3/4 GENERAL MATHEMATICS

Types of Data

Categorical Nominal: - no order
Categorical Ordinal: - have order
Numerical Discrete: - how many?
Numerical Continuous: - how much?

Data Displays

There are many forms of ways to display data. For categorical you can use...

- **frequency table**
- **bar chart**
- **segmented bar cahrt**

And for numerical data you can use...

- **frequency table**
- **histogram**
- **dot plots**
- **stem and leaf plots**

Log Scale

A **log scale** spreads out the countries with small populations and 'pulls in' the countries with huge populations.
If $\log_{10} a = b$ then $10^b = a$
A logarithmic transformation involves changing the scale on the horizontal axis from x to $\log_{10}(x)$, and replacing each of the data values with its logarithm.

Measures of centre and spread

Mean: "average" - sum of all data values divided by amount of values
Median: the middle value when placed in ascending order
Mode: most occuring number
Range: the largest number subtract the smallest number
IQR: spread of middle half of data values quartile 3 - quartile 1

5 number summary

The **five number summary** includes:

- minimum (lowest number)
- quartile 1 (median of lower half)
- median
- quartile 3 (median of upper half)
- maximum (largest number)

A **boxplot** displays this.
To find outliers...
UPPER FENCE: Q3 + 1.5 x IQR
LOWER FENCE: Q1 - 1.5 x IQR

Normal Distribution

Standard Deviation: how much members from a group differ from the mean value
Normal Distribution: data distribution with a bell shape 68-95-99.7% rule.
If in a normal distribution, approximately:

- 68% of the observations lie within one standard deviation of the mean
- 95% of the observations lie within two standard deviations of the mean
- 99.7% of the observations lie within 3 standard deviations of the mean

Standard score = $\frac{\text{actual score} - \text{mean}}{\text{standard deviation}}$

Population

Population: set of all eligible members of a group which we intend to study
Sample: a subset of the population

Bivariate Data

When investigating the association between two variables the **explanatory** variable (EV) is the variable we expect to explain or predict the value of the **response** variable (RV).
Which Graph to use with Bivariate Data?
BV and EV are both categorical

- segmented bar chart

BV and EV are both numerical

- scatterplot

BV is numerical EV is categorical

- parallel box plot/dot plot
- back to back stem plot

Scatterplot

Things to note when interpreting:

- **Direction** (positive/negative/none)
- **Outliers**
- **Form** (linear or non-linear)
- **Strength** (strong moderate or weak)

CC & CoD

Correlation Coefficient: measures strength of linear relationship in 1, value is between -1 (strong positive) and 1 (strong negative), 0 is no relation
Coefficient of determination: degree to which one variable can be predicted from another linearly related variable, this is the squared value of r

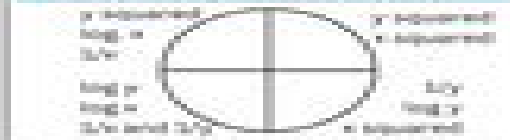
Causality

- **Common response** (correlation & farming - not weather temperature)
- **Confounding variables** (two possible explanatory variables)
- **Coincidence** (divorce rate & margarine consumption)

Regression Line

The **least squares line** is the line that minimises the sum of the squares of the residuals. It is given by:
$y = a + bx$
b (slope)
$b = \frac{r \times \text{standard deviation of } y}{\text{standard deviation of } x}$
a (y-intercept)
mean value of y - "b" x mean value of x
INTERPOLATION: Predicting within the range of values (reliable)
EXTRAPOLATION: Predicting outside range of values (unreliable)
RESIDUAL PLOT: residual values actual data value - predicted data value

Transformations



Time Series data

Patterns in this data include:

- **trends** (increase/decrease)
- **cycles** (recurrent movements)
- **seasonality** (related to calender)
- **structural change** (sudden change)
- **possible outliers** (stand out)
- **irregular fluctuations** (random)

SMOOTHING
Can help to get rid of irregularities in data/ seasonality
- mean smoothing (calculate)
- median smoothing (visual)

SEASONAL INDEX
actual figure ÷ deseasonalised figure = seasonal index
Using a **trend line** fitted to a time series plot to make predictions about future values is known as trend line **forecasting**.

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Jiyuan Zhang

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