
DTU

Mads Paulsen, DTU Management

Spatial Interpolation

Skills acquired from today's activities

- After today you should be able to:
  - Calculate predictions at specific locations using Inverse Distance Weighting (IDW) and Voronoi Diagrams
  - Create an IDW surface that predicts the value at all locations in Python
  - Anticipate the behaviour of IDW when changing the exponent
  - Draw a Voronoi Diagram that predicts the value at all locations

Mads' Part of 42588 Data & Data Science

- Week 6 – Data Visualisation & Communication
- Week 7 – Spatial Data
- Week 8 – Project 2 Presentations + Data Weighting and Imputation

- Feedback from last time:
  - Those who answered seemed to enjoy the active parts
    - » The Figure Fight was really popular
  - Hard to see what happened during the live-coding
  - No obvious gaps identified

Agenda

External speaker from Niras

Exercises on spatial interpolation

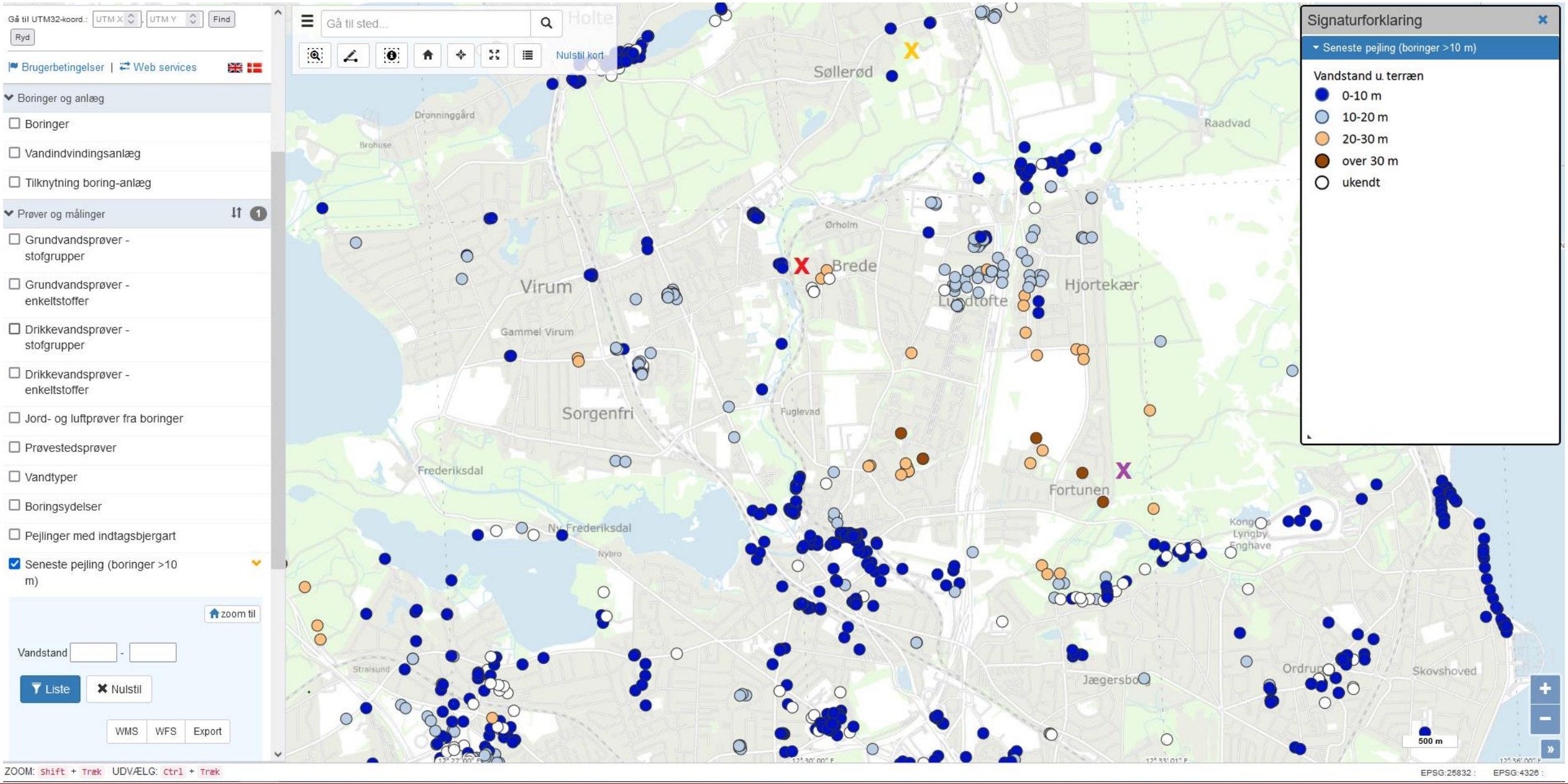
Work on Project 2

Special but important case: Spatial data

- Data with relevant variables available at selected geographical locations

- Relevant examples
  - Weather stations
