Supplementary Concept & Numerical Practice Notes

Module 1 – Data Analytics (Numerical Additions)

1. Z-Score Calculation Example

In a normal distribution, the z-score tells how many standard deviations a value is away from the mean.

Formula:

$$z = \frac{x - \mu}{\sigma}$$

Example:
For pulse rates with mean $\mu = 72$ bpm and standard deviation $\sigma = 6$ bpm, find z for $x = 84$.

$$z = \frac{84 - 72}{6} = 2$$

Interpretation: The pulse rate of 84 bpm is 2 standard deviations above the mean.

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2. P-Value and Hypothesis Testing Example

A sample of 36 observations has $\bar{x} = 60$, $\mu = 65$, and $\sigma = 12$. Test $H_0 : \mu = 65$ at 5% significance.

$$z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}} = \frac{60 - 65}{12/6} = \frac{-5}{2} = -2.5$$

From z-tables, $p = 0.0124 < 0.05$.
Reject H_0: Evidence suggests the mean differs significantly from 65.

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3. Poisson Probability Example

If the average number of emails per hour is $\lambda = 4$, find the probability of receiving exactly 2 emails.

$$P(X = 2) = \frac{e^{-4} * 4^2}{2!} = e^{-4} * 8/2 = 0.1465$$

Probability ≈ 0.147

Module 2 – GIS and Spatial Data (Applied Examples)

1. Representative Fraction Example

If 2.5 cm on map represents 100 m on ground:

Convert both to same unit: 100 m = 10,000 cm

$$RF = \frac{2.5}{10,000} = 1:4000$$

Representative fraction = 1:4000

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2. Buffer Example

Creating a 500 m buffer around all schools in a GIS map identifies zones that fall within walking distance. This is useful for locating potential student housing or playgrounds.

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3. Overlay Analysis Example

Overlay soil type layer with rainfall layer to find regions suitable for rice cultivation.

GIS performs a pixel-by-pixel comparison to generate a new combined layer.

Module 3 – Social Network Analysis (Computation Examples)

1. Degree and Centrality Example

In a graph:
A—B, A—C, A—D, B—E, C—D

- Degree of A = 3 (connected to B, C, D)
- Degree of B = 2 (A, E)
- Degree of D = 2 (A, C)

Nodes with higher degree are more influential.

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2. Betweenness Centrality Example

Consider nodes A–B–C–D in a line. - Shortest paths between A–C, A–D, B–D all pass through B and C. - B and C have highest betweenness centrality.

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3. Closeness Centrality Example

For the same graph A–B–C–D:

Node	Distances to Others	Sum	Closeness = 1/Sum
A	0,1,2,3	6	0.167
B	1,0,1,2	4	0.25
C	2,1,0,1	4	0.25

Node	Distances to Others	Sum	Closeness = 1/Sum
D	3,2,1,0	6	0.167

B and C are most central (close to all others).

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4. Edge Betweenness Centrality Example

In the same graph A–B–C–D: - Edge B–C lies on all shortest paths between A–D, A–C, and B–D. Hence, B–C has the highest edge betweenness and would be the first removed in Girvan–Newman community detection.