Faculty of the Built Environment & Architecture

Digital terrain modelling (GEO1015) — 5 EC

Location: Building #26 zaal 2
Date & time: 31 January 2020, 09:00–11:00
Responsible teacher: Hugo Ledoux

1. The subject matter is in full accordance with the study guide.
2. This final exam is worth 30% of the final mark for the course.
3. There is 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]
4. The maximum grade for this course is 10.
5. The minimum (unrounded) final mark to pass this course is 5.75, which will be rounded to 6.0. However, you need at least a 50% in this final exam to be able to pass the course.
6. This is a closed-book exam. The use of a computer is forbidden, but a calculator is fine.
7. Before starting, check if all the pages and questions are there.
8. Fill out your name and student ID.
9. Write clearly, and formulate concisely and to-the-point. Do not hesitate to draw a figure to help us understand, if needed.
10. Answer directly on these pages. If there is not enough space, use extra sheets and staple them at the end.
11. The total number of pages of this exam is 15 pages.
12. You have 2 hours to do this exam.

Name:

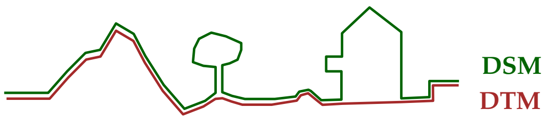
Student ID:

Multiple choice questions (20 points)

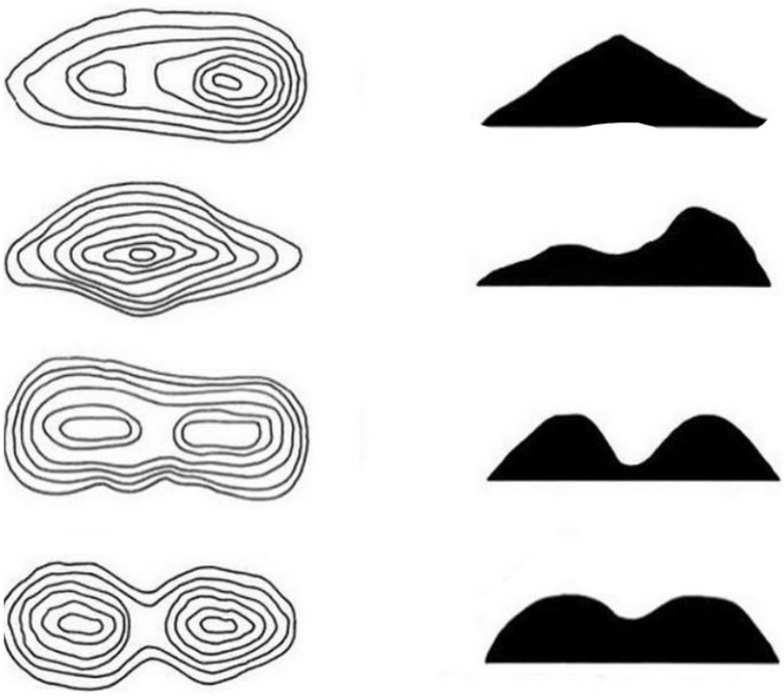
[Only one good answer, unless otherwise stated]

1. (2 points) When modelling terrains, one should be aware of the differences between a DTM and a DSM. If an area has a tree and a building, is the figure below correct?

   - ◯ Yes
   - ◯ No



2. (2 points) Join, with a line, the terrain and its mostly likely corresponding contour lines.



3. (2 points) [What is the missing word?] Given a bivariate field $f(x, y) = z$, ---------- is the set of points in space where $f(x, y) = z_0$ (z_0 being a constant).

   - ◯ a tessellation
   - ◯ a piecewise linear cell
   - ◯ an isoline
   - ◯ the α-shape

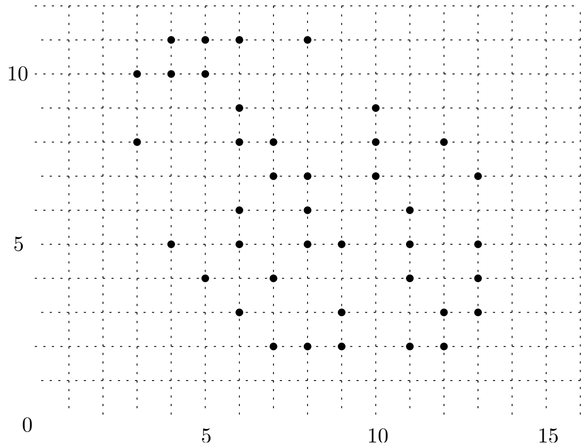
4. (2 points) Which of the following disadvantages is **false** for multiple flow direction methods?

   - ◯ they are harder to implement
   - ◯ they cause flows to diverge
   - ◯ they are computationally less efficient
   - ◯ they are more prone to creating artefacts

5. (2 points) If you construct the α-shape of this set of points in $\mathbb{R}^2$ with $\alpha = 1.5unit$ (where α is the radius of the circle), the result be the same as the convex hull of S.