  - Vehicle trajectory data (gps data)
  - Polution data
  - Geological data
  - …

- Data is geographically incomplete
  - Spatial interpolation needed…


Gå til UTM32-koord.:
UTM X
UTM Y
Find
Ryd
Brugerbetingelser | Web services
Boringer og anlæg
Boringer
Vandindvindingsanlæg
Tilknytning boring-anlæg
Prøver og målinger
1
Grundvandsprøver - stofgrupper
Grundvandsprøver - enkeltstoffer
Drikkevandsprøver - stofgrupper
Drikkevandsprøver - enkeltstoffer
Jord- og luftprøver fra boringer
Prøvestedsprøver
Vandtyper
Boringsydelser
Pejlinger med indtagsbjergart
Seneste pejling (boringer >10 m)
zoom til
Vandstand
Liste
Nulstil
WMS
WFS
Export
Gå til sted...
Nulstil kort
Signaturforklaring
Seneste pejling (boringer >10 m)
Vandstand u. terræn
0-10 m
10-20 m
20-30 m
over 30 m
ukendt
Holte
Søllerød
Dronninggård
Brohuse
Raadvad
Ørholm
Brede
Virum
Lundtofte
Hjortekær
Gammel Virum
Sorgenfri
Fuglevad
Frederiksdal
Fortunen
Ny Frederiksdal
Nybro
Kongens Lyngby
Enghave
Stralsund
Jægersborg
Ordrup
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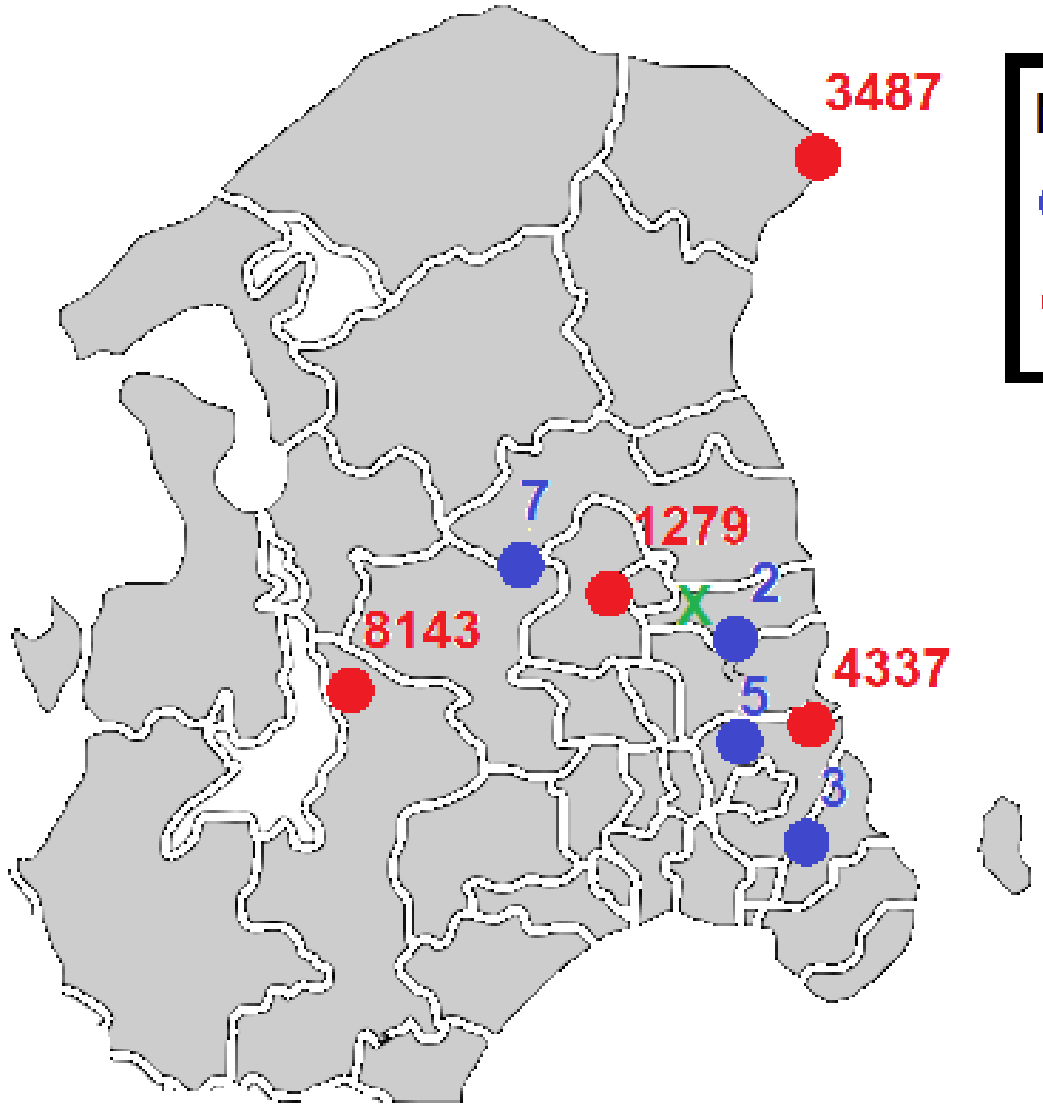
500 m
ZOOM: Shift + Træk UDVÆLG: Ctrl + Træk
EPSG:25832 :
EPSG:4326 :



