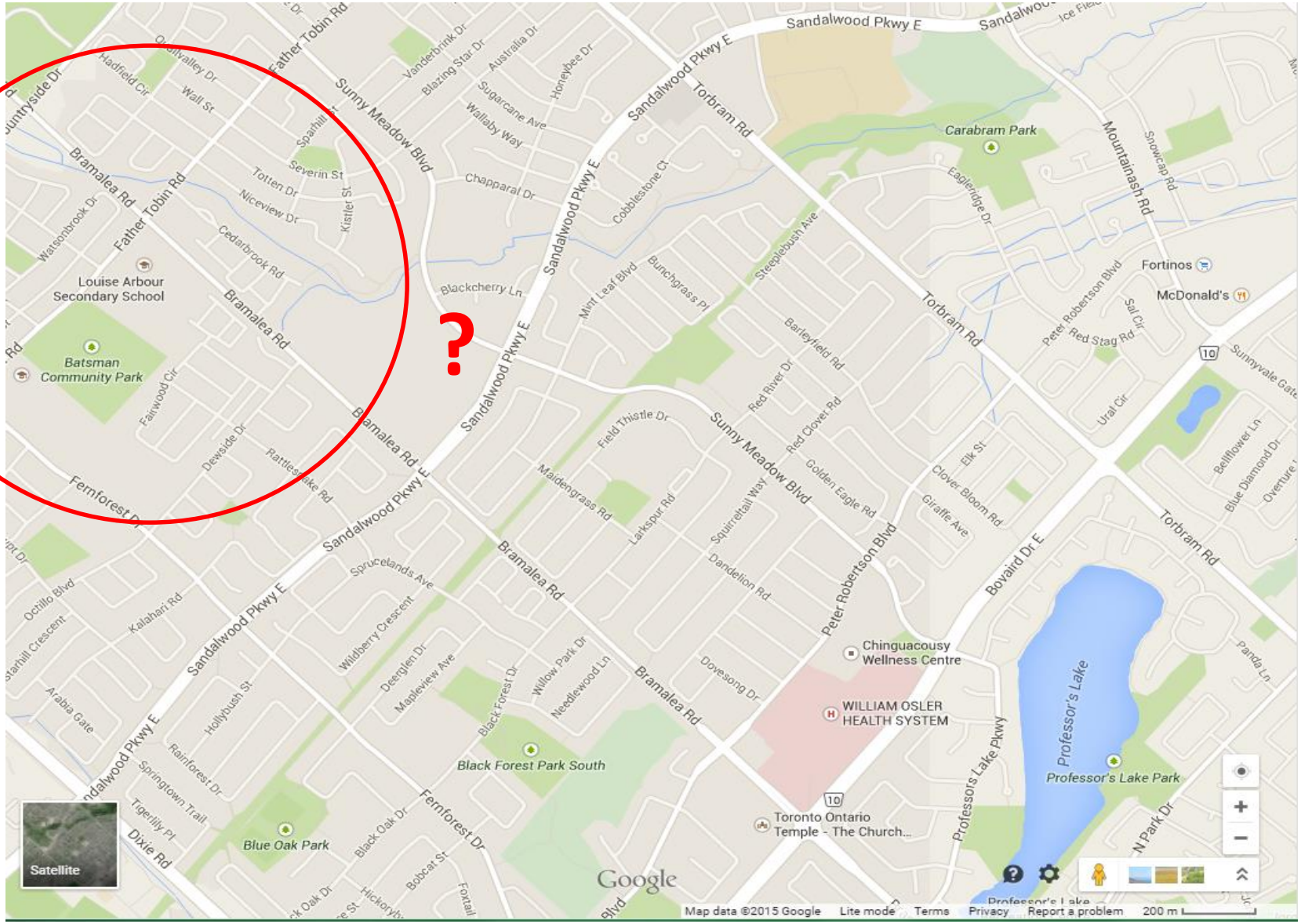
Vectors & Scalars

- Vectors (*Displacement is a Vector*)
  - Have both a number (magnitude) and a direction
  - The arrow indicates a vector
  - $\mathbf{\Delta \vec{d}}$ = 3.2 Km [East]
- Scalars (*Distance is a scalar*)
  - Have just a number (no direction, no arrow)
  - $\mathbf{\Delta d}$ = 5 Km

