COIS 1400H Assignment 2 Question 1

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Estimate (no programming needed) how much memory and how much computational power would be required to predict the weather, given two scenarios. I will post a video that explains these scenarios during reading break.

a) **Predict the weather for the next day. the size of Ontario at a resolution of 1km in two directions but at only 1km in height. Updates are to happen every minute, for a whole day.**

Size of Ontario = 1.076 million km^2

Calculating the length & width of the Rectangle –
Length X width of Rectangle = 1037 km * 1037 km

Number of 1 km^2 boxes = 1,075,369 boxes

Floating point operations on Prediction of following 6 variables –

1. Wind speed (x , y, z) – considering 1 km height,
2. Temperature
3. Pressure
4. Humidity

To estimate the memory requires to predict the weather, we try to see how much memory is utilised by these 6 factors that affect the weather.

These factors are all floating-point operations that take 8 bytes.

- ⇨ So, total memory by the six floating type values per cell (1 km^2) = 8 * 6 = 48 bytes

Or 6 floating point operations per minute

Every minute of day = 1440 minutes

- ⇨ Memory Used Every day per cell (1 km^2) = 48 * 1440 = 69,120 bytes

Or 6 * 1440 = 8640 floating point operations per day

Total memory required for predicting data in Ontario every minute of day = 1,075,369 * 69,120
= **74,329,505,280 bytes**
= 74 GB
Or 1,075,369 * 8640 = **9,291,188,160 floating-point operations every day for Entire Ontario**

b) **Predict the weather for an area the size of Canada, for a week, at a resolution of 100 km in two directions, and also, like in the first scenario, one layer for height. Your goal is to predict the weather for a week, calculating updates every 10 minutes.**

Size of Canada = 9.985 million km^2

Calculating the length & width of the Rectangle –
Length X width of Rectangle = 7560 km * 9306 km

Number of 10 km^2 boxes = 703,533 boxes

Floating point operations on Prediction of following 6 variables –

5. Wind speed (x , y, z) – considering 1 km height,
6. Temperature
7. Pressure
8. Humidity

To estimate the memory requires to predict the weather, we try to see how much memory is utilised by these 6 factors that affect the weather.

These factors are all floating-point operations that take 8 bytes.

- ⇨ So, total memory by the six floating type values per cell (10 km^2 cells) = 8 * 6 * 10= 480 bytes

Or 6*10 = 60 floating point operations per 10 minutes

Every 10 minutes of a week = 1008

- ⇨ Memory Used Every day per cell (10 km^2 cells) = 480 * 1008 = 483840 bytes

Or 60 * 1008 = 60,480 floating point operations every 10 minute for a week

Total memory required for predicting data in Canada every 10 minutes for a week = 703,533 * 483840
= **340,144,134,840 bytes**
= 340 GB
Or 60,480 * 703,533 = **42,549,675,840 Floating point operations for entire Canada every week every 10 minutes**

c) **Is there a computer that is able to achieve these calculations in a day for Scenario A and a week for Scenario B? If yes, find a price for that computer. If not, estimate how long it will take to have such a computer available by looking at the performance development over time at top500.org**

We have many supercomputers today that can do calculations in Teraflops which is 1 Trillion Floating operations per second!

For Scenario A, our calculation in a day is approximately 9.2 Gigaflops of memory.
For Scenario B, our calculation in a week is approximately 42.5 Gigaflops of memory.

According to my understanding and calculations, **Fujitsu Numerical Wind Tunnel** should be able to do both these calculations. It has a memory capacity of 124.50 GFlops. And of course, the supercomputer's price is only equal to $100 million dollars.