R12 - Interactions

HCI/PSYCH 522
Iowa State University

April 26, 2022

Independent variables

- Functions ($f(X)$)
- Dummy variables for categorical variables ($X_1 = \mathrm{I}()$)
- Higher order terms (X^2)
- Additional explanatory variables (X_1, X_2)
- Interactions ($X_1 X_2$)
  - Continuous-continuous
  - Continuous-categorical
  - Categorical-categorical

Definition

Two independent variables are said to interact if the effect that one of them has on the mean of the dependent variable depends on the value of the other.

When to include interaction terms

Adapted from The Statistical Sleuth (3rd ed) page 250:

- when a research question pertains to an interaction
- when good reason exists to suspect an interaction or
- when statistical evidence exists to include the interaction.

R code for interaction

```
longnosedace <- read_csv("longnosedace.csv")
lm_dace <- lm(log(count) ~ do2 + no3 + do2:no3, data = longnosedace)
summary(lm_dace)$coef

##               Estimate Std. Error    t value   Pr(>|t|)
## (Intercept) -1.9149442 2.25394656 -0.8495961 0.39876678
## do2          0.5111851 0.26781104  1.9087529 0.06085177
## no3          1.0972513 0.85554847  1.2825121 0.20436193
## do2:no3     -0.1023408 0.09821613 -1.0419953 0.30139605

lm_dace2 <- lm(log(count) ~ do2 * no3, data = longnosedace)
summary(lm_dace2)$coef

##               Estimate Std. Error    t value   Pr(>|t|)
## (Intercept) -1.9149442 2.25394656 -0.8495961 0.39876678
## do2          0.5111851 0.26781104  1.9087529 0.06085177
## no3          1.0972513 0.85554847  1.2825121 0.20436193
## do2:no3     -0.1023408 0.09821613 -1.0419953 0.30139605
```

R code for interaction

```
glm_dace <- glm(count ~ do2 + no3 + do2:no3, data = longnosedace, family = poisson)
summary(glm_dace)$coef
```

```
##               Estimate Std. Error    z value     Pr(>|z|)
## (Intercept) -0.2297477 0.41254423 -0.5569044 5.775927e-01
## do2          0.3883040 0.04764847  8.1493475 3.658932e-16
## no3          1.2056535 0.13101995  9.2020603 3.511513e-20
## do2:no3     -0.1171250 0.01504934 -7.7827322 7.097476e-15
```

```
glm_dace2 <- glm(count ~ do2 * no3, data = longnosedace, family = poisson)
summary(glm_dace2)$coef
```

```
##               Estimate Std. Error    z value     Pr(>|z|)
## (Intercept) -0.2297477 0.41254423 -0.5569044 5.775927e-01
## do2          0.3883040 0.04764847  8.1493475 3.658932e-16
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## do2:no3     -0.1171250 0.01504934 -7.7827322 7.097476e-15
```

F-test or Chi-squared test to help assess the need for an interaction

```
lm_dace <- lm(log(count) ~ do2 * no3, data = longnosedace)
drop1(lm_dace, test="F")


## Single term deletions
##
## Model:
## log(count) ~ do2 * no3
##         Df Sum of Sq    RSS    AIC F value Pr(>F)
## <none>                81.141 20.831
## do2:no3  1    1.3984 82.540 19.975  1.0858 0.3014


glm_dace <- glm(count ~ do2 * no3, data = longnosedace, family = poisson)
drop1(glm_dace, test="Chi")


## Single term deletions
##
## Model:
## count ~ do2 * no3
##         Df Deviance    AIC    LRT  Pr(>Chi)
## <none>       2310.6 2646.6
## do2:no3  1   2375.8 2709.9 65.273 6.521e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

F-test or Chi-squared test to help assess the need for an interaction

```
glm_breaks <- glm(breaks ~ wool*tension, data = warpbreaks, family = poisson)
summary(glm_breaks)$coef
```

```
##                  Estimate Std. Error   z value     Pr(>|z|)
## (Intercept)     3.7967368 0.04993753 76.029734 0.000000e+00
## woolB          -0.4566272 0.08019202 -5.694172 1.239721e-08
## tensionM       -0.6186830 0.08440012 -7.330357 2.295399e-13
## tensionH       -0.5957987 0.08377723 -7.111702 1.146202e-12
## woolB:tensionM  0.6381768 0.12215312  5.224400 1.747203e-07
## woolB:tensionH  0.1883632 0.12989529  1.450115 1.470263e-01
```