   ◯ True

   ◯ False



6. (2 points) How can the flow direction in flats be determined? [2 good answers]

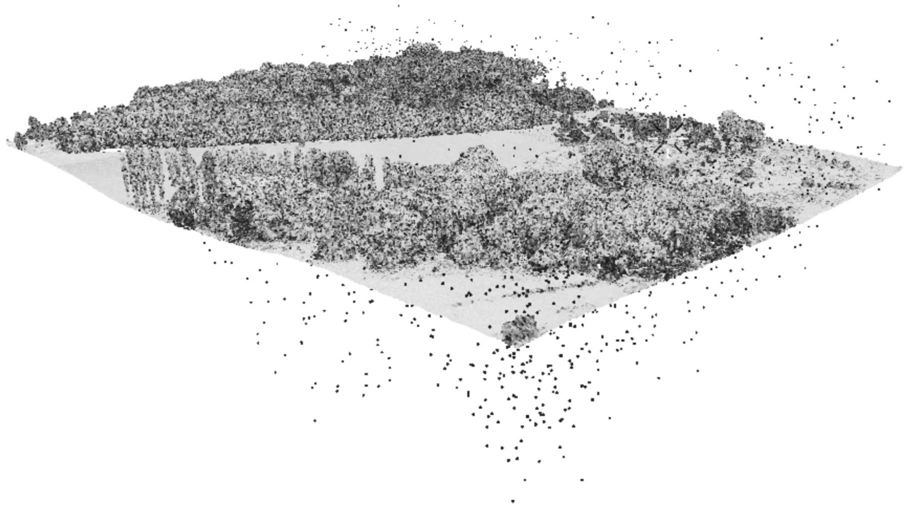
   ◯ using a gradient towards higher terrain

   ◯ using a gradient away from higher terrain

   ◯ using a gradient towards lower terrain

   ◯ using a gradient away from lower terrain

7. (2 points) Consider the point cloud below. What do you need to do before you can successfully perform the ground filtering algorithm described in the book? Assume you have an infinitely fast computer and computation times are of no concern!



   ◯ outlier detection

   ◯ thinning

   ◯ thinning and shape detection

   ◯ perform the Hough transform

8. (2 points) Which one is true for the RANSAC algorithm?
   - ◯ it is very sensitive to small numbers of outliers
   - ◯ if you run it several times with the same input you can get different results
   - ◯ nearest neighbour searches, e.g. using a *k*d-tree, play an essential role
9. (2 points) Which of the following are properties of simple kriging? [2 good answers]
   - ◯ we can use simple kriging only when the trend is known
   - ◯ simple kriging estimates the trend automatically as a constant
   - ◯ we can use the variogram in simple kriging
   - ◯ in simple kriging we need to manually define a covariance function
10. (2 points) The number of axes of the accumulator used in the Hough transform algorithm depends on _________
   - ◯ the number of shape instances you want to detect in your dataset
   - ◯ the dimensionality of the shape of interest
   - ◯ the quantisation of the shape parameters
   - ◯ the number of shape parameters

Short answer questions (60 points)

11. (6 points) You are given a set of isocontours for a part of the seabed next to the Netherlands, these isocontours were generated from the raw multibeam echosounding points (eg as in the figure below). Explain why generalising the line (with Douglas-Peucker algorithm for instance) cannot be done, and explain an alternative to obtain suitable isocontours for an hydrographic chart.

12. (6 points) Given a set S of points in $\mathbb{R}^2$, give the definition of the convex hull of S. Also, describe the algorithm to extract it from a Delaunay triangulation of S (given the data structure you used for the Assignment 1).

13. (6 points) The official AHN3 dataset is available as a raw point cloud (.laz files) or as gridded DTM 50cmX50cm. However, there are several pixels having `no_data`, that is no value was assigned to those. Given one gridded DTM containing such artefacts, describe in details the methodology you would use to fix this, and produce a "complete surface".

14. (6 points) Given a viewpoint v, located 2m above the ground in a raster DTM (1mX1m), we want to calculate its viewshed. Explain what a viewshed is (what is its result/output?) and describe briefly how to calculate it *efficiently*.

15. (6 points) During the assignments, you often used a *k*d-tree to speed up operations like finding the closest neighbour(s) of a given location in 3D. Explain in your own words what a 3D *k*d-tree is, and give a concrete example with a few points.

16. (6 points) What is the main advantage of kriging over other interpolation methods?

17. (6 points) Draw a small DTM that contains both a sink and a flat. (you can draw with contour lines and/or a perspective view, it is up to you)

18. (6 points) You are given an unclassified urban point cloud and you are given the task of classifying this point cloud into three classes: 1) ground points, 2) building points, and 3) other points (eg vegetation, street furniture, cars etc). You may assume that all the buildings are composed of large planar surfaces. Describe how you could achieve this using the methods you learned in this course.

19. (6 points) Explain in your own word what a weighted-average interpolation methods is, and give two concrete examples of methods (and why they are weighted-average methods).

20. (6 points) To represent a terrain, there is a constant discussion "TIN versus grids, which one is best?". Based on everything you have learned in this course, you should now have an opinion. Pick one and argue why it is better than the other one (give 3 distinct arguments).

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