Number of football juggles

- Mads Paulsen
- Mikkel Damsgaard

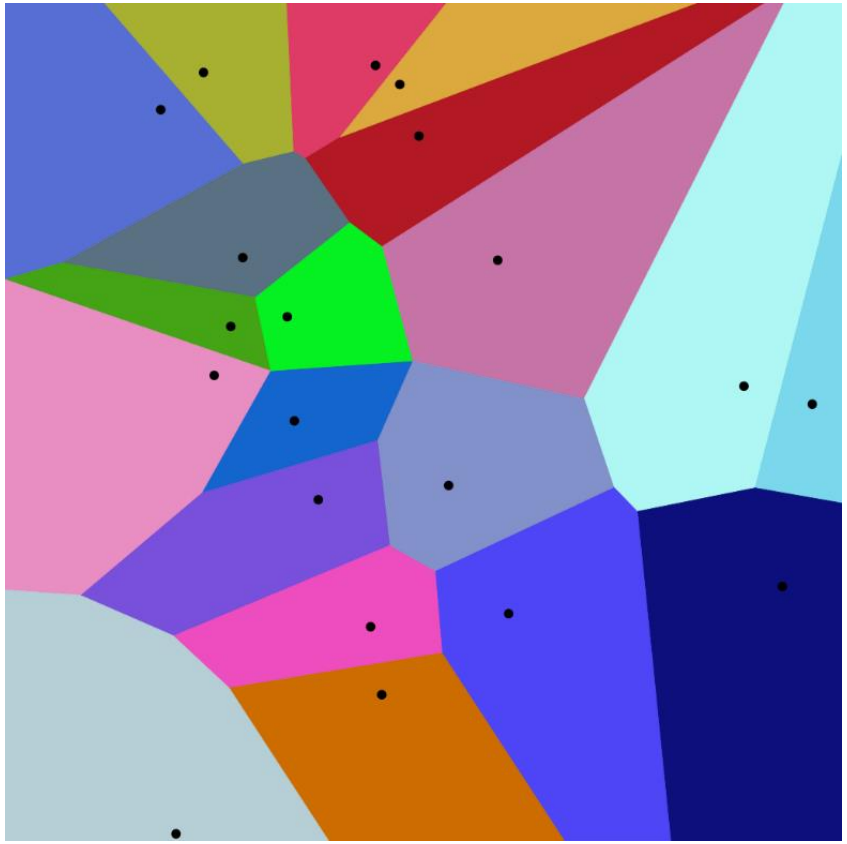
Fictive example…

Voronoi Diagrams

- Value point *P* is assumed equal to the value at the closest observed point
  - Special instance of geometrical *K* nearest neighbor with *K* = 1

