Name: _____

Student ID: _____

This mid-term exam is worth 15% of the final mark for the course.

There is 82 points to earn:

- 8 multiple choice questions [4 points each]. For this section, there is **negative marking**. That is, for each question, if you get it right you get 4pts, if you answer nothing you get 0pt, and if you get it wrong you get -2pt. You cannot get less than 0pts in total for these questions.
- 5 short answers [10 points each]

Answer directly on these pages. If there is not enough space, use extra sheets and staple them at the end.

This is an open-book exam, only paper is allowed. No computer/phone/etc, a calculator is fine.

The total number of pages of this exam is 9 pages.

You have 1h15min to do this exam.

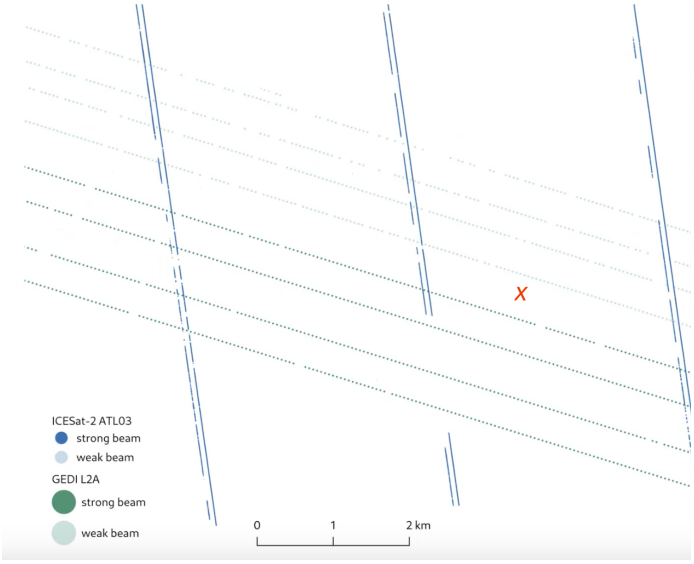
Multiple choice questions (32 points)

[Only one good answer, unless otherwise stated]

1. (4 points) In the context of this course, a triangulated irregular network (TIN) is:
   - ◯ a piecewise tessellation of the plane into adaptive cells where a linear function is used to estimate the elevation
   - ◯ a hierarchical tessellation of the plane space into triangles where a linear function is used to estimate the elevation
   - ◯ a hierarchical tessellation of the plane space into triangles where a constant function is used to estimate the elevation
   - ◯ a piecewise tessellation of 3D space into tetrahedra where a linear function is used to estimate the elevation
2. (4 points) [What is the missing word?] Given a bivariate field $f(x, y) = z$, a/an _____ is the set of points in space where $f(x, y) = z_0$, where z_0 is a constant.
   - ◯ 2.75D surface
   - ◯ C^1 interpolant
   - ◯ hierarchical tessellation
   - ◯ none of these

3. (4 points) Say you have some elevation points coming from ICESat-2 and GEDI, see figure. Those have a very anisotropic distribution. If you wanted to interpolate at location x, which method would yield the best results?

   - ◯ nearest neighbour interpolation
   - ◯ natural neighbour interpolation
   - ◯ IDW
   - ◯ TIN with higher-order function inside each triangle



4. (4 points) In a typical variogram, ...

   - ◯ $\gamma^\star(0) = 0$
   - ◯ as $|h|$ increases, $\gamma^\star(|h|)$ increases
   - ◯ as $|h|$ increases, $\gamma^\star(|h|)$ reaches a maximum before dropping
   - ◯ $\gamma^\star(|h|)$ increases fastest when $|h|$ is close to zero

5. (4 points) For a given set of elevation points, which one will yield, in most cases, a smoother surfaces (less 'bumpy'):

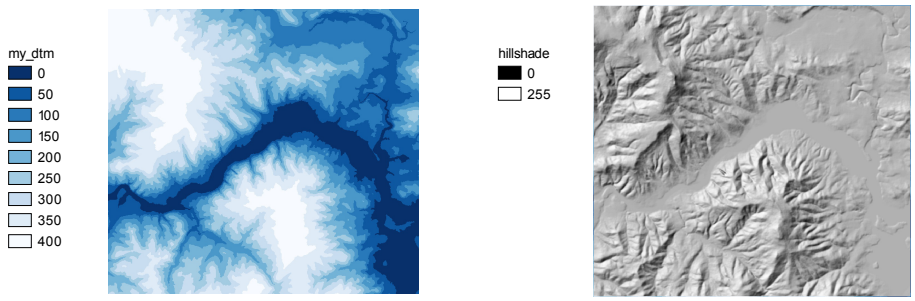
   - ◯ IDW; power=2; search circle with radius=10m
   - ◯ IDW; power=2; search ellipse with radius1=10m and radius2=5m

