

Multiple choice questions (28 points)

[Only one good answer, unless otherwise stated]

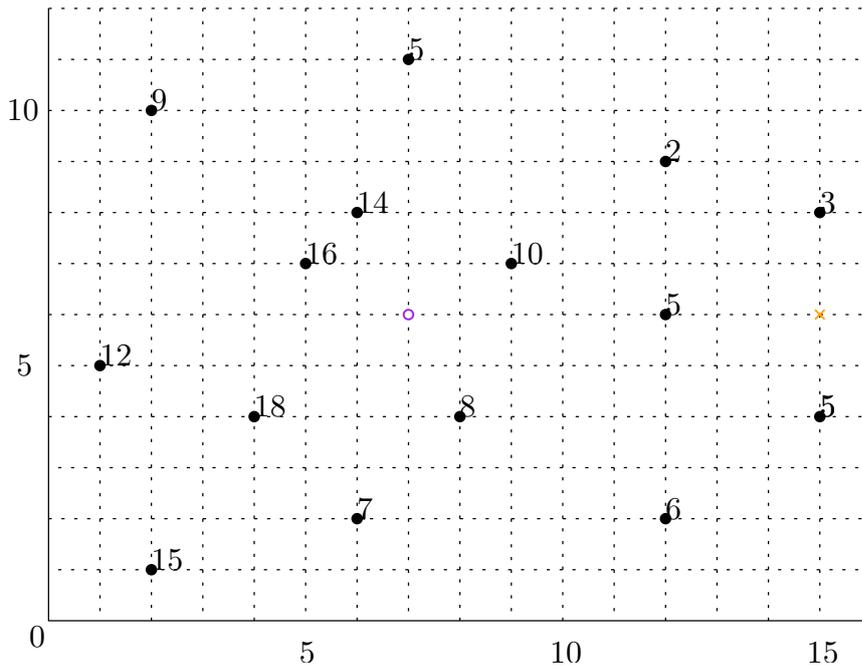
1. (2 points) A C^0 interpolant (a function) is a continuous function whose first derivative might not be possible to calculate at certain points.
 - true
 - false
2. (2 points) When we say that a terrain is a '2.5D' object, which ones of the following are true? [2 good answers]
 - for each location (x, y) there is one and only one elevation value
 - for each location (x, y) there is a maximum of two z values, one for x and one for y
 - it can have vertical surfaces, as long as these are 2-manifold
 - it is a surface embedded in 3D space
 - the surface must be triangulated
3. (2 points) When is bilinear interpolation used in a DTM context?
 - for any bivariate datasets
 - when there are 2 dependent values to (x, y) , eg elevation and time
 - when the input is a grid raster
 - when the input is a TIN
4. (2 points) The Voronoi diagram (VD) and the Delaunay triangulation (DT) are dual. Let e be a given edge in the DT: what is its dual in the VD?
 - a Voronoi cell perpendicular to e
 - an edge formed by the 2 endpoints of e
 - an edge formed by the circumcentres of all the triangles incident to both end points of e
 - an edge formed by the 2 vertices dual to the 2 triangles incident to e
5. (2 points) What does kriging try to minimise?
 - the difference between the sum of the weights and one
 - the variance of the estimation
 - the Lagrange parameter
 - the bias of the estimation

6. (2 points) The 15 elevation samples below have been collected. You want to interpolate at two location:

1. at location (7, 6) with IDW (radius=3; power=2); the purple circle.
2. at location (15, 6) with linear interpolation in TIN; the orange cross.

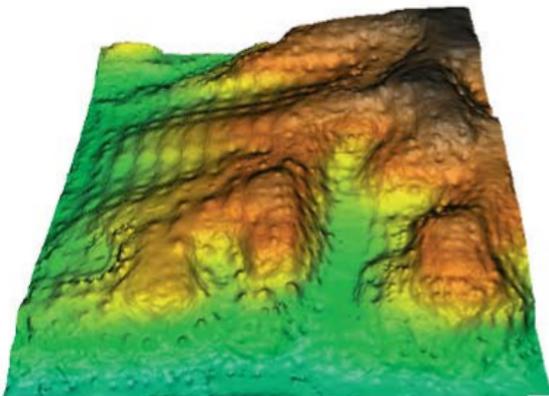
What are the respective answers?

- 12.54 and 2.6
- 12.54 and 4
- 12 and 4
- none of the answers



7. (2 points) You used the inverse distance weighting (IDW) method to generate a surface from samples, but the result is very 'bumpy' like in the figure below. How do you fix it?

