Cat Toy Preference

NCSU ST 542 Consulting Project

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Cat Toy Preference Analysis

The stated *goals of this study are, therefore, to determine the preferences for type of enrichment in laboratory-housed cats, and to determine if FIV status impacts these preferences. We hypothesize that cats do have a preference toward the type of enrichment they want to receive, and the FIV status of the cat will not impact their preferences*

Statistical Analysis

We perform a non parametric Kruskal-Wallis [@KruskalWallis] one-way analysis of variance by ranks as a precursor to selecting the optimal toy preference. The Kruskall-Wallis analysis of variance is an extension of the Mann-Whitney U test to multiple groups. The assumption of the Kruskal-Wallis is that all the groups come from identical distributions with common variance. The null hypothesis is the medians are all the same for the groups. Using the notation above, the hypothesis are

$$H_0 : P(\mu_j > \mu_k) = \frac{1}{2} \ \ \forall \ \ j, k \in 1, \ldots, J$$

$$H_a : \exists \ \ j, k \ \ \in 1, \ldots, J : P(\mu_j > \mu_k) \neq \frac{1}{2}$$

A significant Kruskal-Wallis test indicates that at least one experimental median stochastically dominates the others. We do not know which one. The common options for determining stochastic order are to perform pairwise Mann-Whitney tests or to perform Dunn's Multiple Comparison Test [@DUNN]. Dunn's test has several technical advantages over running pairwise Mann-Whitney tests. The main advantages are that it uses the pooled variance estimate from the Kruskal-Wallis test, and that it reuses the average rank scores from the Kruskal-Wallis test.

The input to the Dunn test is the per group average rank $\bar{R}_j = \frac{R_j}{n_j}$ and the z-test statistic for groups j, k is

$$z_{j,k} = \frac{\bar{R}_j - \bar{R}_k}{\sigma_{j,k}}$$

$\sigma_{j,k}$ is a funtion of the overall, group, and rank tie counts. The null hypothesis of the group pairwise comparison is that the probability of observing a randomly selected value from the first group that is larger than a randomly selected value from the second groups is one half - $H_0 : P(X_j > X_k) = \frac{1}{2}$.

The null hypothesis for each pairwise comparison is that the probability of observing a randomly selected value from the first group that is larger than a randomly selected value from the second group equals one half; this null hypothesis corresponds to that of the Wilcoxon-Mann-Whitney rank-sum test.

The Kruskal-Wallis is implemented in R in the `kruskal.test` function in the core `stats` package. The Dunn test is implemented in the `dunn.test` package. R version 3.4.2 (2017-09-28) is used to perform the analysis.

The data is presented in a Excel spreadheet with the following columns

col	description
Cat_Name	Name of individual cat (unique identifiers)
Device	Enrichment choice (brush, laser, ball, human, scratching item)
Group	Room in which the cat was housed
Day	Six separate days over six weeks
Order	The order of the activities (changed every 2 weeks)
Scale	The interest level of the cat (0=no interest; 1=moderate interest; 2=intense interest)
Preference	The device the cat chose to interact with
Pref2	The device the cat chose to interact with, if applicable
FIV	FIV Status

-

Kruskal-Wallis Test

```
kruskal.test(Scale ~ Device, data = df)
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  Scale by Device
```

```
## Kruskal-Wallis chi-squared = 38.124, df = 2, p-value = 5.265e-09
```

The Kruskal-Wallis rank sum test shows that there is a difference in the medians, we now perform the Dunn test to see what the preference ranking are.

Dunn Test

```
##   Kruskal-Wallis rank sum test
##
## data: Scale and Device
## Kruskal-Wallis chi-squared = 38.1245, df = 2, p-value = 0
##
##
##                           Comparison of Scale by Device
##                                   (Holm-<U+008A>idák)
## Col Mean-|
## Row Mean |       Ball      Human
## ---------+----------------------
##    Human |   0.917928
##          |     0.1793
##          |
##    Laser |  -4.828889  -5.746818
##          |    0.0000*    0.0000*
##
##
## List of pairwise comparisons: Z statistic (adjusted p-value)
## ------------------------------------
## Ball - Human  :  0.917928 (0.1793)
## Ball - Laser  : -4.828889 (0.0000)*
## Human - Laser : -5.746818 (0.0000)*
##
## alpha = 0.05
## Reject Ho if p <= alpha/2
```

The Dunn test shows that cats prefer the laser to humans and balls. `(Holm-<U+008A>idák)` is R's broken unicode way to indicate that we choose the Holm-Sidák adjustment . We tried the Bonferroni adjustment and got the same results.

Impact of FIV status

To determine if the FIV status we perform the Kruskal-Wallis Test for a difference in Scale for each of the devices.

```
## [1] "Laser"
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  Scale by FIV
## Kruskal-Wallis chi-squared = 0.50483, df = 1, p-value = 0.4774
```

```
## [1] "Ball"
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  Scale by FIV
## Kruskal-Wallis chi-squared = 1.4624, df = 1, p-value = 0.2265
```

```
## [1] "Human"
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  Scale by FIV
## Kruskal-Wallis chi-squared = 3.3334, df = 1, p-value = 0.06788
```

The FIV status does not affect the scale for laser and ball. But it's interesting to note that the FIV may affect the scale for human.