6. (4 points) Which of the following statements regarding artefacts in data acquisition are true? [more than one answer possible]

   - ◯ Occlusion can lead to no-data gaps
   - ◯ Occlusion can lead to outliers
   - ◯ The multi-path effect can lead to outliers

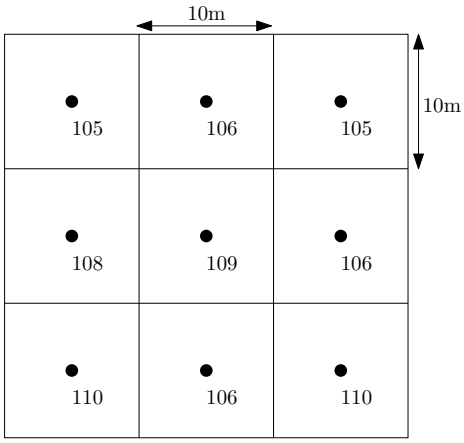
7. (4 points) Given a raster of elevation like the one below (left), which parameters must be extracted from it to obtain a hillshade (right). [more than one answer possible]

- ◯ the aspect of each cell
- ◯ the gradient of each cell
- ◯ the height of the sun with respect to each cell
- ◯ the azimuth of the sun with respect to each cell



8. (4 points) If we want to compute the slope for the cell at the centre of this 3×3 DTM with the 'finite difference method', what results will we get?

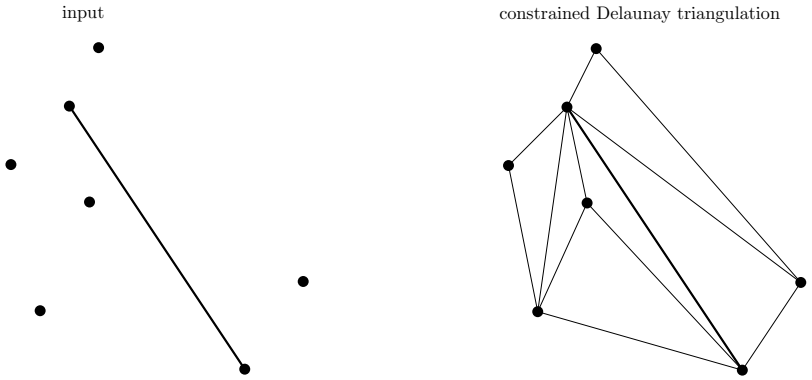
- ◯ gradient=20% & aspect=0°
- ◯ gradient=10% & aspect=45°
- ◯ gradient=20% & aspect=90°
- ◯ gradient=10% & aspect=180°



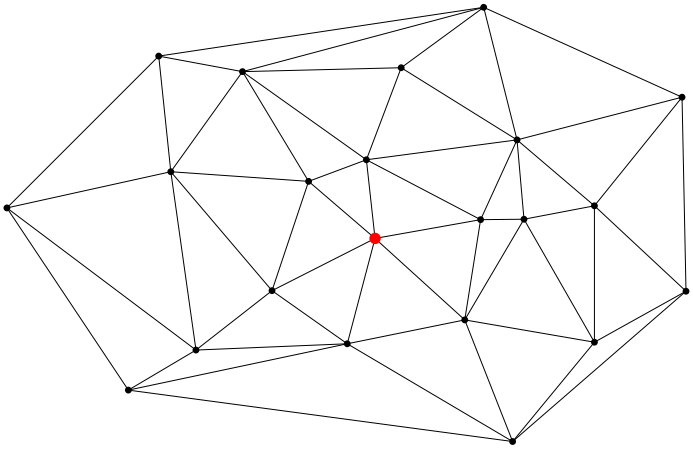
Short answer questions (50 points)

9. (10 points) Calculate the slope (gradient+aspect) for the location (12.0, 13.0), knowing that in your TIN you have one triangle formed by the following 3 vertices: (10.0, 11.0, 17.0), (10.0, 21.0, 19.0), and (22.0, 11.0, 17.0).

10. (10 points) Is the constrained Delaunay triangulation below a valid one? If not, point out the error/s and correct it/them.



11. (10 points) Given a Delaunay triangulation of a set of point S, describe in details the steps necessary to compute the area of the Voronoi cell of a vertex that is not on the boundary of the convex hull of S. (for instance the point in red below)



12. (10 points) What makes kriging different from the other interpolation methods discussed in the course?

13. (10 points) In runoff modelling, methods to assign flow direction in flats tend to combine two approaches: (i) assigning an artificial gradient away from higher terrain, (ii) and assigning an artificial gradient towards lower terrain. Why are both of these approaches necessary? Or in other words: why is a single approach sometimes insufficient to deal with certain datasets?

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