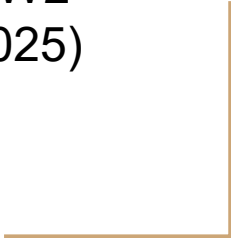# Programming, Problem Solving, and Algorithms

CPSC 203, 2024 W2
(January – April 2025)
Ian M. Mitchell
Lecture 08B

# Everyone needs a Tim Horton

Every address in Vancouver has a nearest TH.

Partition Vancouver into regions so that points are in the same region if they have the same nearest TH.

# Voronoi Diagrams

Given a (finite) set of "centers" $c_1$, $c_2$, … $c_k$, a Voronoi region, $R_j$ consists of the set of points nearer to center $c_j$, than to any other center.
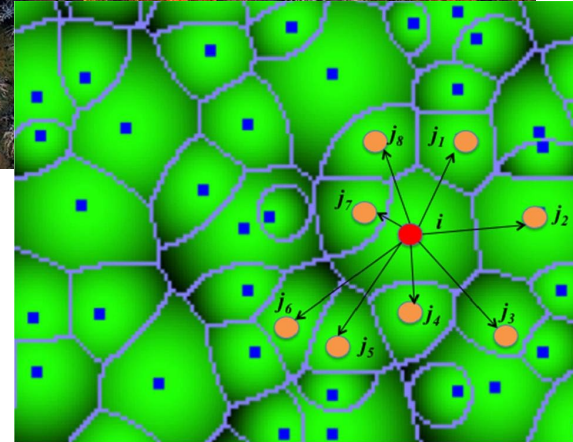
Together, the $R_j$ regions compose the Voronoi Diagram of a plane.

The applications of this structure go far beyond our coffee fix!!

# Forest Canopy

- If trees all grow at the same time





http://revistas.inia.es/index.php/fs/article/view/8021/2913

# More examples...

Too good not to share:
https://www.khanacademy.org/partner-content/pixar/pattern/dino/v/patterns2_new

# Yet more examples...

Robotics -- Path planning in the presence of obstacles

Zoology -- Model and analyze the territories of animals

Astronomy -- Identify clusters of stars and clusters of galaxies

Biology, Ecology, Forestry -- Model and analyze plant competition

Cartography -- Piece together satellite photographs into large "mosaic" maps

Geography -- Analyzing patterns of urban settlements

Marketing -- Model market of US metropolitan areas;

Metallurgy -- Modelling "grain growth" in metal films

Meteorology -- Estimate regional rainfall averages, given data at discrete rain gauges

Physiology -- Analysis of capillary distribution in cross-sections of muscle tissue to compute oxygen transport ("Capillary domains")

Anthropology and Archeology -- Identify regions under the influence of different neolithic clans, chiefdoms, ceremonial centers, or hill forts.

Crystallography and Chemistry -- Study chemical properties of metallic sodium); Modelling alloy structures as sphere packings ("Domain of an atom")

Geology -- Estimation of ore reserves in a deposit using info obtained from bore holes; modelling crack patterns in basalt due to contraction on cooling
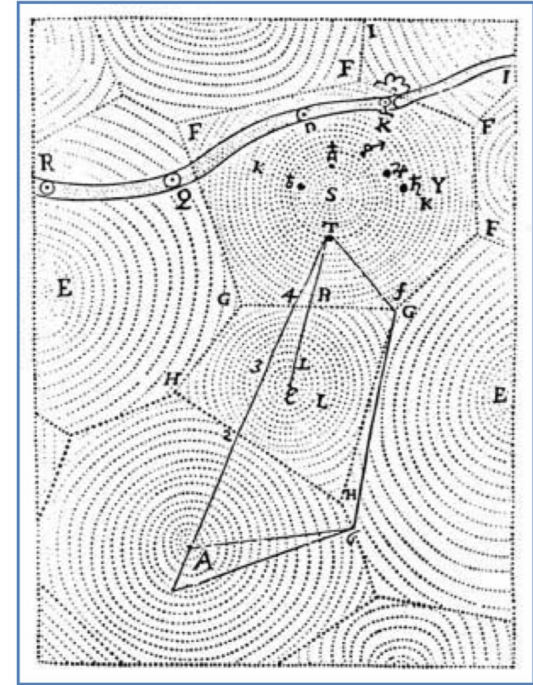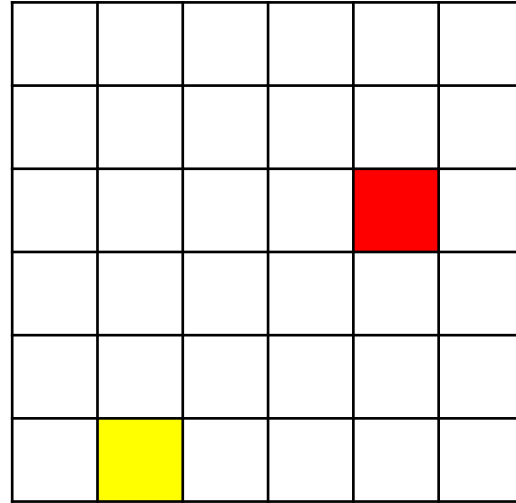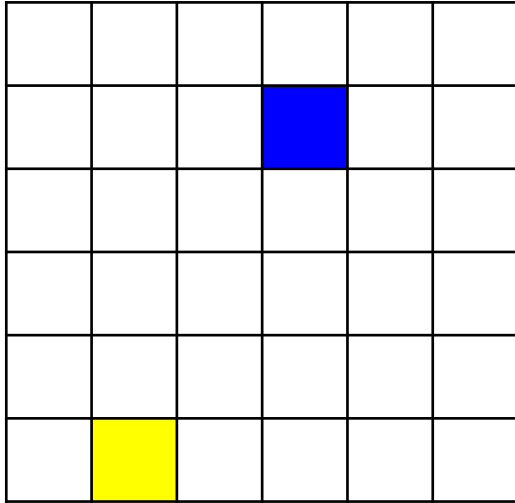
# Distance between pixels

