Programming, Problem Solving, and Algorithms

CPSC203, 2019 W1

Announcements

Project 1 is released. Due 11:59p, Oct 17.

“Problem of the Day” continues!

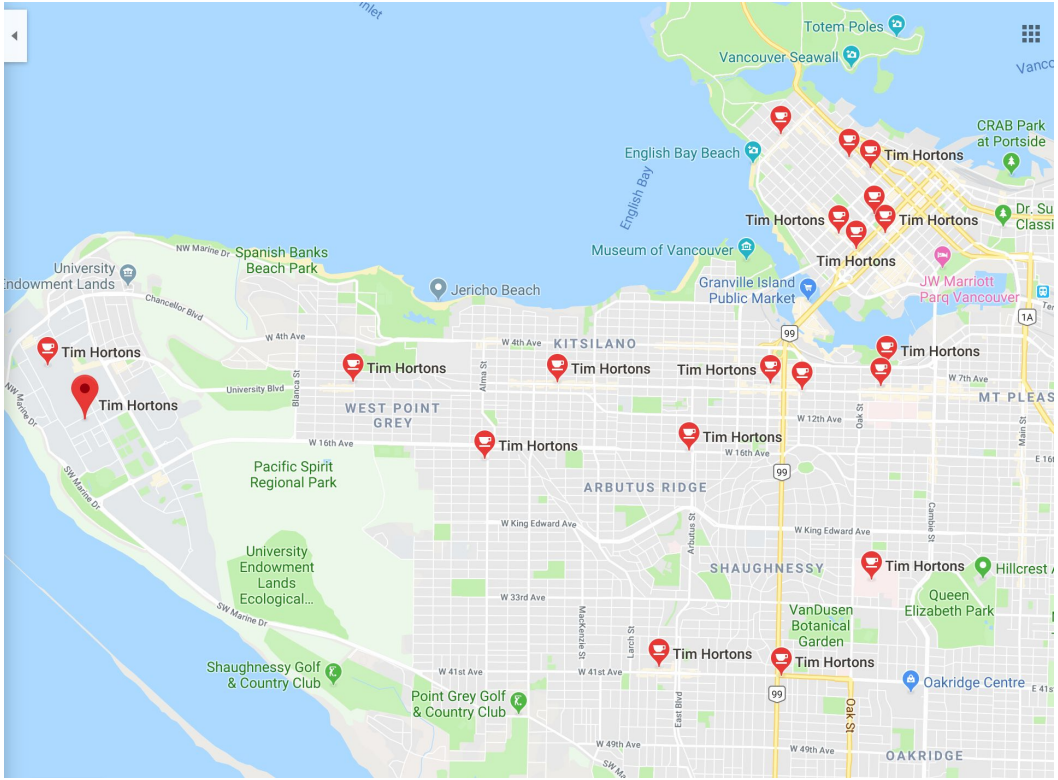
Today:

Voronoi Diagrams

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.