Distance vs. Displacement

- Distance:
  - *The total length of the path taken to move from one position to another position, regardless of direction.*
  - *The symbol for distance is:* $\mathbf{\Delta d}$
- Displacement:
  - *The net change in position, regardless of the path taken.*
  - *Displacement has both a length and a direction.*
  - *The symbol for displacement is:* $\mathbf{\vec{\Delta d}}$

I live 1Km from school



Vector or Scalar

- Which of the following are vectors?
  a. 50 m [North]
  b. 120 Km
  c. 22 cm [Up]
  d. 3.3 mm
  e. -5 m [Left]

- Can the following measurements ever be vectors?
  a. 45 Seconds
  b. 2.5 Liters
  c. 10 Kilograms

Δ – A Symbol for Change

- Displacement is the change in position…

$$\Delta\vec{d} = \vec{d}_f - \vec{d}_i$$

Where:

- $\vec{d}_i$ is the ***Initial*** position
- $\vec{d}_f$ is the ***Final*** position

Position ($\vec{d}$)

- A specific point in space relative to a chosen reference point.
  - (x, y) relative to origin
  - 10 m [North] relative to a landmark

- A position must include
  a) A distance from the reference point
  b) A direction from the reference point

Back To Our Map

- Assume
  - Bramalea Rd. runs North / South
  - Bovaird Dr. runs East / West
  - Corner of Bovaird & Bramalea is our point of reference

1. What is the position of LASS?
   - Initial position

2. What is the position of McDonalds?
   - Final position

3. What is the displacement?


2.8 Km [North]
3.2 Km [South East]
2.2 Km [East]
North
East
Reference Point
Map Scale
Louise Arbour Secondary School
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Displacement Example

- Initial position = 5 m [East]
- Final position = 25 m [East]
- What is the displacement?

Displacement Example

- Initial position = 5 m [East]
- Final position = 25 m [East]
- What is the displacement?

Solution:

$\vec{d}_i = 5\ m\ [E]$

$\vec{d}_f = 25\ m\ [E]$

$\vec{\Delta d} = \vec{d}_f - \vec{d}_i$

$\vec{\Delta d} = 25m\ [E] - 5m\ [E]$

$\vec{\Delta d} = 20m\ [E]$

Directions

- Directions come in pairs
  - Left / Right
  - Up / Down
  - North / South
  - East / West

- Conventions:
  - Pick one direction to be ***positive*** (it doesn't matter which one)
  - The other direction is then ***negative***
  - e.g. 55 m [Left] = -55m [Right]

Displacement Example (2)

- Initial position = 5 m [East]
- Final position = 25 m [West]
- What is the displacement?