- Boundaries of cells can be constructed geometrically
  - You get to try this in Exercise 3…

- Predictions discontinuous at cell boundaries



Inverse Distance Weighting (IDW)

- General idea:
  – Value at some point *P* depends on the value at multiple nearby locations **Q**
  – The closer to *P*, the higher the weight

- An estimate of a value Z_P at point *P*, can be found as,

$$Z_P = \frac{\sum_{Q \in \mathbf{Q}} w_Q Z_Q}{\sum_{Q \in \mathbf{Q}} w_Q}$$

with

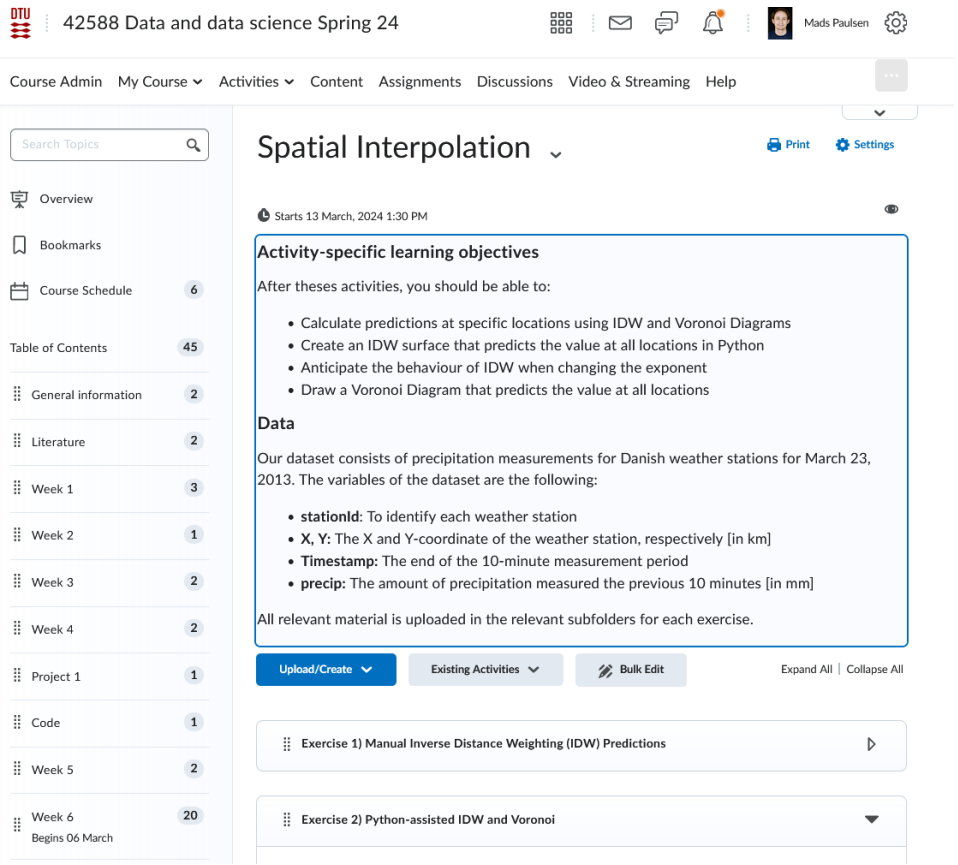
$$w_Q = \left(\frac{1}{d(P,Q)} \right)^{\alpha}.$$

- $d(P,Q)$ is the Euclidean distance between P and Q, and Z_Q is the value at point Q

- α is a parameter controlling how fast the weights decay as a function of distance.