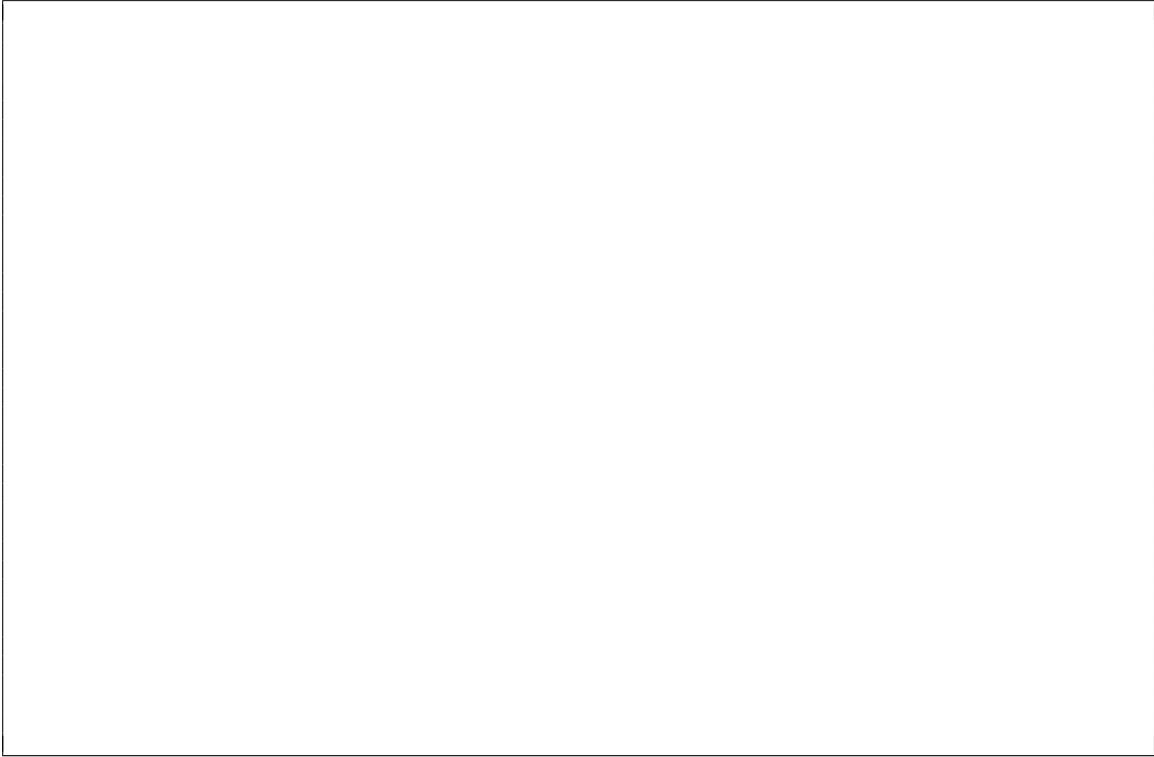
- increase the search radius
- decrease the search radius



