Forward Modelling for Gravity Anomalies

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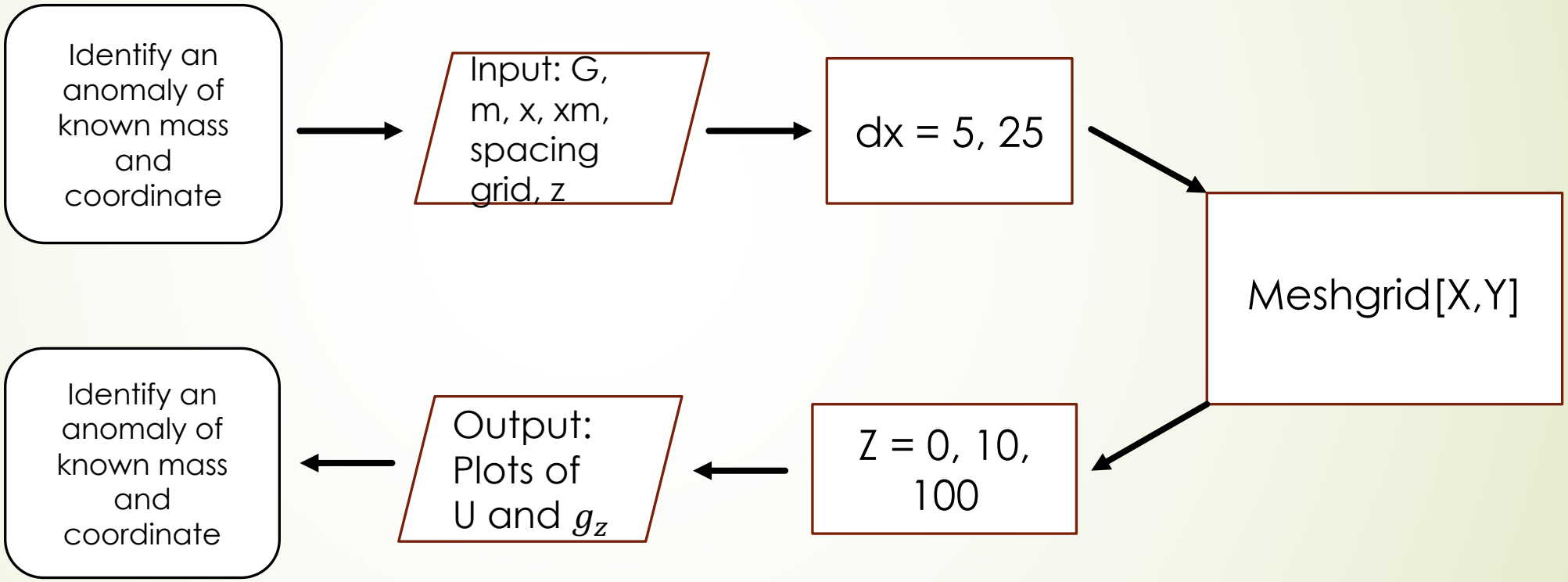
Overview

- Gravitational potential (U) and gravity effect (g_z) are dependent on mass of anomaly and distance ('depth')
- Perform forward modelling to visualize how U and g_z is affected with varying distance, mass distributions and viewed by changing grid spacings
- Approximating U and g_z of nonuniform object via derivatives and testing against calculated results
- A general goal: raise awareness on nonuniqueness within gravity surveys that rise from existence of two free parameters; depth and density

