QGIS & DATA ANALYSIS

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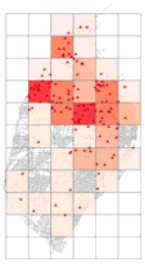
Common functionality required from GIS (1)

Researchers often want to create….

- Random sample points
- Regular sampling grid
- Random sampling points within regular grid



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Common functionality required from GIS (2)

Researchers also want to measure….

- Number (count of individuals)
- Length
- Area: planar or topological
- Perimeter
- Density
- Environment: landscape features at particular point
- Proximity (distance to): between individuals & landscape features

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Why…

- Describe ***and*** understand
- Show differences, relationships, proportions

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Next part of course….

Exercises

- Operations already done
- Some new operations
- *Using* GIS = whole process + stats !!

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DATA & ANALYSIS

a quick word….

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Statistics (describe & understand)

Your new mantra….

- Statistics are **good**
- Statistics are **fun**
- Statistics are **easy**

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Three core test statistics

1. Tests to show ***differences***
2. Tests to identify ***relationships***
3. Tests to compare ***proportions***

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Types of data: scales of measurement

Four key types

1. Nominal scale data
2. Ordinal scale data
3. Interval scale data
4. Ratio scale data

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Nominal scale measurements

Classifying samples into mutually exclusive ***categories***

Examples

- Taxonomic groups such as *Coleoptera*, *Collembola* & *Diptera*
- Habitat groups such as *forest, grassland & urban*
- Male or female
- Colour groups

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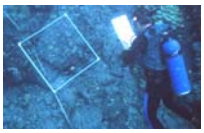
Ordinal scale measurements

Placing mutually exclusive categories into *rank order*

Example

The DAFOR scale of abundance



- *Dominant*
- *Abundant*
- *Frequent*
- *Occasional*
- *Rare*

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Interval & Ratio scale measurements

Placing observations (measurements) into rank order **and** saying *how far apart* they are

Example without absolute zero (interval)

- Temperature (Celsius)

Examples with absolute zero (ratio)

- Length
- Weight

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Scales of measurement

Why this is important for GIS studies…….

The *scale of measurement* you use limits the ***type*** of statistical analyses that are possible for your data

DO THIS *BEFORE* COLLECTING DATA !!

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Variables

Response variables

- The measure that responds to '*conditions*'
- Dependent variable
- Y-axis (vertical)

Explanatory variables

- The environmental *condition* to be measured (they drive and *explain* the response)
- Independent variable
- X-axis (horizontal)

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Which is which – how to remember

Response variables

- The measure that responds to '*conditions*'
- Dependent variable
- Y-axis

Explanatory variables

- The environmental *condition* to be measured
- Independent variable
- X-axis

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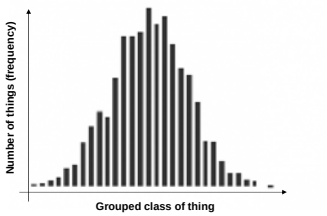
Frequency diagram

A simple but *VERY* important data representation in statistics



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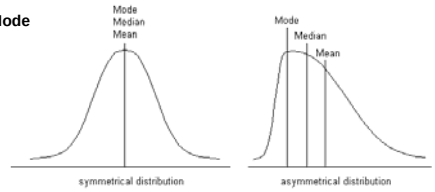
Central tendency

Three commonly used measures of central tendency

- **Mean**
- **Median**
- **Mode**



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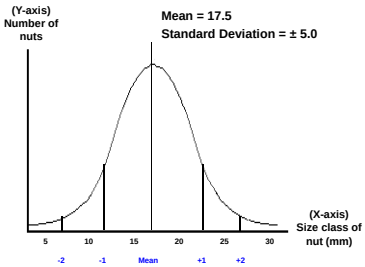
The normal distribution



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Residuals

Residual = the mean value minus any particular value

$(\bar{X} - X)$

Also known as the ***deviation from the mean***

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Standard deviation (s)

We often need to know how much variability there is about the central tendency i.e. *how spread out is our frequency diagram* ?