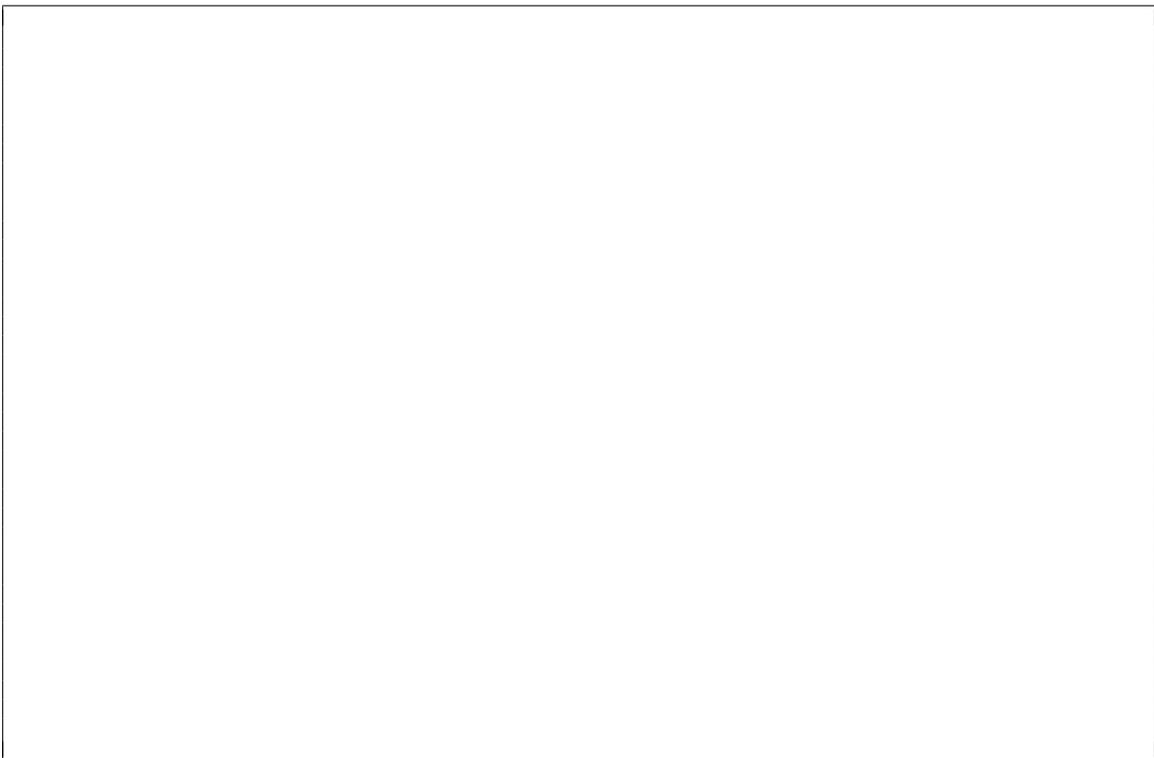
8. (2 points) How is precipitation typically modelled in runoff modelling in GIS? [2 good answers]
- using historical and meteorological data
 - based on the width of the flow
 - as one unit of water per DTM cell in a raster grid
 - proportional to the area of each triangle in a TIN
 - for each cell it is the sum of the cells above it
9. (2 points) What acquisition techniques are based on the time-of-flight principle? [2 good answers]
- lidar
 - photogrammetry
 - InSAR
 - echo sounding
10. (2 points) What is generally true for airborne lidar acquisition? [2 good answers]
- the ability to measure the ground surface below trees
 - apart from elevation it also measures colour
 - it is not affected by multi-path effects
 - building faades typically have a lower point density than roof tops
11. (2 points) [What is the missing word?] The _____ is the 2nd derivative of the surface representing the terrain, it represents the rate of change of the gradient.
- aspect
 - slope
 - curvature
 - none of these
12. (2 points) The medial axis transform is dual to the boundary representation.
- true
 - false
13. (2 points) Which one is true for the RANSAC algorithm?
- it is very sensitive to outliers
 - if you run it several times with the same input you can get different results
 - nearest neighbor searches, e.g. using a *kd*-tree, play an essential role
14. (2 points) What is stored in the header of a LAS file?
- GPS time of all points
 - classification of all points
 - CRS of all points
 - none of these are stored

Short answer questions (72 points)

15. (6 points) It is mentioned in the Lesson 01 handout that “a point cloud is an incomplete representation for a terrain”. Explain what that means.



16. (6 points) We saw in the handouts that an ‘ideal’ interpolation method for terrain datasets should have different properties (7 were listed). Give 3 and explain what they mean.