```
drop1(glm_breaks, test="Chi")
```

```
## Single term deletions
##
## Model:
## breaks ~ wool * tension
##              Df Deviance    AIC    LRT  Pr(>Chi)
## <none>            182.31 468.97
## wool:tension  2   210.39 493.06 28.087 7.962e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

F-test or Chi-squared test to help assess the need for an interaction

```
glm_breaks <- glm(breaks ~ wool*tension, data = warpbreaks, family = poisson)
summary(glm_breaks)$coef
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##                  Estimate Std. Error   z value     Pr(>|z|)
## (Intercept)     3.7967368 0.04993753 76.029734 0.000000e+00
## woolB          -0.4566272 0.08019202 -5.694172 1.239721e-08
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```
drop1(glm_breaks, test="Chi")
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```
## Single term deletions
##
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## breaks ~ wool * tension
##              Df Deviance    AIC    LRT  Pr(>Chi)
## <none>            182.31 468.97
## wool:tension  2   210.39 493.06 28.087 7.962e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```
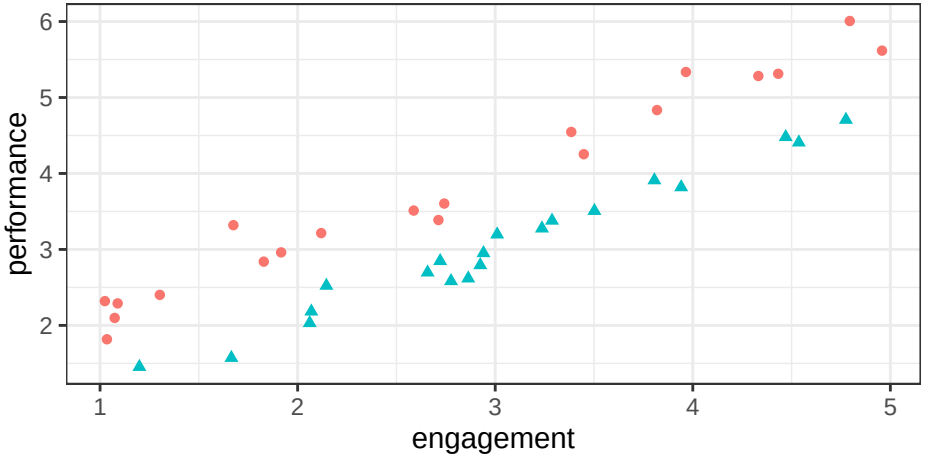
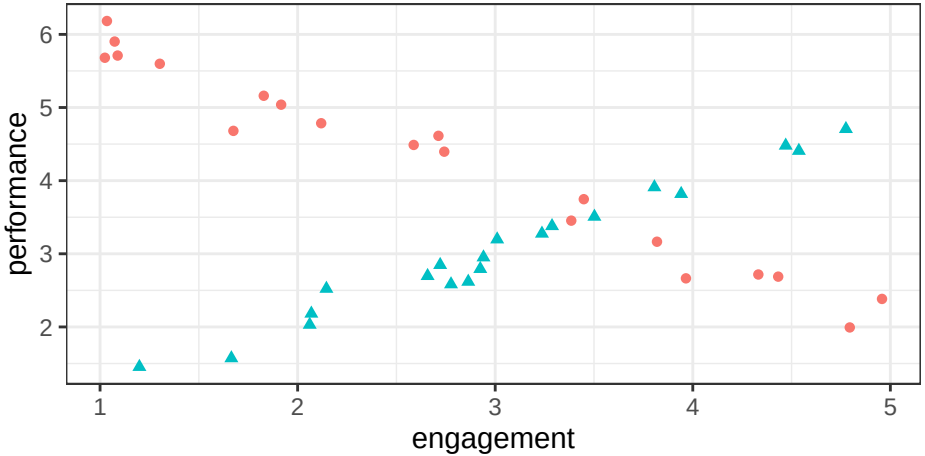

No Interaction = Parallel Lines

A model without an interaction is often referred to as a main effects model. Models without an interaction result in parallel lines.

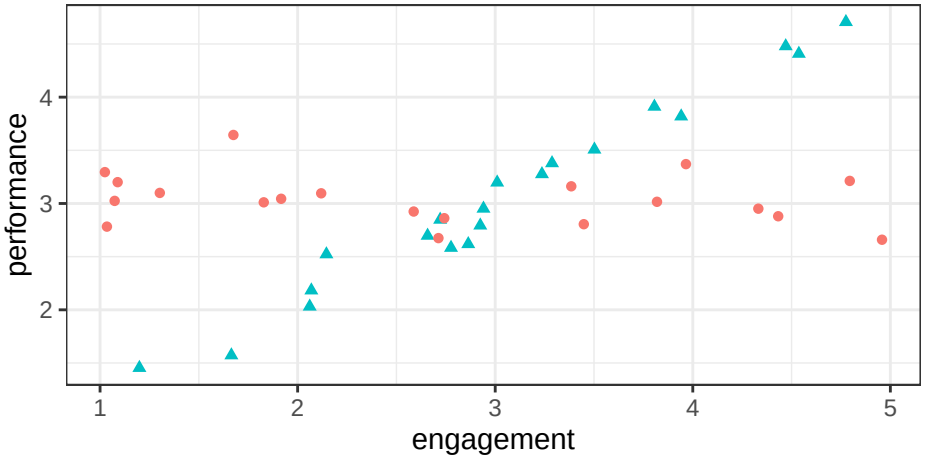
No interaction



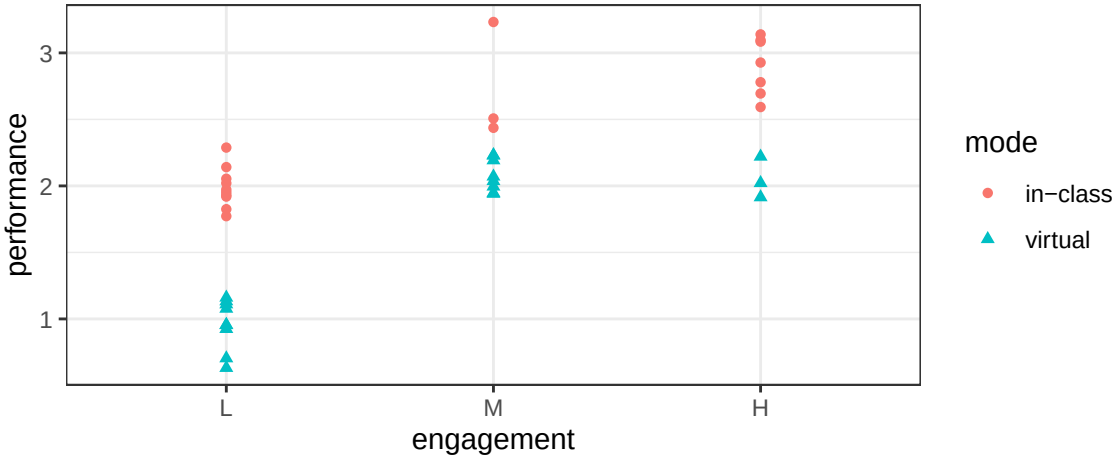
With interaction (extreme)



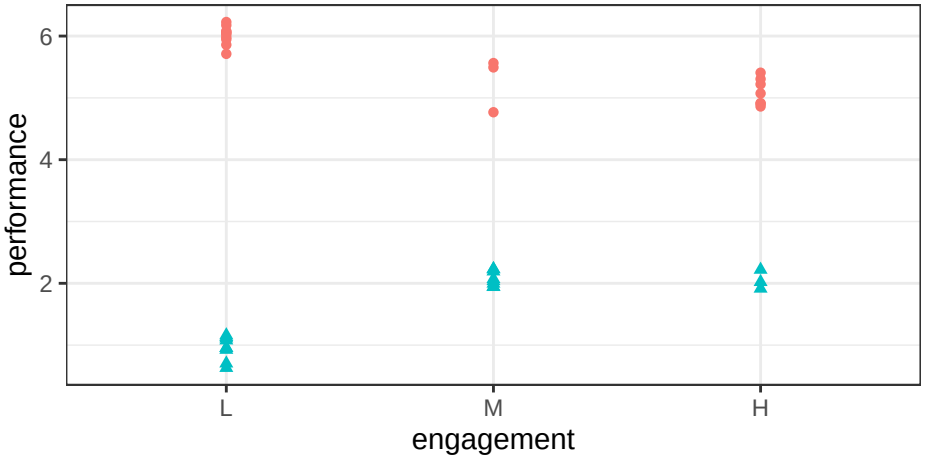
With interaction (not so extreme)



No interaction



With interaction (extreme)



With interaction (not so extreme)