Faculty of the Built Environment & Architecture

Digital terrain modelling (GEO1015) — 5 ECTS

31 January 2025, 9:00–11:30
Location: 34.D–1–200
Responsible teacher: Hugo Ledoux

1. The subject matter is in full accordance with the study guide.
2. This final exam is worth 50% of the final mark for the course.
3. The maximum grade for this course is 10.0. The minimum (unrounded) final mark to pass this course is 57.5%, which will be rounded to 6.0. However, you need at least a 50% in the combined exams (midterm + this one) to be able to pass the course.
4. There are 80 points to earn:
   - 10 multiple choice questions [2 points each]. For this section, there is **negative marking**. That is, for each question, if you get it right you get 2pts, if you answer nothing you get 0pt, and if you get it wrong you get −1pt. You cannot get less than 0pts in total for these questions.
   - 10 short answers [6 points each]
5. Answer directly on these pages. If there is not enough space, use extra sheets and staple them at the end.
6. This is an open-book exam, only paper is allowed. No computer/phone/etc; a calculator is fine.
7. In all cases of alleged fraud, the invigilator is required to report it to the Board of Examiners of the ABE Faculty. **Fraud is always sanctioned**.
8. Fill out your name and student ID.
9. This exam has 20 questions, and 15 pages.
10. You have 2h00min to do this exam.

Name: _____

Student ID: _____

Multiple choice questions (20 points)

[only one good answer for each question]

1. *(2 points)* You have 2 gridded datasets for an area, and for one xy-location both values for the DSM and the nDSM are exactly the same. Where is this dataset most likely from?

   - ◯ Amsterdam, the Netherlands
   - ◯ the top of the Mount Everest, Nepal
   - ◯ Zürich, Switzerland
   - ◯ it's impossible to have the same value for a DSM and a nDSM

2. *(2 points)* The _____ is the 1st derivative of the surface representing the terrain.

   - ◯ curvature
   - ◯ hillshading
   - ◯ gradient
   - ◯ none of the above

3. *(2 points)* Referring to the properties of an ideal interpolation method on p.47 of the book. Can we say that Ordinary kriging is both *local* and *automatic*?

   - ◯ yes
   - ◯ no

4. *(2 points)* Fill the blank: _____ is a correlation between the proximity in space of geometric entities and the proximity of their representations in a file.

   - ◯ spatial extent
   - ◯ spatial resolution
   - ◯ spatial tessellation
   - ◯ none of these

5. *(2 points)* Where are you more likely to have many ICESat-2 measurements for a given area?

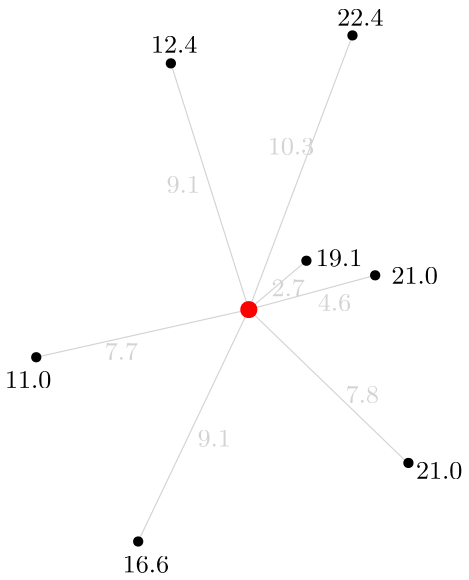
   - ◯ Tromsø (Norway)
   - ◯ Kuala Lumpur (Malaysia)

6. *(2 points)* When modelling a theoretical variogram function, what could a small range represent?

   - ◯ a dataset with a lot of noise
   - ◯ a dataset with a small bulge in the middle
   - ◯ a dataset with limited spatial correlation
   - ◯ a dataset with a continuous slope

7. *(2 points)* If you interpolate with IDW (radius=8.0; power=2) at the location in red, what estimation of the elevation do you obtain? [light grey: 2D distance; black: elevation of the sample]

- ◯ 18.37
- ◯ 19.03
- ◯ 19.54
- ◯ none of these

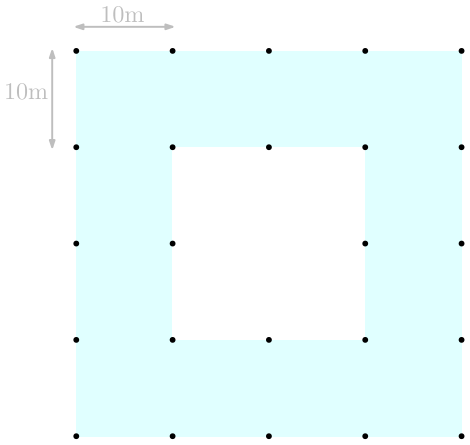


8. *(2 points)* Imagine you have a set of S of 37 points in the plane, you construct its Delaunay triangulation and you obtain 64 triangles. How many points are on the boundary of the convex hull of S?