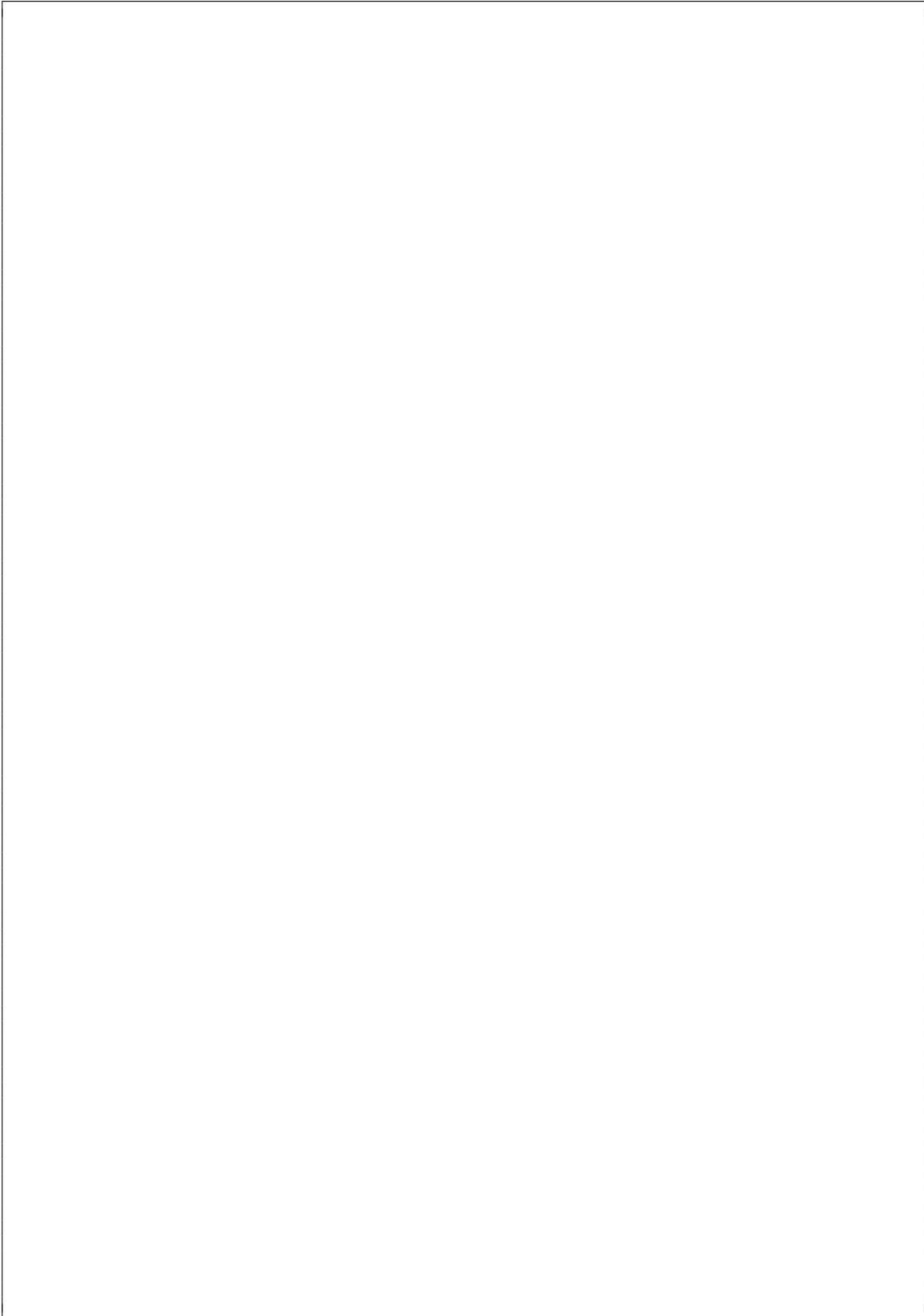


17. (6 points) When converting isolines to a TIN, what main “problem” should you be aware of? Describe *in details* one algorithm to convert isolines (given for instance in a *shapefile*) to a TIN and avoid this problem.

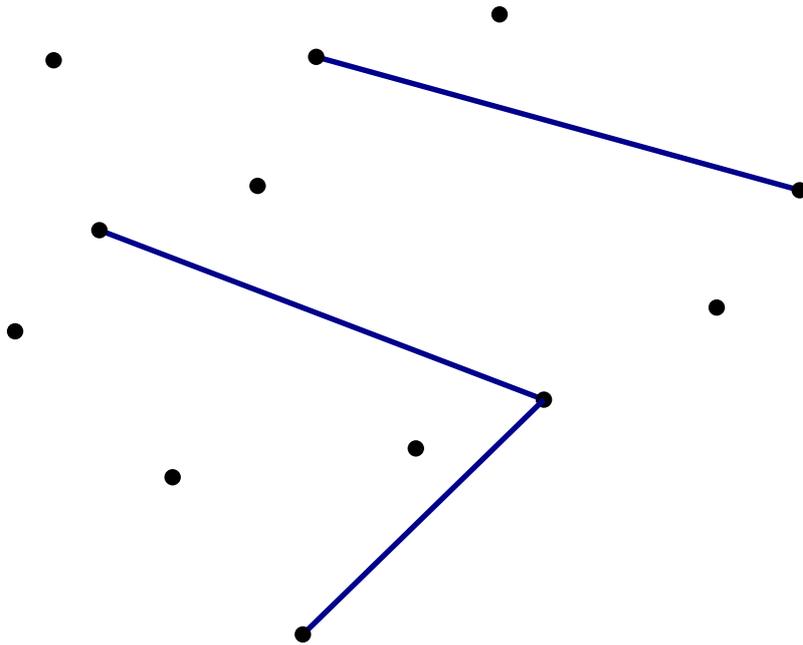
18. (6 points) Explain in your own words what the streaming of geometries is, and how it concretely helps to construct the raster DTM of massive datasets.