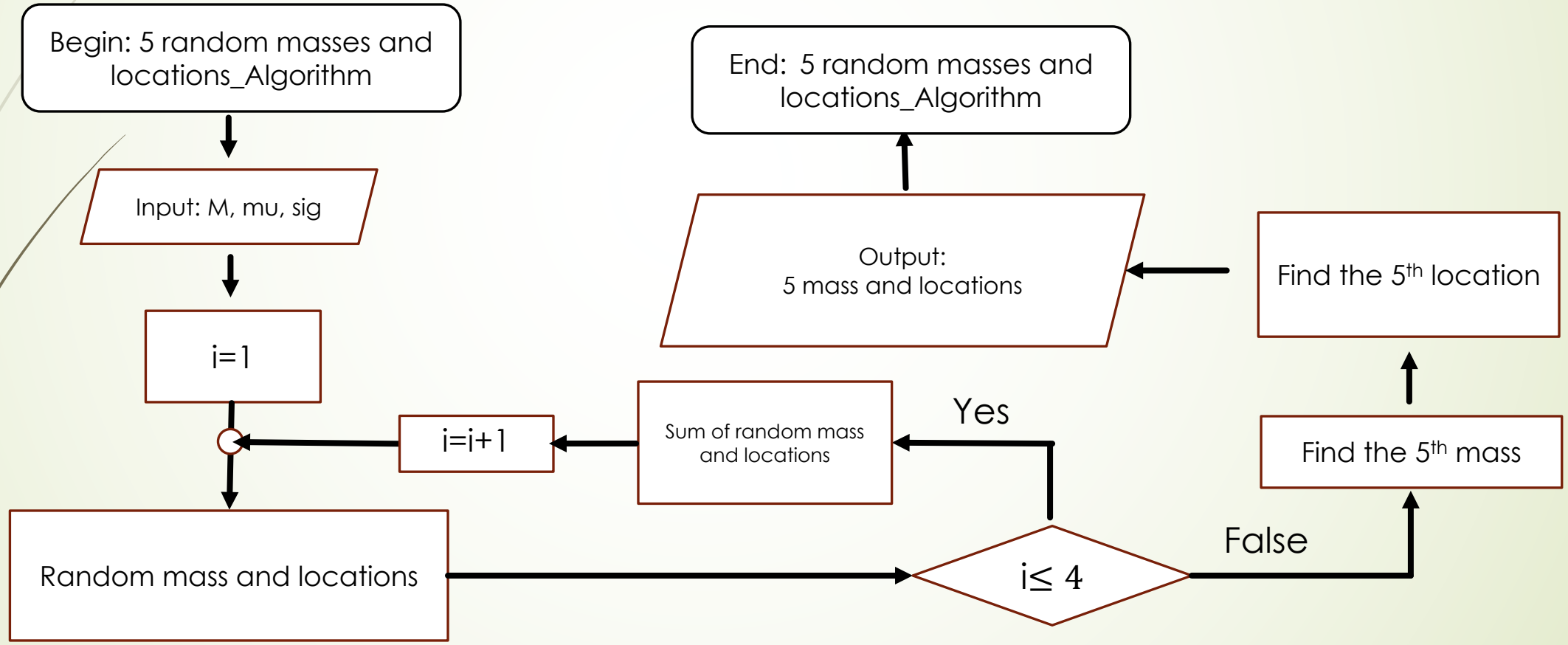
Background and Theory

- *Gravitational Potential, U*
  - $U(r) = \frac{Gm}{r}$
  - $r = \sqrt{x^2 + y^2 + z^2}$
  - $U \propto 1/r$
- *Gravity Effect, g_z*
  - $g_z = -\frac{\partial U}{\partial z} = Gm\frac{z - z_m}{r^3}$
  - $g_z \propto \frac{1}{r^3}$
- Assumptions:
  - In equation used, derived volume integrals in Cartesian coordinates[1]
  - Worked with scalar potential[2], obtaining **g** through **g** = -∇U
  - Mass and mass sets in q3/q4 were treated as point sources
- Boundary condition
  - Homogenous halfspace layer (excluding anomaly points embedded)