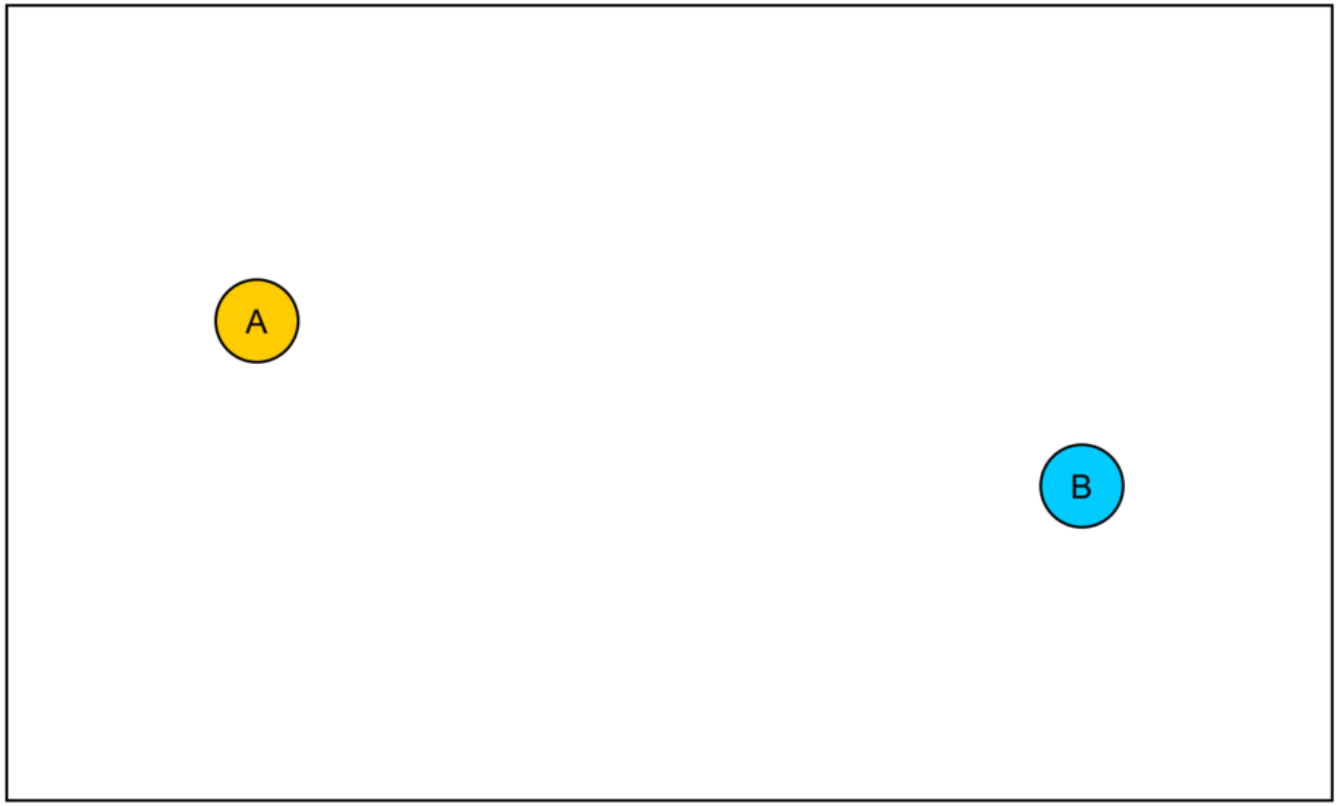
Time for Exercises… (…Tid til at regne…)

- There are three exercises to be found on DTU Learn:
  - Week 7 → Spatial Interpolation
- Exercise 1 using ”Simulated hand calculations”
- Exercise 2 using Python implementations
- Exercise 3 using a ruler and a pen