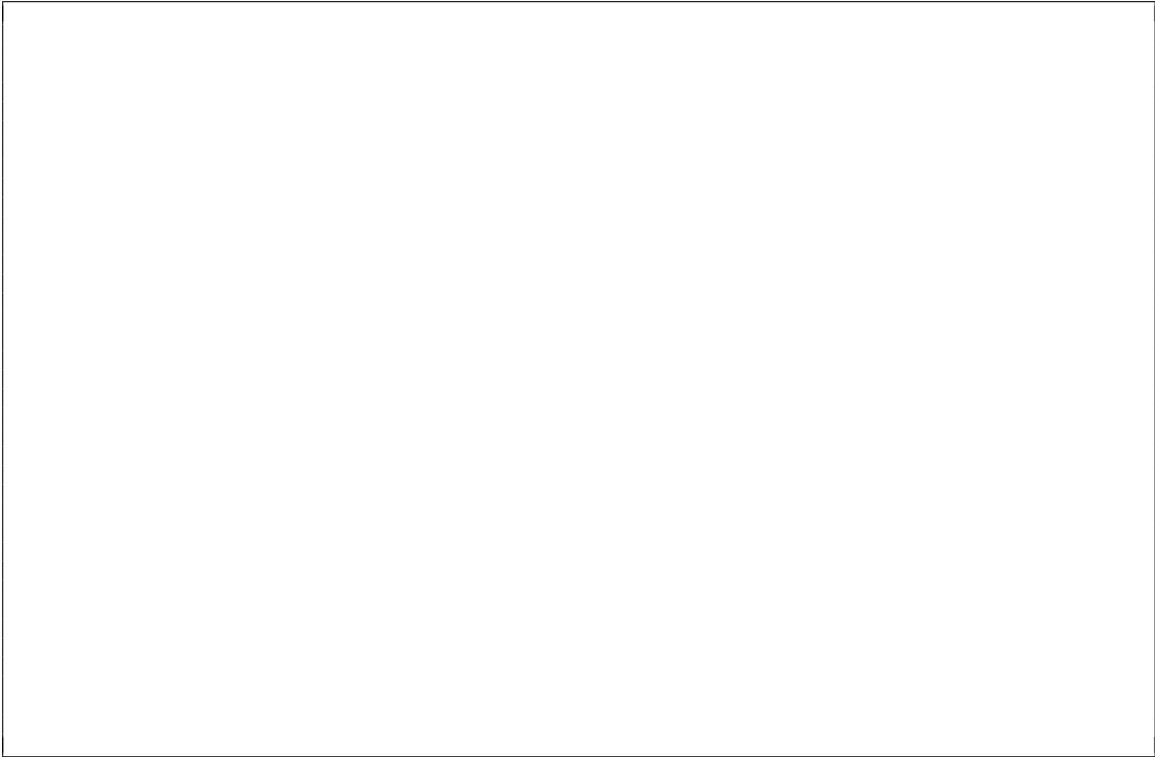
19. (6 points) During the assignments, you often used a *kd*-tree to speed up operations like finding the closest neighbour(s) of a given location in 3D. Explain and draw a simple *kd*-tree in 2D, and explain how the closest point to a given location (x, y) can be obtained (the full algorithm not necessary, the main ideas only).



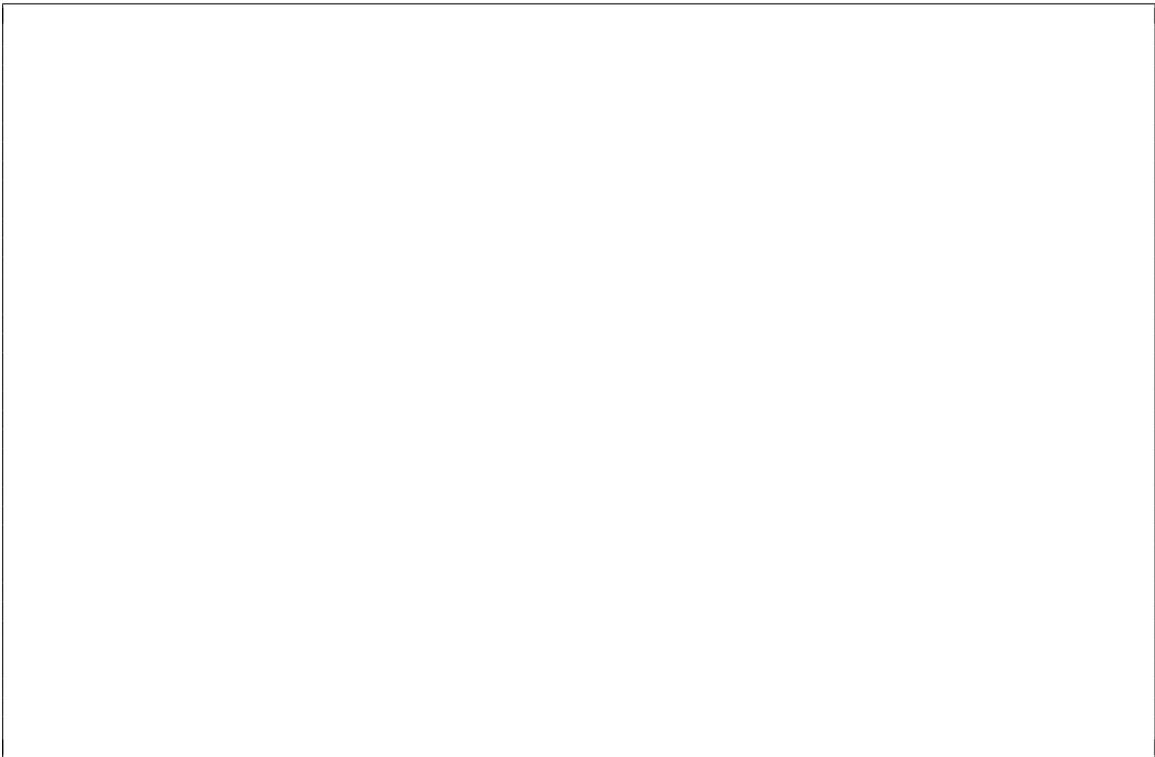
20. (6 points) Given the input formed of elevation points and breaklines below (both projected to the xy -plane), explain what the conforming Delaunay triangulation is and draw it (an approximation is fine).