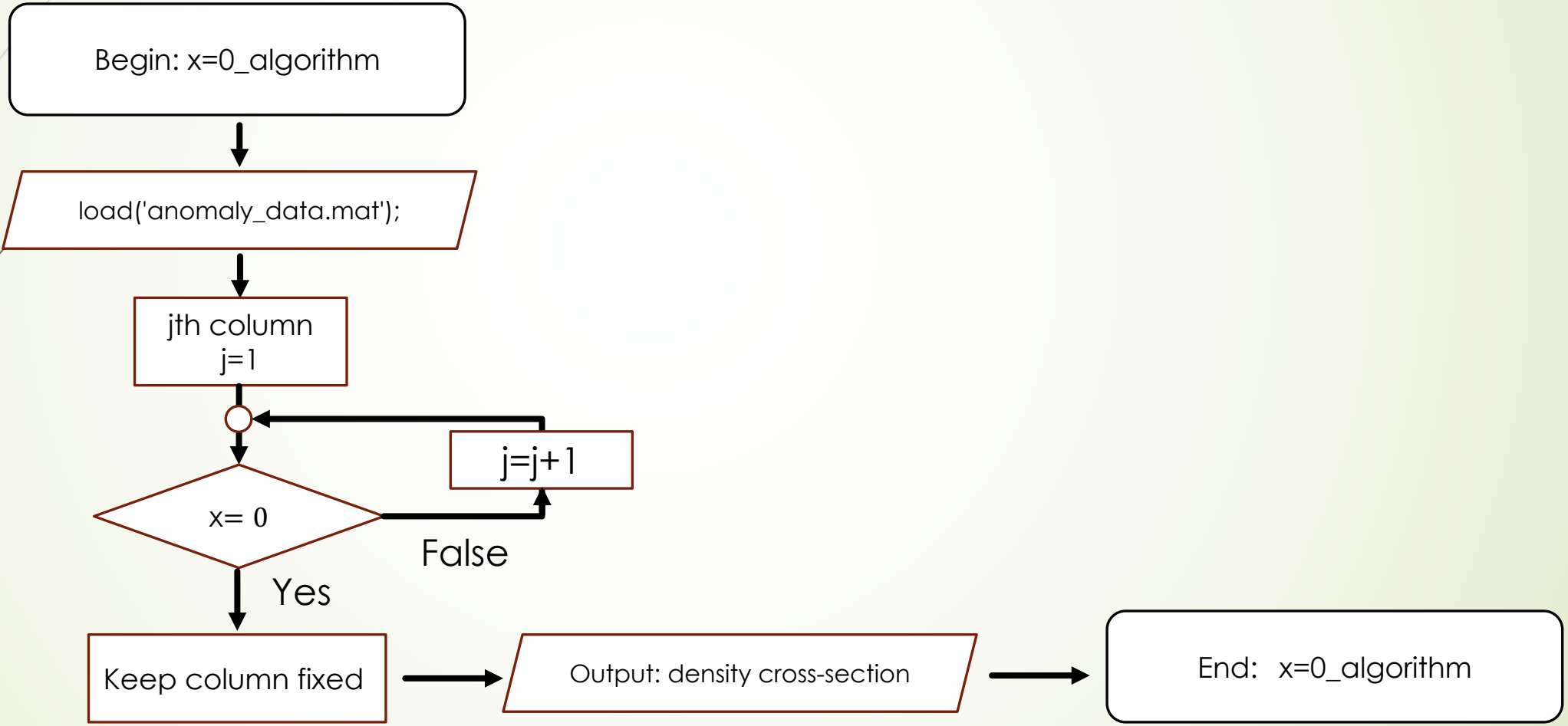
Question 3
Mass anomaly of U and g_z



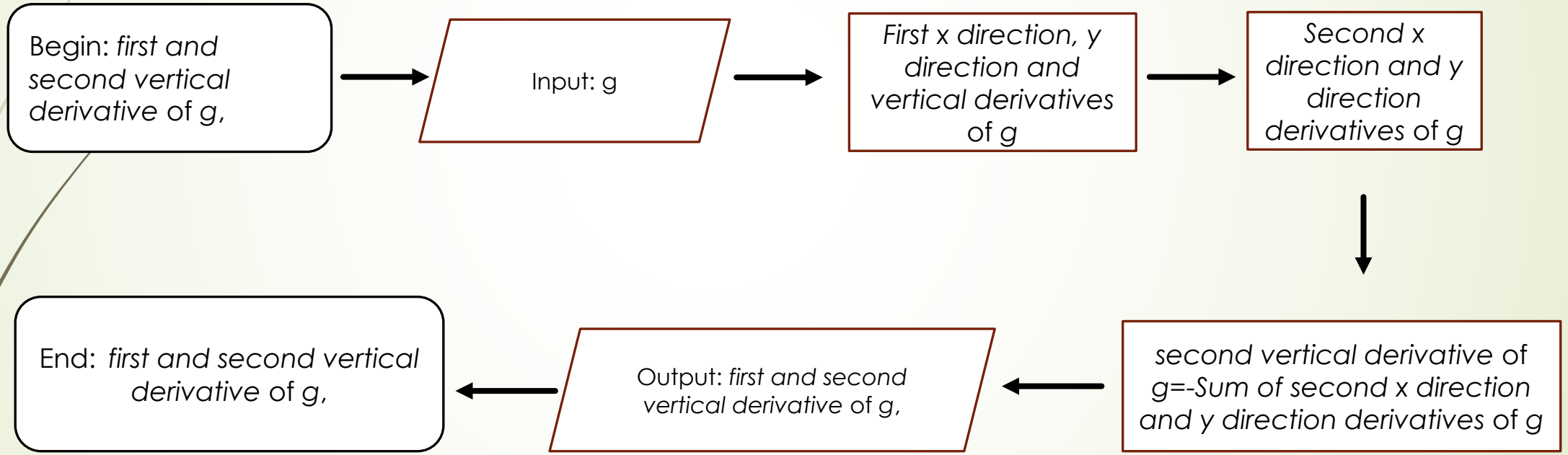
Question 4
Random mass and locations



Question 5
Density cross-section of the anomaly



Question 5
Derivatives



Concluding Remarks

- 'Resolution' most clear of U and g_z at shallowest depths
- Smaller grid spacings resolve mass points more effectively
- Density cross sections of irregular shape help visualize geometry of object
  - Similar results to mass points earlier; shallow/small grid spacing = better
  - Partial derivatives are good approximations, yet resolution slightly lower
- Exercise demonstrated the ultimate problem of nonuniqueness

References

- [1,2]Karchewski, B. (2017). GOPH 547 - Gravity and magnetics. Retrieved from https://d2l.ucalgary.ca/d2l/le/content/169330/viewContent/2346958/View
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