Practice – Find the Displacement

1. Initial Position = 25 m [Up],
   Final Position = 35 m [Down]

2. Initial Position = 60 Km [East],
   Final Position = 60 Km [West]

3. Initial Position = 20 Km [North],
   Final Position = 0 Km [South]

4. Initial Position = 30 cm [Up],
   Final Position = 40 cm [Left]

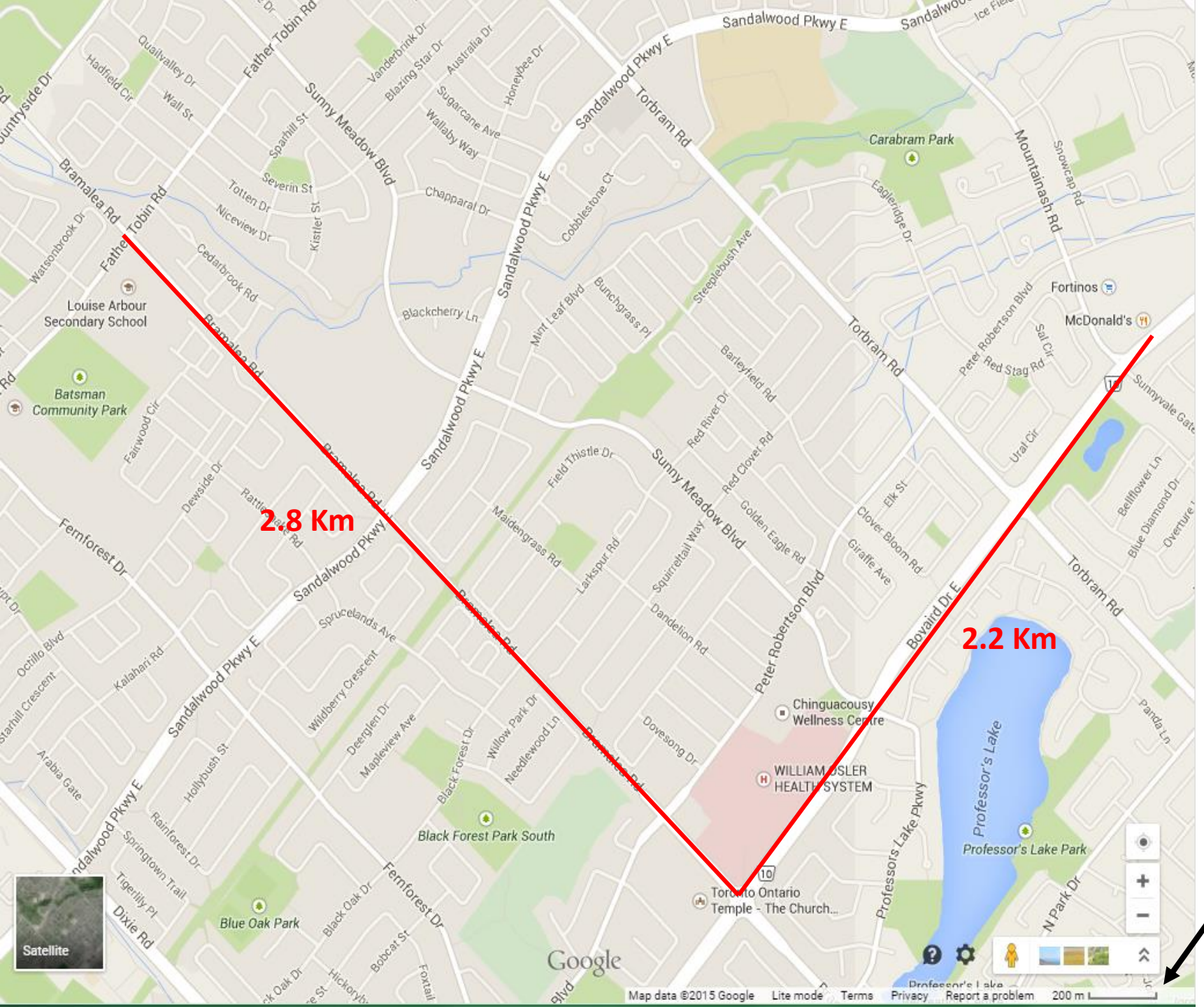
Speed

- Speed formula:

