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# Predicting Job Offer Acceptance with Fractional Factorial Design

Alex Caruso, Erika Deckter, Gorav Kumar

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# Project Motivation

## Project Summary

- The objective of this project is to determine which factors influence the likelihood that a candidate accepts a job offer
- The population of interest is undergraduate and graduate students at Stevens

## Project Applications & Value

- This experiment will be of interest to HR departments and hiring managers when deciding the best way to recruit top talent
  - Our analysis will help to maximize the likelihood that a candidate accepts an offer, thus minimizing wasted expenses incurred during the recruiting process
- In addition, as students about to enter the job market ourselves, this topic is relevant to us in terms of what to look for when evaluating job offers

# Factors



Factor ID	Factor	- Level	+ Level
A	Salary	Median - \$10,000	Median + \$10,000
B	Insurance	No	Yes
C	401K	No	Yes
D	Relocation Required	No	Yes
E	Travel Required	No	Yes
F	Work Remotely	No	Yes
G	Vacation/Paid Time Off	2 weeks	3 weeks



# Fractional Factorial Design

Our experimental design is a fractional factorial design using a  $2^{7-3}$  design

The design is **resolution IV**

- Main effects are confounded with three-factor interactions
- Two-factor interactions are confounded with other two-factor interactions
- Interactions of three-factors and above are ignored in the analysis

Generators:

- $E = ABC$
- $F = BCD$
- $G = ACD$

# Design Matrix



Run ID	A	B	C	D	E = ABC	F = BCD	G = ACD	AB = CE = FG	AC = BE = DG	AD = CG = EF	BC = AE = DF	BD = CF = EG	CD = AG = BF	AF = BG = ED
1	-1	-1	-1	-1	-1	-1	-1	+1	+1	+1	+1	+1	+1	+1
2	+1	-1	-1	-1	+1	-1	+1	-1	-1	-1	+1	+1	+1	-1
3	-1	+1	-1	-1	+1	+1	-1	-1	+1	+1	-1	-1	+1	-1
4	+1	+1	-1	-1	-1	+1	+1	+1	-1	-1	-1	-1	+1	+1
5	-1	-1	+1	-1	+1	+1	+1	+1	-1	+1	-1	+1	-1	-1
6	+1	-1	+1	-1	-1	+1	-1	-1	+1	-1	-1	+1	-1	+1
7	-1	+1	+1	-1	-1	-1	+1	-1	-1	+1	+1	-1	-1	+1
8	+1	+1	+1	-1	+1	-1	-1	+1	+1	-1	+1	-1	-1	-1
9	-1	-1	-1	+1	-1	+1	+1	+1	+1	-1	+1	-1	-1	-1
10	+1	-1	-1	+1	+1	+1	-1	-1	-1	+1	+1	-1	-1	+1
11	-1	+1	-1	+1	+1	-1	+1	-1	+1	-1	-1	+1	-1	+1
12	+1	+1	-1	+1	-1	-1	-1	+1	-1	+1	-1	+1	-1	-1
13	-1	-1	+1	+1	+1	-1	-1	+1	-1	-1	-1	-1	+1	+1
14	+1	-1	+1	+1	-1	-1	+1	-1	+1	+1	-1	-1	+1	-1
15	-1	+1	+1	+1	-1	+1	-1	-1	-1	-1	+1	+1	+1	-1
16	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1	+1



# Data Collection

## Response Variable

- Likelihood of accepting a job offer given a set of factor levels (treatments)
- Respondents rated each job offer on a scale of 0 (will not accept) to 100 (definitely accept)

Example of Job Offer Treatment as Shown on Survey

Salary	Median - \$10,000
Insurance	No
401K	Yes
Relocation Required	Yes
Travel Required	Yes
Work Remotely	No
Vacation/Paid Time Off	2 weeks
<b>Rating (0 to 100)</b>	