Find the distance between two pixel locations:
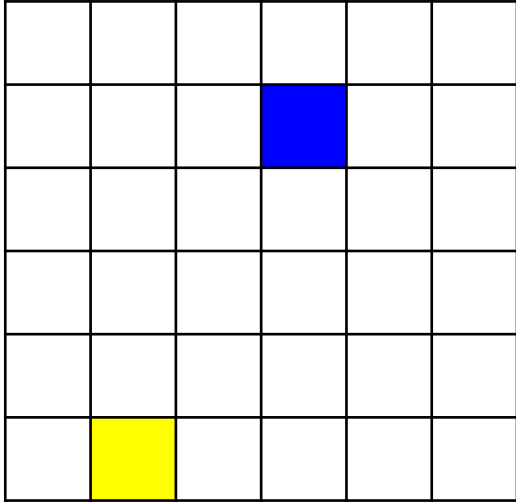
# Distance between pixels

Given a point and two centers, determine which is the nearest center…

# Design an Algorithm

# Pointillism



A Sunday on La Grande Jatte, Georges Seurat

# The Idea…



1) Select a subset of points from the original image.
2) Use those points, with their colors, as centers in a new image of the same size.
3) Build the voronoi diagram in the new image, using the ctr colors from the original image.

The quality of the new image

depends on _____.

# Planning

Point:

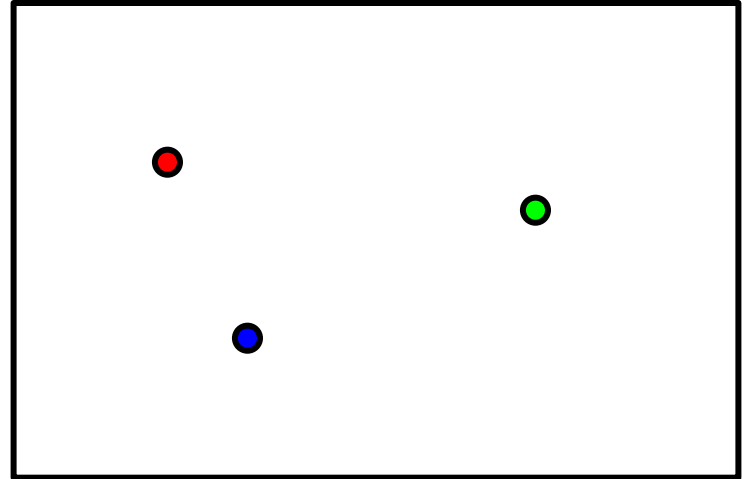Color:

Center:

Centers:

Image:

# Planning

Data flow:
1)


2)


3)


4)

# Demo and Analysis

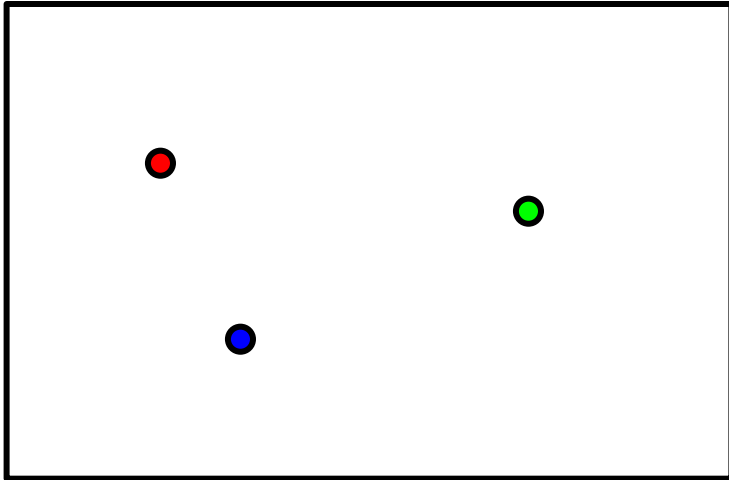How much work is done? Let n denote the size of the image, n = width * height

1) Read image:

2) Choose centers:

3) Build new image:

4) Write out new image:

# Can we do better?

The running time of the original algorithm: _____

What would be better? _____

Orchestrate a fill from each center, growing out at the same rate.

Each pixel is processed exactly once, not once per center as before.

This means we can have lots of centers!