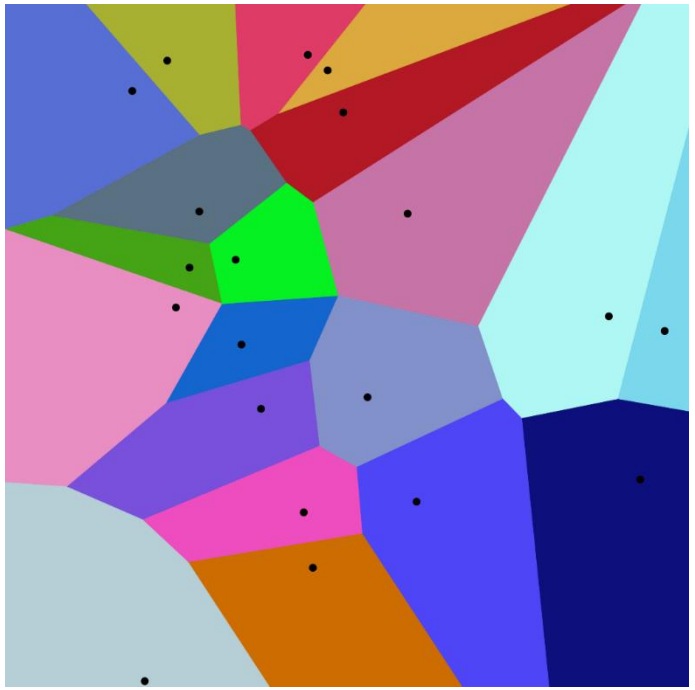
- At 14:50(-ish?) I will give some additional perspectives + information regarding Project 2

Help for Voronoi Diagrams (Exercise 3)

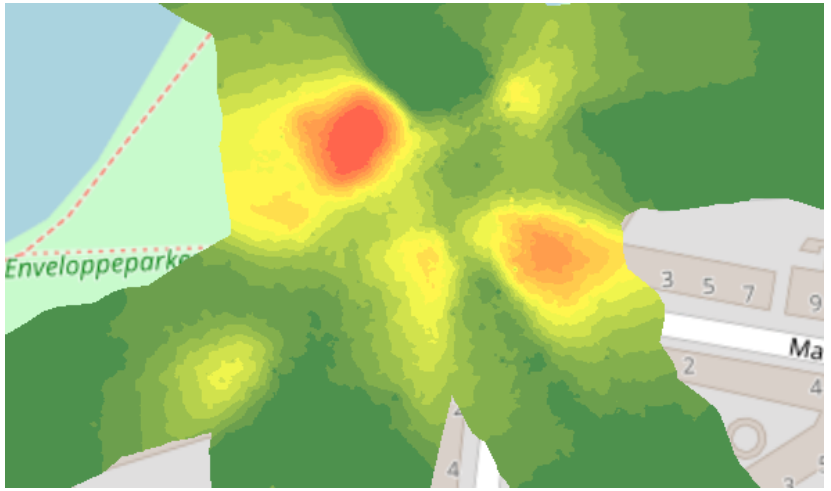


When to use which approach (IDW vs Voronoi)