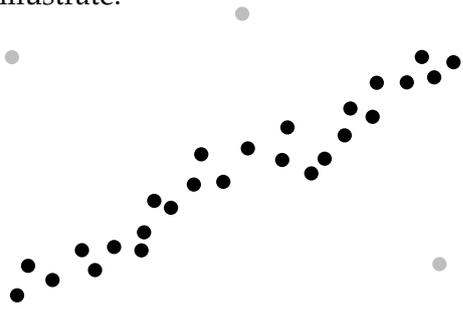
21. (6 points) Given a raster terrain (GeoTiff format) that contains several cells with no_data values, describe the methodology you will use to extract contour lines from it. As a reminder, contours lines should be closed curves, except at the boundary of the dataset.



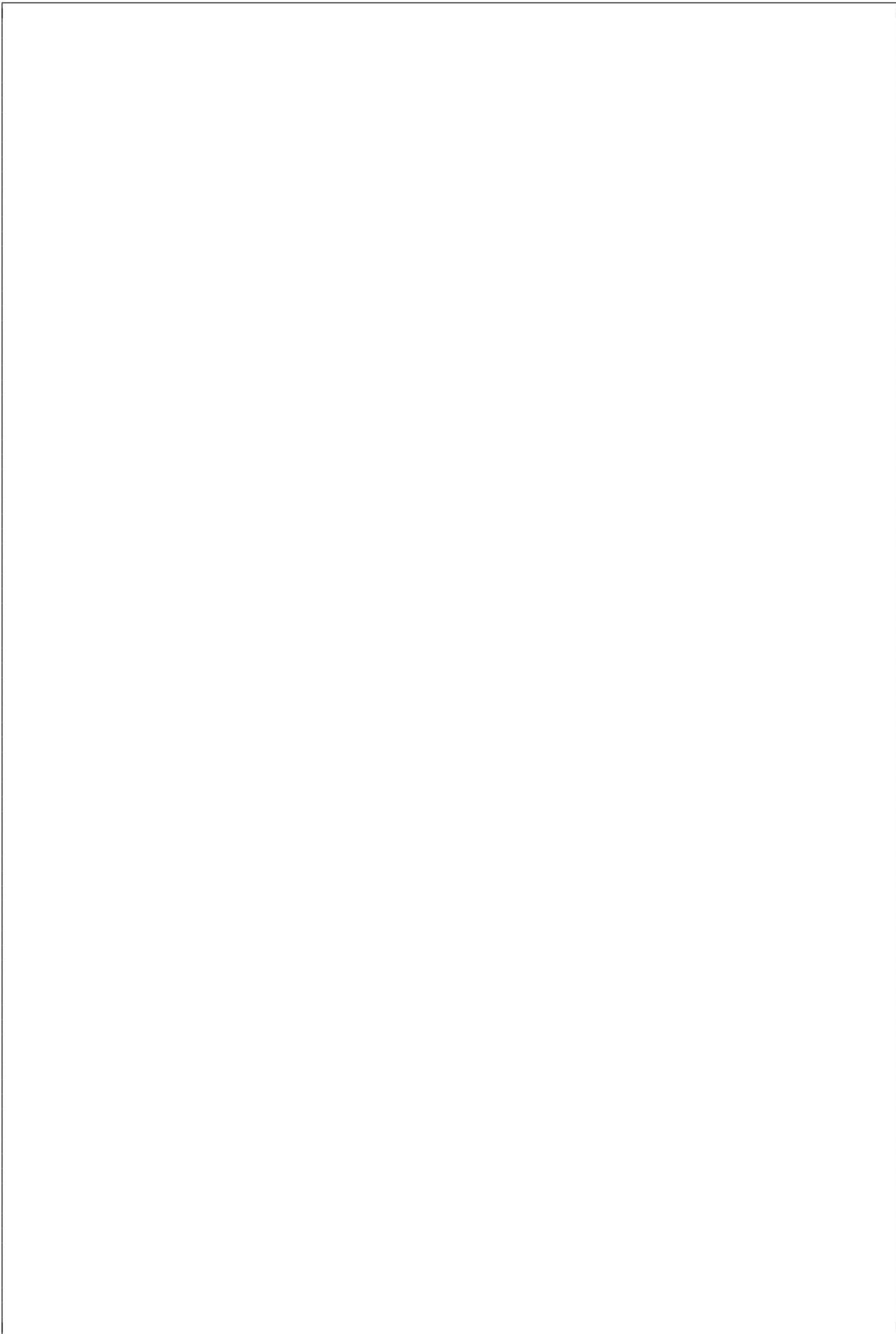
22. (6 points) What is a saddle point in a terrain? Draw/describe a concrete example.



