**1. Linear Models**

Linear models put together many statistical tests like regression, t-tests, ANOVA, ANCOVA, correlation and mixed-effects models.

The general form of a linear model is:

y = β0 + β1x + ε, where

β0 = intercept

β1 = slope

x = predictor variable

ε = error term

We use linear models to estimate the slope, intercept, and standard deviation of the error, and determine whether the slope is significantly different from 0 (i.e., if x significantly predicts y).

**2. Visualizing and Running Simple Regression**

Things to keep in mind

* We need to visualize data first using a scatter plot.
* If both x and y are continuous, we need to run a regression using a linear model.
* It is recommended to look for summary statistics like p-values, R-squared, and coefficient estimates.

**3. ANOVA and Linear Regression**

* ANOVA and linear regression are basically the same.
* ANOVA separate variance into between-group (SSR) and within-group (SSE) components.
* A low p-value indicates that at least one group means is different.

**4. t-tests as Linear Models**

* t-tests are performed to compare two groups testing whether the slope between group indicator and outcome is 0.
* They can be represented as a linear model with a binary predictor (coded 0 and 1).
* The intercept represents the meaning of the baseline group; the slope represents the difference between groups.

**5. ANOVA with Multiple Groups**

* ANOVA compares means across more than two groups.
* Categorical x variables with multiple levels (e.g., V6, V8, V15) are used to predict a continuous y.
* Post-hoc tests are used to determine which specific groups differ.
* The model estimates an intercept and a slope for each level of the categorical variable compared to the reference level.

**6. Interaction Terms**

* Interaction terms allow us to see if the effect of one variable depends on another.
* Significant interaction terms indicate that the relationship between one predictor and the response changes across levels of another predictor.

**7. Post-Hoc Testing**

* Post-hoc tests (like Tukey's HSD) help identify which groups are significantly different
* Groupings and contrasts help summarize where differences lie.

**8. Mixed Effects Models**

* Mixed models include both fixed and random effects.
* Fixed effects: affect the mean (e.g., treatment, species).
* Random effects: account for variation not of primary interest (e.g., year, replicate).
* Mixed models can reduce standard errors of estimates, improving power and inference.

**9. Interpretation**

* R-squared value needs to see to know how much variance the model explains.
* p-values denote significance of the test.
* Residual plots used to diagnose assumptions (e.g., linearity, homoskedasticity)