Statistics in Brain and Behaviour Research

Overview:

Numbers tell powerful stories! This badge demystifies statistics by showing how data is used to understand human behaviour, predict outcomes, and make discoveries about the brain. In this badge, participants will be introduced to how statistical methods are applied in real-world brain and behaviour research. The badge provides a high-level overview of techniques ranging from descriptive statistics to multivariate analysis, aiming to build foundational skills for interpreting data. Participants will explore study design, data collection, and basic statistical analysis using software like SPSS. Special emphasis will be placed on the unique aspects of working with neuroimaging data, psychological assessments, and behavioural experiments.

Learning Outcomes:

- Understand and apply descriptive and inferential statistics to research
- Conduct analyses of neuroimaging data, psychometric tests, and behavioural experiments
- Apply the principles of hypothesis testing, ANOVA, regression, and correlation to interpret research results
- Use statistical software to clean, organize, and analyze research data
- Interpret statistical outputs to draw conclusions about research hypotheses
- Design statistically sound studies, ensuring appropriate data collection and analysis methods

Module 1: Introduction to Statistics – Why Do We Need It?

- Understanding how data shapes research
- Importance of statistics in research: How statistical methods drive discoveries
- Types of data: Nominal, ordinal, interval, and ratio scales
- Overview of data types: Quantitative vs. qualitative data
- Introduction to statistical software: Overview of SPSS, R, and Python for data analysis
- Hands-on: Setting up a dataset in SPSS/R/Python
- Ethics in data collection: Understanding bias, confounding variables, and data integrity

Module 2: Descriptive Statistics and Data Visualization

- Measures of central tendency: Mean, median, mode
- Measures of variability: Range, variance, standard deviation
- Graphical representations of data: Histograms, bar charts, scatter plots, and box plots
- Understanding normal distribution
- Identifying outliers and data cleaning techniques
- Visualizing data using graphs and summary statistics in SPSS/R/Python

Module 3: Probability and Sampling Techniques

- Introduction to probability theory: Random variables, probability distributions, and expected values
- Sampling methods: Simple random sampling, stratified sampling, and cluster sampling
- The role of sample size in statistical power and generalizability of results
- Central Limit Theorem and the importance of large sample sizes

Module 4: Hypothesis Testing – Making Decisions with Data

- Introduction to null hypothesis (H_o) and alternative hypothesis (H_1)
- Type I and Type II errors: False positives and false negatives
- p-values and statistical significance: Understanding the threshold for evidence
- Power analysis: Determining sample size to detect an effect
- Conduct hypothesis tests on real data sets (t-tests, chi-square tests)

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Module 5: Correlation and Regression Analysis – Exploring Relationships

- Understanding the concept of correlation: Pearson's r, Spearman's rho
- Linear regression analysis: Simple and multiple regression
- Identifying predictors and outcomes in behavioural and neurobiological data
- Assumptions of regression: Linearity, homoscedasticity, multicollinearity, and normality
- Conduct correlation and regression analysis with psychological and neuroscience data

Module 6: Analysis of Variance (ANOVA) – Comparing Groups

- Introduction to ANOVA: One-way and two-way ANOVA for comparing multiple groups
- Post-hoc tests: Tukey's HSD, Bonferroni correction
- Understanding interaction effects in factorial designs
- Assumptions of ANOVA: Homogeneity of variance, normality, independence
- Conduct one-way and two-way ANOVA with real datasets (e.g., comparing brain activity between different experimental conditions)

Module 7: Non-Parametric Tests and Multivariate Analysis

- Non-parametric tests: When to use them and how they differ from parametric tests
- Mann-Whitney U and Wilcoxon signed-rank tests for comparing groups
- Multivariate analysis: Principal Component Analysis (PCA), Factor Analysis, and MANOVA
- Perform non-parametric tests and multivariate analysis with research data

Module 8: Advanced Topics in Neuroscience and Psychology Statistics

- Neuroimaging data analysis: Introduction to fMRI, EEG, and PET data analysis
- Generalized linear models (GLM): Applying GLM to brain and behaviour research
- Longitudinal data analysis: Repeated measures, mixed-effects models, and growth curve modeling
- Using Bayesian statistics in brain and behaviour research