- Voronoi diagrams:
  - Categorical data
    - » IDW undefined in these cases

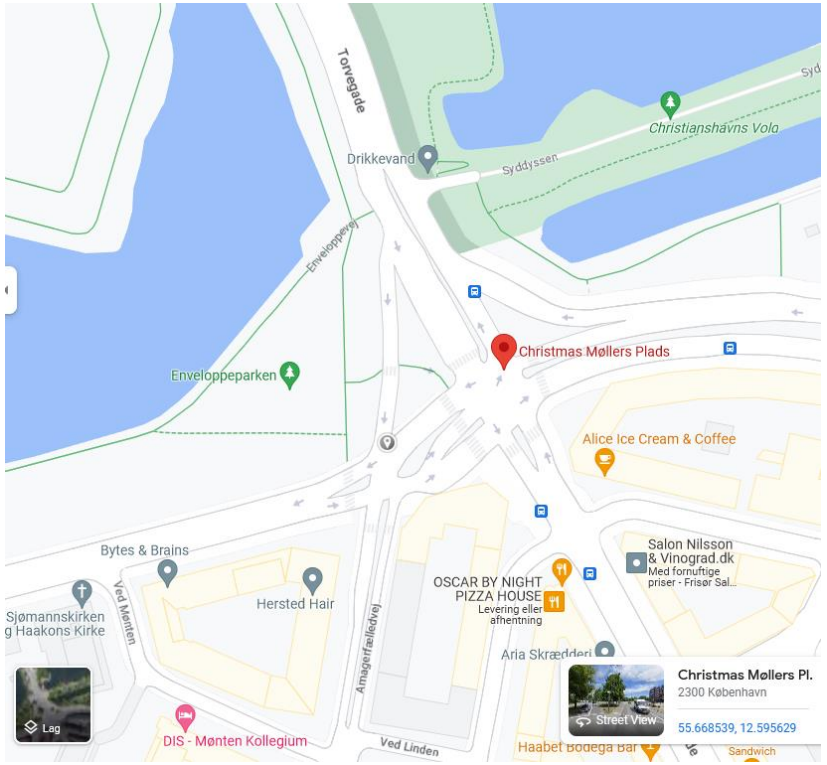


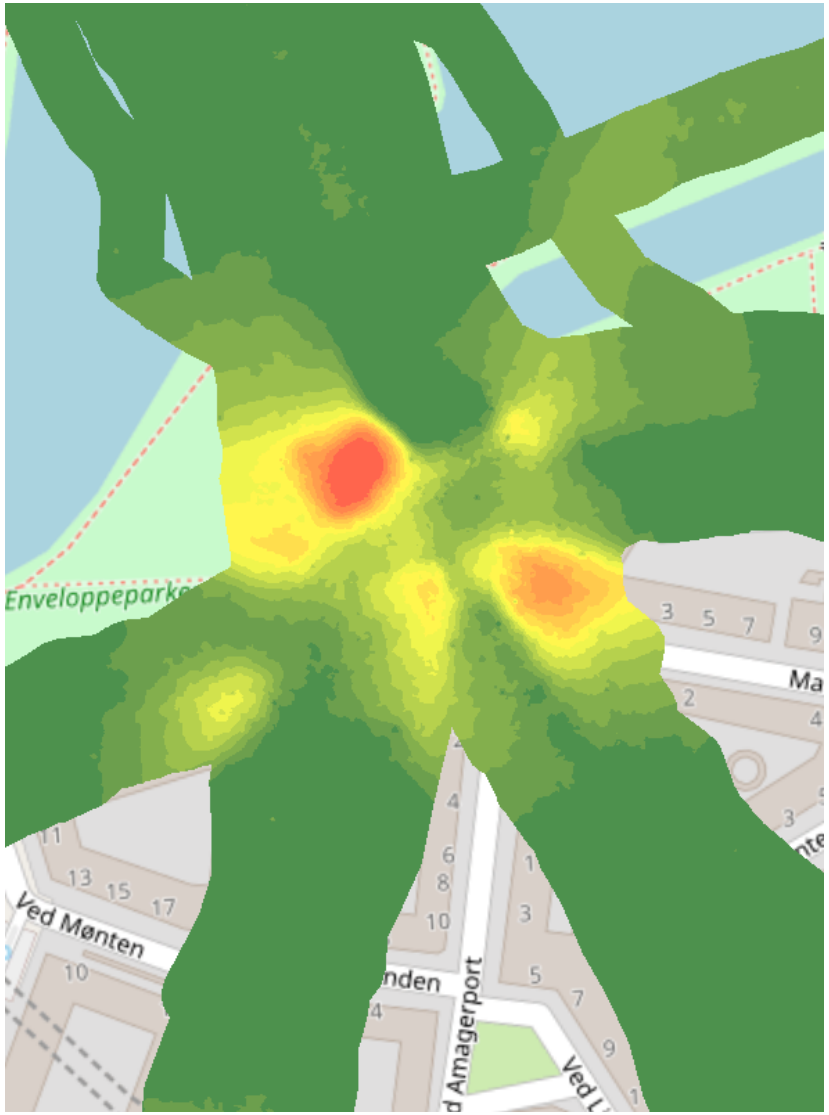
- IDW
  - Large variation at each location
    - » IDW will average the values
  - Geographically dense data
    - » The cells of the Voronoi diagram will be very small