$$v = \frac{\Delta d}{\Delta t}$$

- Note: Speed is a ***scalar***

- If it took you 30 minutes to get to McDonalds what was your speed?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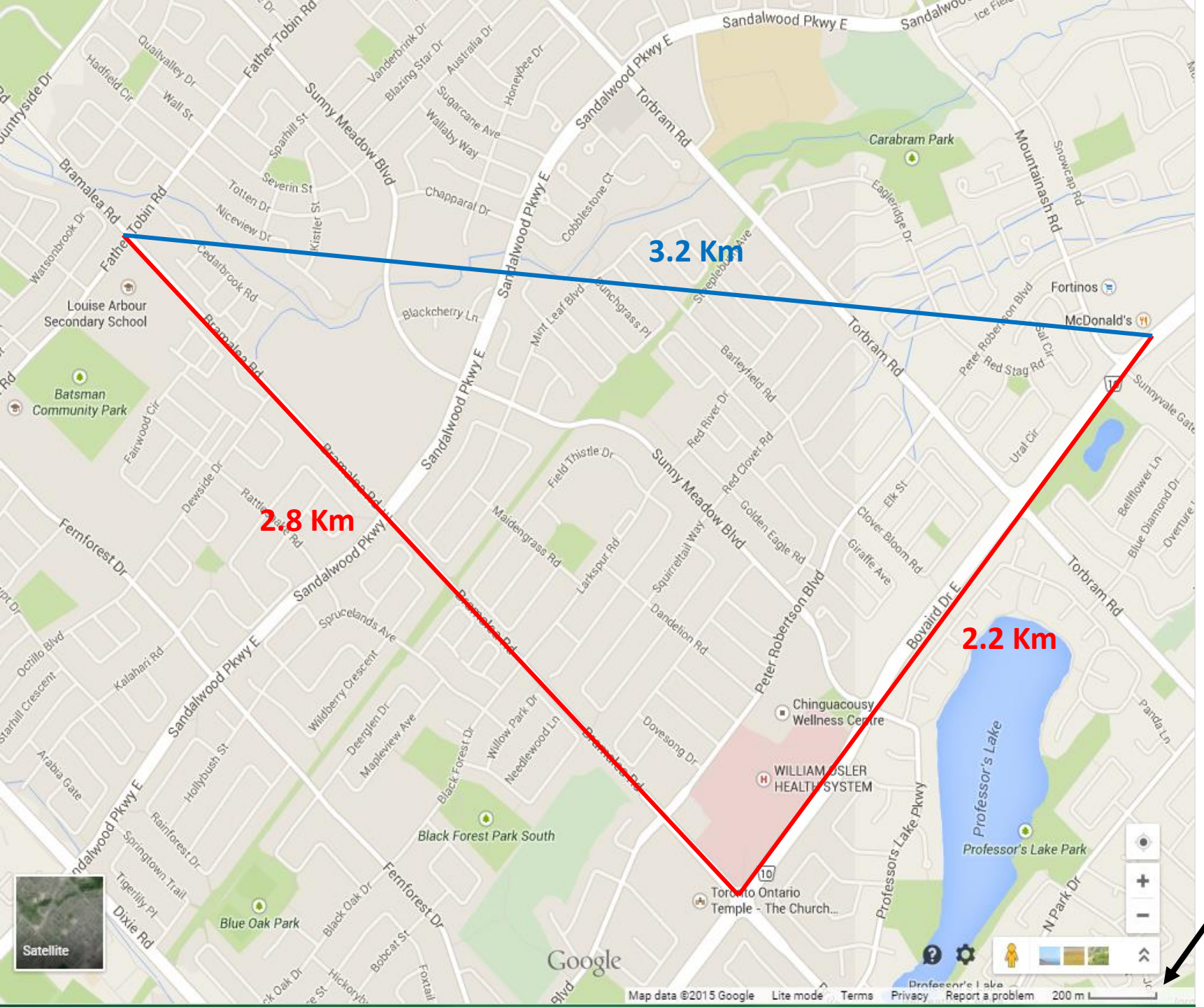
Velocity

- Velocity formula:

$$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$$

- Note: Velocity is a ***vector***

- If it took you 30 minutes to get to McDonalds what was your velocity?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Average Speed

- Average Speed Formula:

$$v = \frac{total\ distance}{total\ time} = \frac{\Delta d_T}{\Delta t_T}$$

- The speed limit on Bramalea and Bovaird is 60 km/h but there are several stop lights. How does this affect your average speed?