## Process

- Each respondent saw all 16 treatments in the fractional factorial design
- The treatments were randomized by creating 10 separate versions of the survey
- Each respondent got a randomized version of one of the 10 survey versions



# Analysis

- Each respondent was considered a “block” in the analysis
- ANOVA analysis was used to evaluate the significance of each factor and the two-factor interactions
- The analysis was performed in R
- Significant effects are in the red boxes

Analysis of Variance Table

Response: Response

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	1	53366	53366	137.8222	< 2.2e-16	***
B	1	145144	145144	374.8476	< 2.2e-16	***
C	1	81004	81004	209.2009	< 2.2e-16	***
D	1	1975	1975	5.1000	0.02407	*
E	1	1318	1318	3.4048	0.06520	.
F	1	7450	7450	19.2410	1.231e-05	***
G	1	11241	11241	29.0298	8.242e-08	***
Respondent_ID	102	417367	4092	10.5675	< 2.2e-16	***
A:B	1	99	99	0.2558	0.61311	
A:C	1	89	89	0.2311	0.63079	
B:C	1	2466	2466	6.3691	0.01171	*
A:D	1	20	20	0.0519	0.81980	
B:D	1	100	100	0.2583	0.61135	
C:D	1	125	125	0.3230	0.56989	
D:E	1	76	76	0.1964	0.65772	
A:B:D	1	12	12	0.0307	0.86090	
Residuals	1530	592428	387			

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1





# Results

- Significant Main Effects
  - Salary
  - Insurance
  - 401K
  - Relocation Required
  - Work Remotely
  - Vacation/Paid Time Off
- Travel Required was not a significant main effect
- BC interaction (Insurance and 401k) is also significant
  - Confounded with AE (Salary and Travel Required) and DF (Relocation and Work Remotely) interactions
  - Using the effect heredity principle, we can rule out AE as a significant effect, since E (Travel Required) is not a significant main effect
  - There is still ambiguity on which of the remaining two interactions is driving the significance





# Results

## Regression Equation

$$\hat{y} = 29.4 + 5.7x_A + 9.4x_B + 7.0x_C - 1.1x_D + 2.1x_F + 2.6x_G + 1.2x_{BC} + \sum_{i=1}^k \beta_i x_i + \varepsilon$$

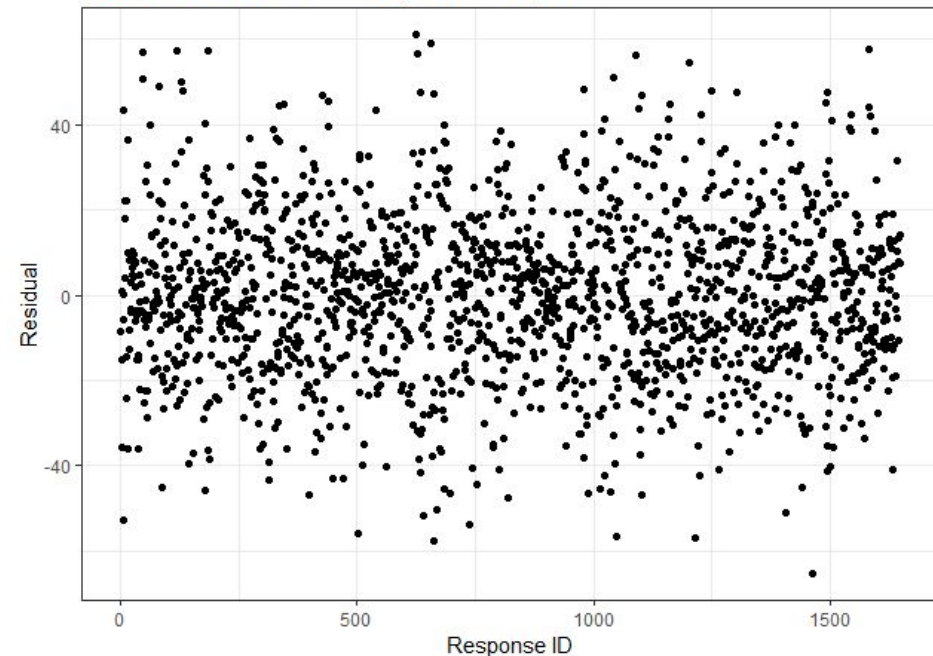
where

$\sum_{i=1}^k \beta_i x_i$  are the terms representing the blocks with  $k$  = the number of respondents (103)