IDW - Example

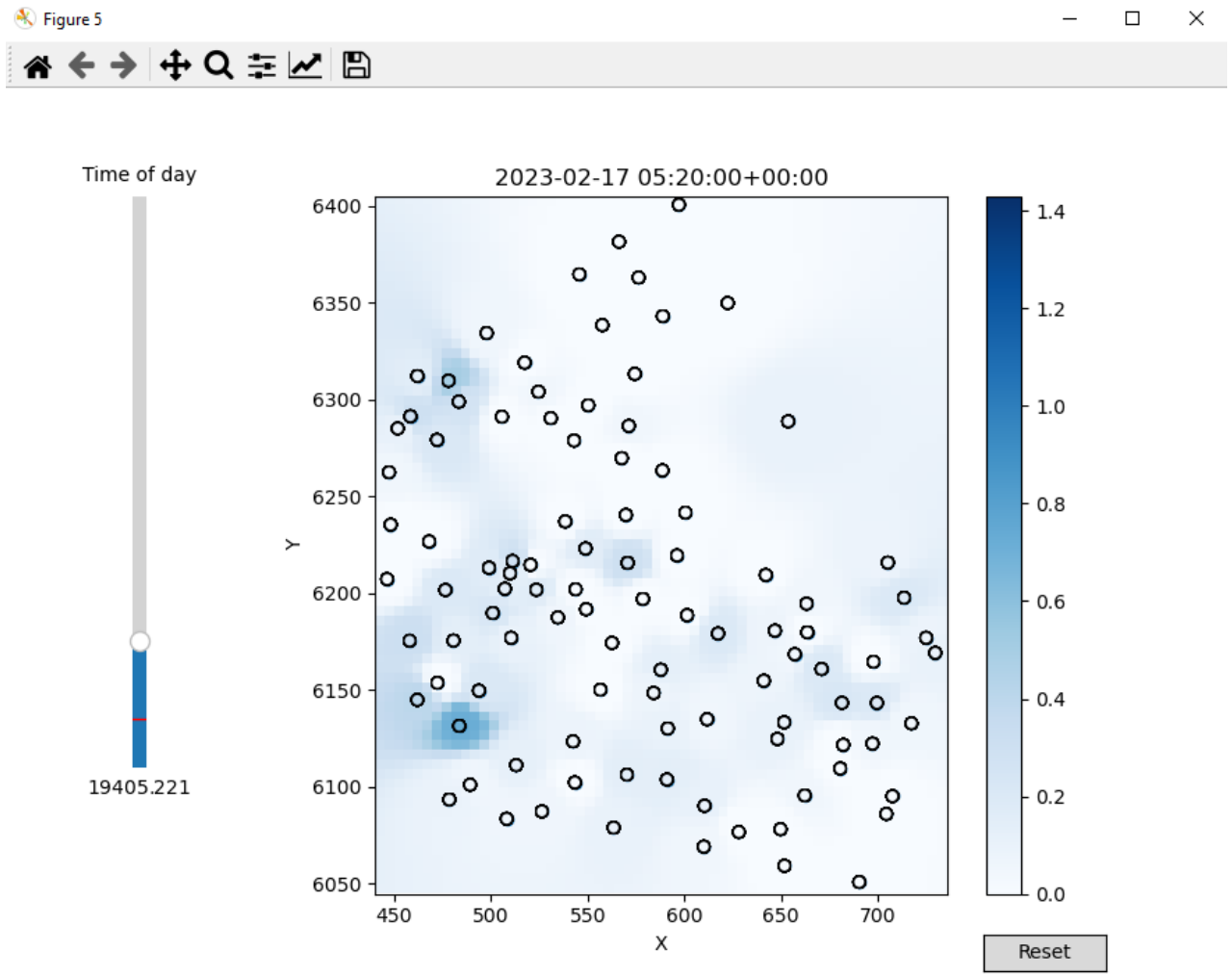
- For bicycle gps data, we have many observations of speed
- Despite large variations, overall trends can be identified through an IDW surface





Dynamic Spatial Interpolation

- Code uploaded on DTU Learn
- Not guarantee that it works with your preferred GUI though.



Work on Project 2

Time for Project Work… Again!

- Check the project description on DTU Learn and align your work accordingly
  - Consult the chapters of Wilke (2019) that are relevant for your figures

- You decide your target group
  - Could be as simple as fellow students in 42588…

- Very important to let me know if you cannot present or give feedback next time
  - Schedule uploaded under Week 8

- Last session before the presentations
  - Last chance to ask me for advise

Midterm Course Evaluation

- Available from 3pm today
- You should all receive a notification about this
  - Might be accessible at evaluering.dtu.dk (but I am actually not sure)
- Answers are used to improve the education