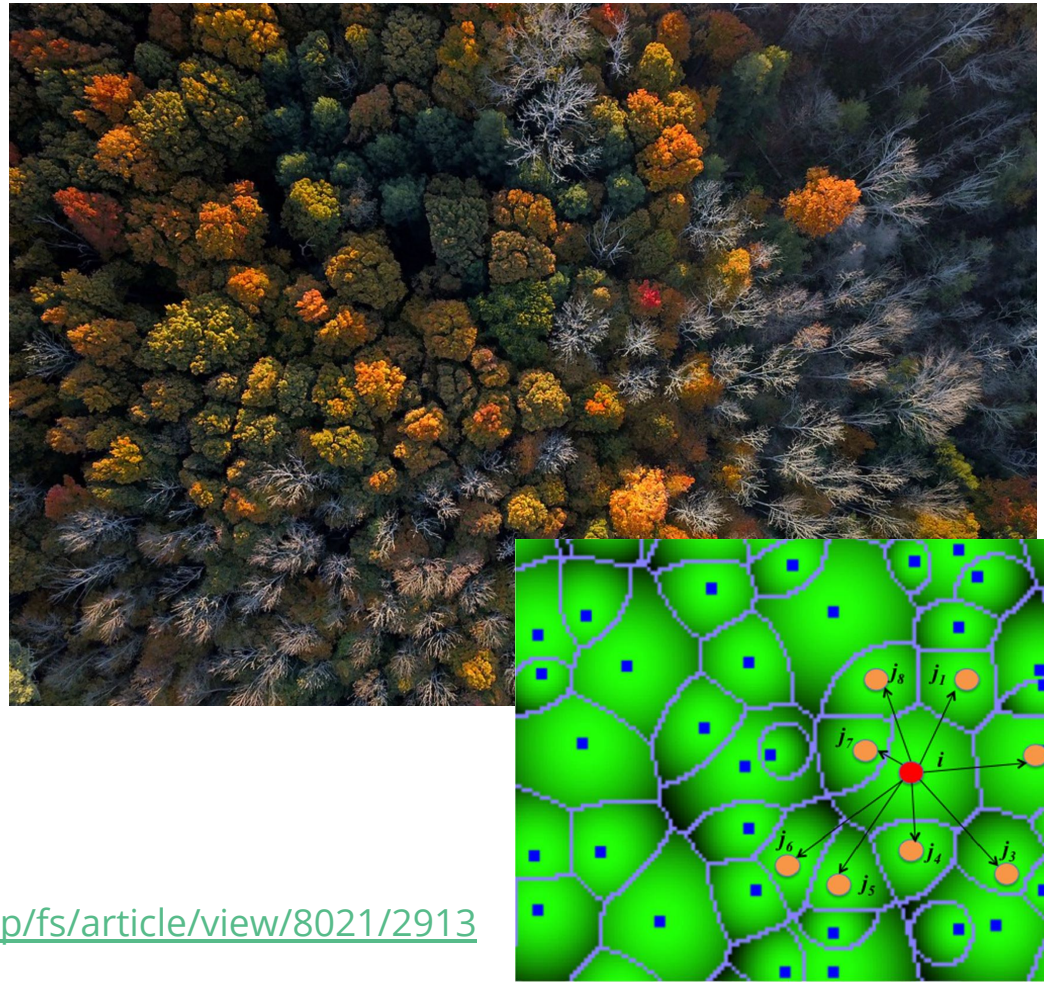


Voronoi Diagrams

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!!

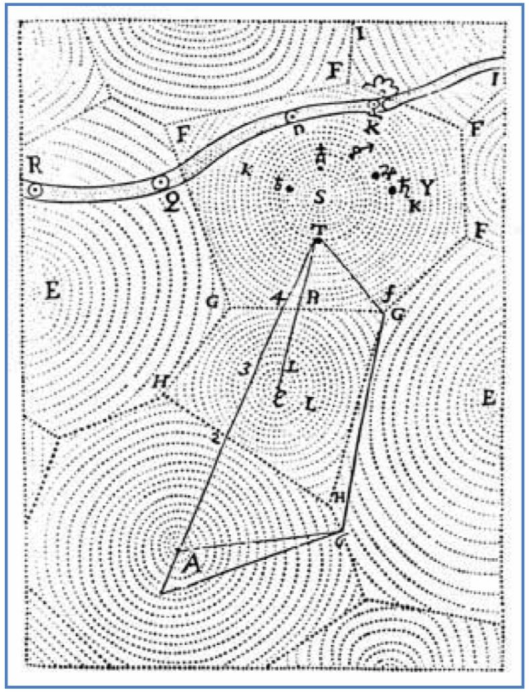


http://revistas.inia.es/index.php/fs/article/view/8021/2913

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

Computing Voronoi Diagrams

Choice of algorithm depends on the domain of your data.