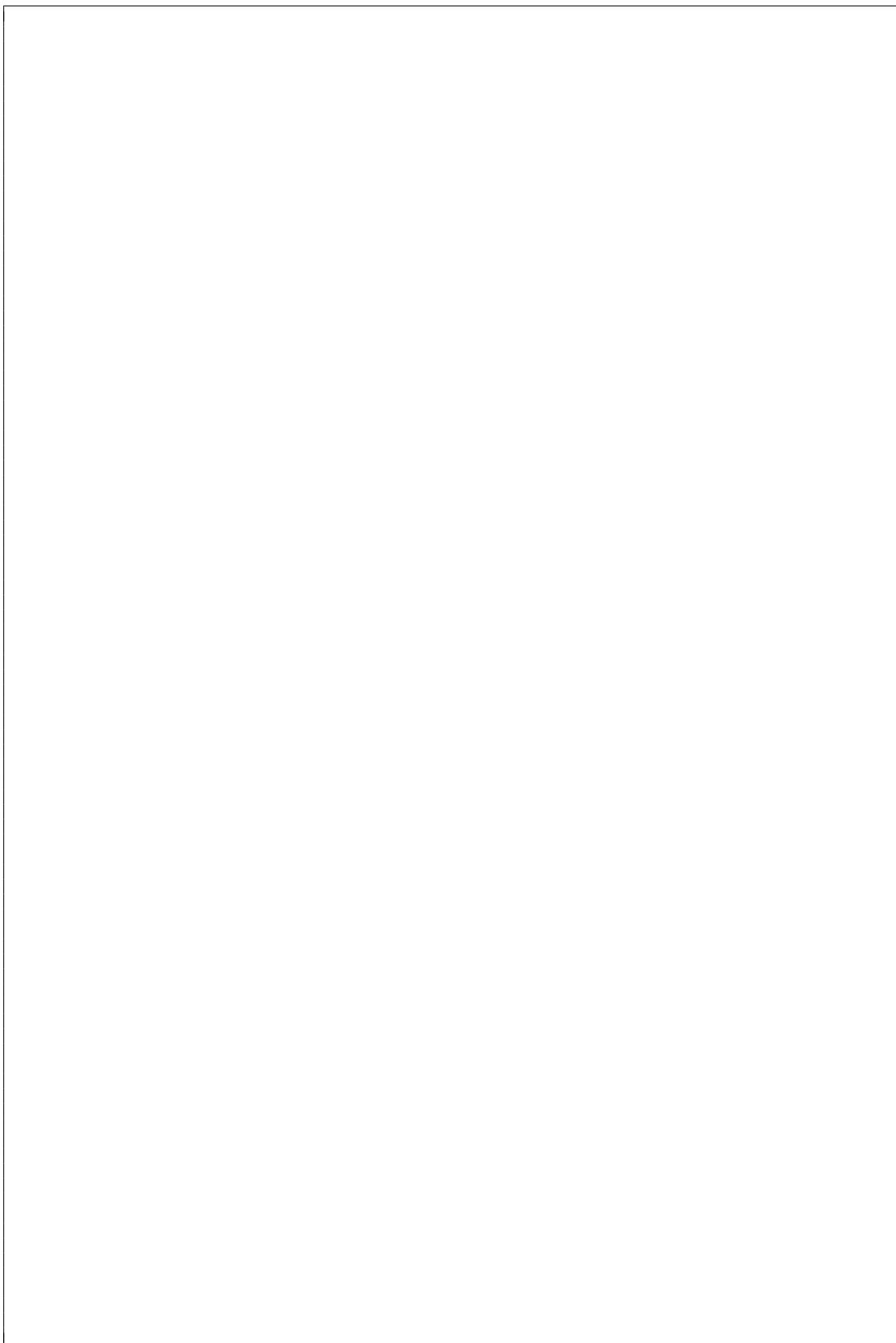
23. (6 points) The point cloud depicted below has a few outliers drawn in grey. Explain in details one algorithm that can be used to automatically remove these. Use the figure to illustrate.