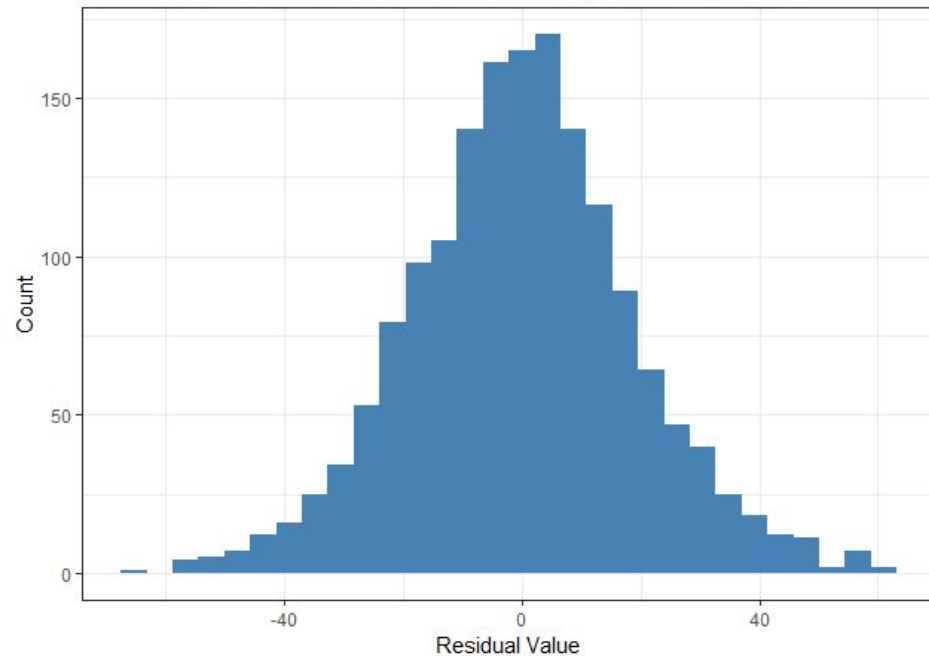
and  $\varepsilon$  is the error term

# Residuals for Regression Equation

Residuals Plot for Final Regression Equation



Histogram of Residual Values for Final Regression Equation





# Conclusions & Recommendations

## Experiment Summary

- Based on the regression equation, factors A, B, C, F and G should be set at their + levels.
- Factor D should be set to its - level
  - There is a slight (0.2 point) improvement in the outcome if D is set to its + level assuming that the significant two-factor interaction is DF (and not BC); however, since this is not confirmed, we will favor the primary interaction

## Recommendation

A successful job offer (high likelihood of acceptance) should have the following characteristics:

- Salary \$10,000 above industry median
- Offer insurance
- Offer 401k
- Allow employee to work remotely
- Minimum of 3 weeks vacation
- No relocation required



# Future Research

- In order to definitively determine which of the potential two-factor interactions are significant, a follow-up experiment with the four main effects (B, C, D and F) can be performed
- This follow-up experiment should be a full factorial design of  $2^4 = 16$  runs
- An experiment with additional levels for certain factors can be conducted to obtain more granular results
  - E.g. 401k: None, Match 50%, Match 100%
- Qualitative analysis of constraints for employers
  - Determine how to maximize the likelihood that a candidate accepts an offer, given certain constraints (e.g. maximum salary that can be offered)



# Questions?