Imperial College London

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Weekly Meeting

Week 5

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Lesson Learned from Arnold Nicholas's Thesis

The research explored the integration of DL architecture, e.g. CNN and point-based networks and addressing the challenge of segmentation algoritms.

Challenges

- Processing 3D point cloud can pose significant computational demands, mainly when dealing with complex and dense scene.
- the absence of GPU strongly influenced the research direction and methodology.
- DL typically require extensive memory and processing power, not viable without GPU

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Summarising Arnold's Outcome

- **Outcome** : Geometric-Partitioning and eXplainable Point Cloud Classifier (GeoPart-XPCC)
- **Data Preprocessing:** Min-Max Normalisation, L2 Normalisation
- **Algorithms and Heuristic:** Greedy Algorithm, Incremental Algorithm, Feedforward Algorithm, **Supervised Learning, Classification, Unsupervised Learning, Clustering, Point Cloud Segmentation**

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LiDAR Data Update

Challenge

- Error
- Crashed
- Time Consuming

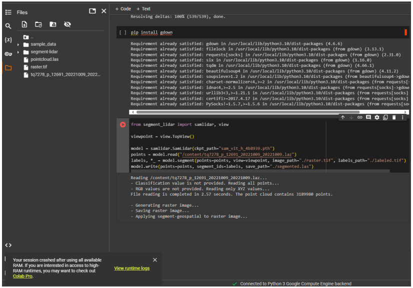

Figure 1: LiDAR Exploration Issue

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Bernoulli's Equation

[1] Water Channel Pressure

$$P + \frac{1}{2}\rho v^2 + \rho g h = constant \tag{1}$$

$$P_1 + \underbrace{\frac{1}{2}\rho v_1^2}_{\text{kinetic energy}} + \underbrace{\rho g h_1}_{\text{potential energy}} = P_2 + \underbrace{\frac{1}{2}\rho v_2^2}_{\text{kinetic energy}} + \underbrace{\rho g h_2.}_{\text{potential energy}} \tag{2}$$

Poiseulle's Law

[1] Poiseulle's law says that the flow rate Q depends on fluid viscosity η, pipe length L, and the pressure difference between the ends P but all these factors are kept constant for this demo so that the effect of radius r is clear.

$$Q = \frac{\pi r^4 P}{8 \eta L} \tag{3}$$

Permeability / Darcy Law [2]

$$Q = -KA\frac{dh}{dx} \tag{4}$$

where K is the hydraulic conductivity and $\frac{dh}{dx}$ is the hydraulic gradient. Q, the total discharge rate, has units of $\frac{m^3}{s}$, the volume of water per time. The negative sign is due to the fact that the fluid flows down (negative) the hydraulic gradient from higher values to lower values.

Hydraulic Conductivity

[3] The hydraulic conductivity is a physical parameter that accounts for how easily the fluid can move through the pore space for the material.

$$K = k\frac{\gamma}{\eta} \tag{5}$$

where k is the intrinsic permeability of the porous media (the solid), η is the dynamic viscosity of the fluid, and $\gamma = \rho g$ is the specific weight of the fluid, which depends on the fluid density, ρ and gravity, g .

Soil shrinkage/swelling

[2]

$$r_s = \ln \frac{V_i}{V_0} / \ln \frac{z_i}{z_0} \quad (6)$$

where V and z are the volume and height of the soil, with the subscript 0 being the initial conditions and subscript i representing the ith step.

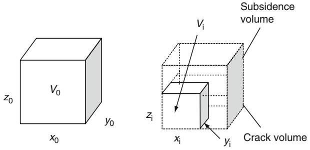

Figure 2: Volume change in vertical and horizontal direction by soil shrinkage.

Failure Mechanism / Terzaghi's soil bearing capacity theory

[2] Skempton's equation is widely used for undrained clay soils:

$$q_f = s_u.N_{cu} + q_o$$

where $N_{cu} =$ Skempton's bearing capacity factor, which can be obtained from a chart or by using the following expression:

$$N_{cu} = N_c.s_c.d_c$$

where s_c is a shape factor and d_c is a depth factor.

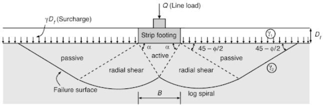

Figure 3: Shear Stresses

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Reference

[1] JJB Bronswijk. "Shrinkage geometry of a heavy clay soil at various stresses". In: *Soil Science Society of America Journal* 54.5 (1990), pp. 1500–1502.

[2] James Kenneth Mitchell, Kenichi Soga et al. *Fundamentals of soil behavior*. Vol. 3. John Wiley & Sons New York, 2005.

[3] Gopal Ranjan and ASR Rao. *Basic and applied soil mechanics*. New Age International, 2011.