- ◯ 4
- ◯ 7
- ◯ 8
- ◯ 11
- ◯ impossible to calculate without knowing the exact position of the points

9. *(2 points)* Given the following set of 24 points in the plane (all on a 10mX10m grid with the middle point missing), we computed its α-shape. What α value did we use?

- ◯ 4m
- ◯ 6m
- ◯ 10m
- ◯ 20m

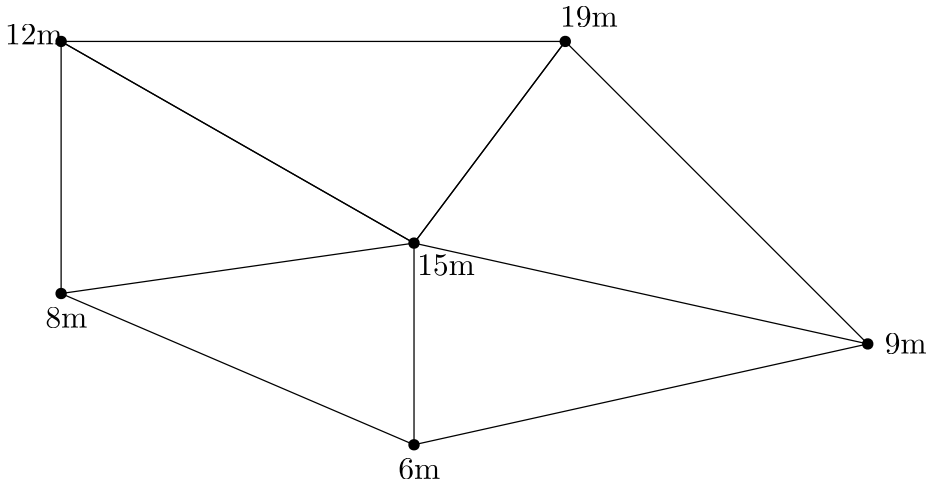


10. *(2 points)* Increasing the parameter d of the GFTIN algorithm (Ground filtering with progressive TIN densification) will mean that generally _____ points will be classified as ground.

- ◯ more
- ◯ less

Short answer questions (60 points)

11. *(6 points)* Assume you have the small terrain in TIN format below, draw the isoline for an elevation of 9m.



12. *(6 points)* We know the slope for a given location (x, y): its gradient (α) is 19° and its aspect (θ) is 95°. Draw the (hypothetical) isolines for the area surrounding this location, and identify clearly where that point would be and what the scale of the map is. An estimation and guessing of the surrounding is fine.

13. *(6 points)* Given an AHN4 tile in LAZ format, how to obtain the *canopy height model* (CHM; as defined on page 1 of the book)? We want it gridded with a resolution of 1m. Describe all the steps and algorithms you need (with parameters, if relevant).

14. *(6 points)* Given one triangle in a TIN formed of the vertices: (1, 1, 5), (4, 2, 6), and (2, 3, 11), calculate the gradient and the aspect (both in degrees) for the location (2, 2). Provide your detailed reasoning.

15. *(6 points)* Referring to Figure 12.5 of the book. If after inserting (7,3) I inserted (6,6), where would it go? Update the *k*d-tree and draw it all here.

16. *(6 points)* In the hw03 reports, most of you ranked the Hough Transform last for detecting planes in a large building like BK-City. Based on the experience you gained during hw03, list the two main drawbacks of this algorithm when compared to other two. Be precise and give me concrete examples for both drawbacks.

17. *(6 points)* You download a given AHN4 tile in LAZ format for which you want to construct the DT (with *startinpy*). If you shuffled randomly the points in the LAZ file, would the construction of the DT be faster or slower? Explain your reasoning.

18. *(6 points)* You are given a set of samples points for an area and your boss wants you to assess *quantitatively* which interpolation method—with which parameters—would yield the best results for creating a gridded DTM. Describe how you would proceed, let us say if you want to know which of those 3 methods works best for that dataset: (1) linear in TIN; (2) IDW with different parameters; (3) Laplace.

19. *(6 points)* Starting from the LAZ file of BK-City (as given to you for hw03), describe how you would identify how many solar panels of 1mX2m can be installed. Those should be not be facing North, and should not be installed on horizontal parts of the roofs or on the façades.

20. *(6 points)* What is the horizontal resolution, in meters, of one grid cell of *CopernicusDEM* in Delft, the Netherlands? The exact value is not necessary, an approximation is sufficient. Provide your detailed reasoning.

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