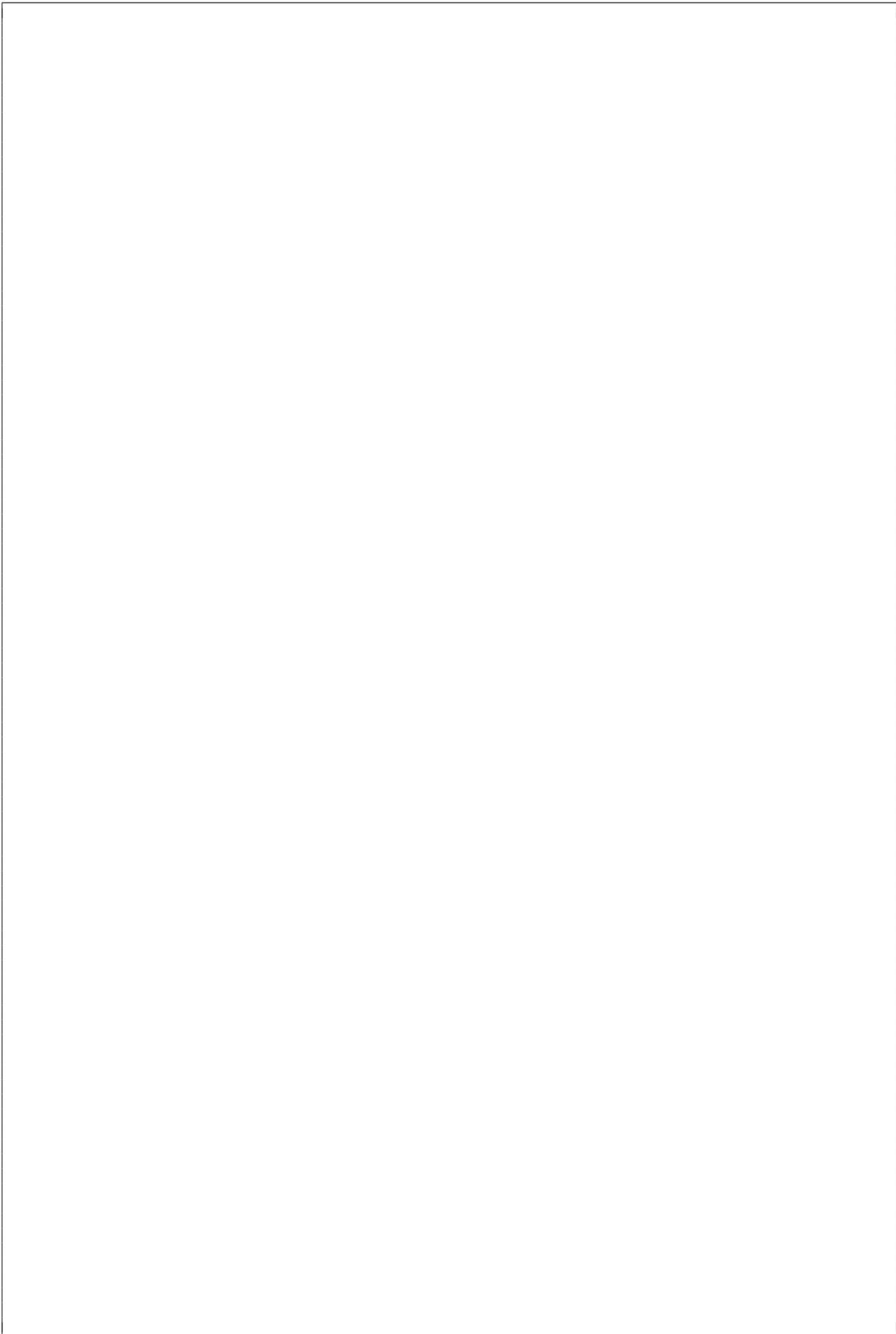
24. (6 points) Ordinary kriging can be very slow if you use all sample points. Why is that and how can we get around that problem?



25. (6 points) Explain what is the difference between single and multiple flow direction methods in runoff modelling?



26. (6 points) Give three reasons for imperfections in a point cloud such as varying point densities or outliers.



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