If real valued domain (like Cartesian Coords) then we use geometry. Exploit the fact that the Voronoi edges are perpendicular bisectors of the edge between 2 centers.

Our computation will always be on planar regions represented by images.

Data for the problem:

1)

2)

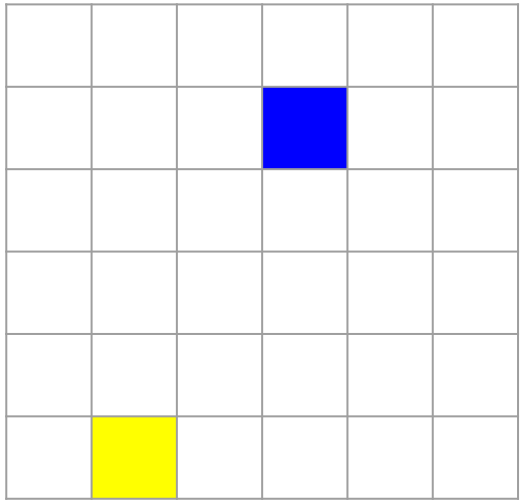
Data for the solution:

1)

2)

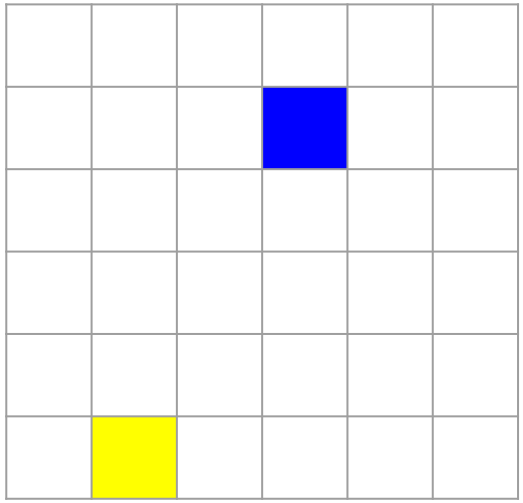
Distance between pixels

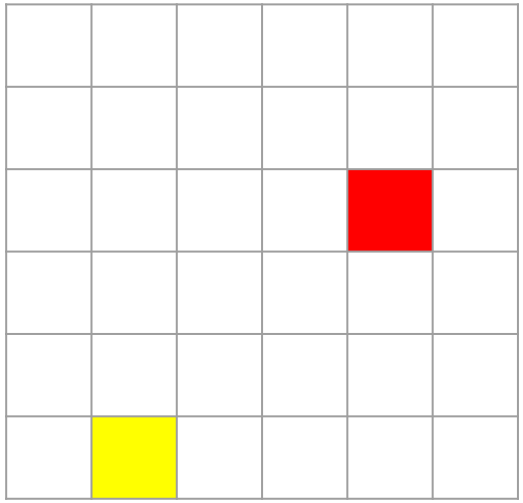
Find the distance between two pixel locations:



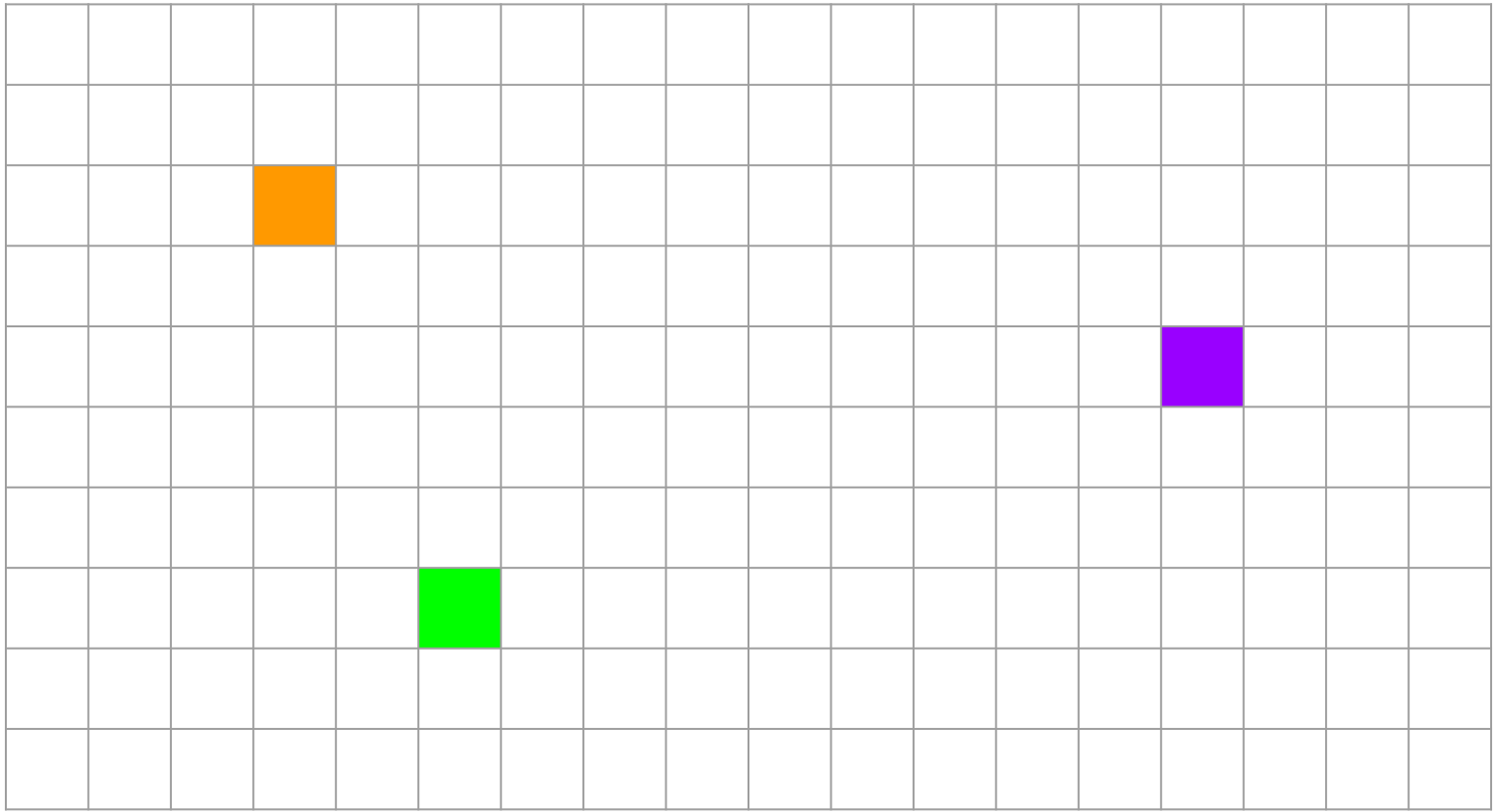
Distance between pixels

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





Design an Algorithm



Pointillism

A Sunday on La Grande Jatte, Georges Seurat

Planning

Point:

Color:

Center:

Centers:

Image:

Planning

Data flow:

1)

2)

3)

4)

Demo and Analysis

https://github.students.cs.ubc.ca/cpsc203-2019w-t1/LecVor

How much work is done?

1) Read image:
2) Choose centers:
3) Build new image:
4) Write out new image:

POTD #11 Thu

https://github.students.cs.ubc.ca/cpsc203-2019w-t1/potd11

Describe any snags you run into:

1. Line ___: _____
2. Line ___: _____
3. Line ___: _____
4. Line ___: _____
5. Line ___: _____

ToDo for next class...

POTD: Continue every weekday! Submit to repo.

Reading: TLACS Ch 10 & 12 (lists and dictionaries)

References:

https://en.wikipedia.org/wiki/Voronoi_diagram