We need to know ***average*** deviation from mean *(residual)*

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Standard deviation (s)

How do we calculate a mean (average) ?

Mean = $\frac{\text{sum of all measurements}}{\text{number of measurements}}$

Mean = $\frac{\sum X}{n}$

Average deviation from mean *(residual)*

Mean deviation = $\frac{\sum(X-\bar{X})}{n}$

$S = \sqrt{\frac{\sum(X-\bar{X})^2}{n-1}}$

Degrees of freedom

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Standard deviation (s)

Always report as…..

Mean ± standard deviation

Avoid the term <u>average</u>

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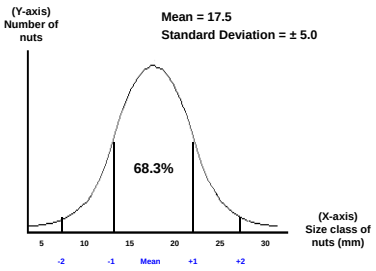
The normal distribution



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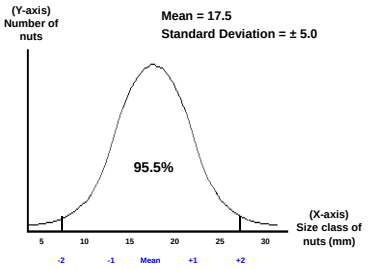
The normal distribution



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The basis of all statistical tests

- Compare an observation against a 'Test Statistic'
- Nowadays, stats software does this for you !!!
- Many Test Statistic types (but all work on same general principles)

THAT *P* VALUE… why so important?

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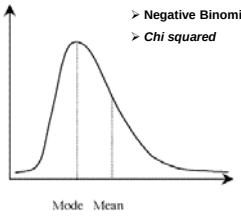
Also note……

There are other 'distributions' with their own *properties*

Examples

- Poisson distribution
- Negative Binomial
- *Chi squared*



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Parametric & non-Parametric statistics

- Some statistical tests require data to be normally distributed. They have this (and other) requirements.
- These requirements are called the parameters of the mathematical models used in the test.
- Tests that have these requirements are called Parametric tests.
- Tests that do not have these requirements are called Non-Parametric tests.

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Also note……

- Tests for normality
- Data transformation

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EXAMPLES: *types* of statistical tests in GIS

1. Tests to show ***differences***
2. Tests to identify ***relationships***
3. Tests to compare ***proportions***

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Scenario for examples of generic statistical test types

- ***Gloucester Wildlife Trust*** have been using pit-fall traps to monitor ***beetle*** numbers at ten forest sites in local nature reserves
- Trapping occurs monthly, with ten years of data available
- Halfway through the ten years of monitoring five sites received management aimed specifically at enhancing habitats for beetles

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1. Tests to show *differences*

Monitoring question

Does forest management increase *beetle* numbers

Statistical question

Are there significant differences in the number of beetles caught before and after management

Statistical method

Test for differences in mean (or median) *beetle* numbers caught before and after management

Explanation on flip chart……
Mention ANOVA….

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2. Tests to identify *relationships*

Monitoring question

Have *beetle* numbers in the forest changed with time

Statistical question

Is there a significant relationship (trend) between the number of *beetles* caught and year

Statistical method

Use regression to test for significant (non-zero) slope in graph of *beetle* numbers (y-axis) and year (x-axis)

Explanation on flip chart……

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3. Tests to compare *proportions*

Monitoring question

Are *beetle* numbers at the forests seasonal

Statistical question

Are the proportions of *beetle* in traps significantly different for either spring, summer, autumn or winter

Statistical method

Use Chi squared contingency table (or G test) to test for data homogeneity between seasons

Explanation on flip chart……

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Take home message

- Variables all derived *directly* from a GIS
- We are going to do some worked examples

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Multivariate analyses (models)

Many techniques…

- Generalised Linear [mixed] Models (GLMs)
- General Estimating Equations (GEEs)
- Multiple Regression
- General Additive Models
- *Etc*

Variables also derived *directly* from a GIS….

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