Analyzing Resume Bias

Abby and Josie

Introduction/Background

- Resume screening occurs all the time when applications are sent to a job posting. Hiring teams quickly scan resumes, and sometimes bias can slip through. One example of this bias is assuming some applicants are more qualified for jobs based on the way their name sounds.

- Hiring teams are beginning to use machine learning to screen resumes. However, this can also cause unintentional bias on the bases of perceived race, gender, skills, and so on if the model are trained on data that shows a bias?

Source/Study on Callbacks and Race

- The paper finds that callbacks can be discriminatory towards Black sounding names

- For example, the study finds that Black applicants must submit 50% more job applications to get a callback.

- The paper also suggests that employers pay less attention to Black sounding names, even if they are qualified.

- It seems like some employers are using race as a proxy for other skills

Bertrand M, Mullainathan S. 2004. "Are Emily and Greg More Employable than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination". The American Economic Review 94:4 (991-1013)

Methods

- We use a data frame of descriptions of resumes that were sent to job openings in Boston and Chicago and a label: callback or no callback, this was the same data used in the study we found

- We performed Chi Squared Test of Independence, Logistic Regression Analysis, Odds Ratio, and Decision Tree Models in Python

- Cleaned data and dropped unnecessary variables

- Grouped names based on race and gender

Our Data - 4870 samples

- Dependent variable: resume received callback or not

- Many features about job description and resume. We chose to focus on the resume descriptions listed below

- Independent variables: first name, years college, worked during school, years experience, computer, skills special skills, employment holes, and resume quality.

Chi-Squared Scores

We first ran a chi-squared table test on our variables, and we found three independent variables to be the most statistically significant for determining callback: race, first name, and special skills.

```
received_callback
+-----------+-----+------+
| firstname |  1  |  2   |
|-----------+-----+------|
|         1 | 241 | 2258 |
|         2 | 151 | 2220 |
+-----------+-----+------+

+-----------+-----------+-----------+
| firstname |         1 |         2 |
|-----------+-----------+-----------|
|         1 | 0.0964386 | 0.903561  |
|         2 | 0.0636862 | 0.936314  |
+-----------+-----------+-----------+
The p-value (Chi-square test of independenc:
3.37518399258651e-05
```

```
received_callback
+-------+------+-----+
| race  |  0   |  1  |
|-------+------+-----|
| black | 2278 | 157 |
| white | 2200 | 235 |
+-------+------+-----+

+-------+----------+-----------+
| race  |        0 |         1 |
|-------+----------+-----------|
| black | 0.935524 | 0.0644764 |
| white | 0.903491 | 0.0965092 |
+-------+----------+-----------+
The p-value (Chi-square test of independenc:
4.997578389963253e-05
```

```
received_callback
+---------------+------+-----+
| special_skills |  0   |  1  |
|---------------+------+-----|
|             0 | 3075 | 194 |
|             1 | 1403 | 198 |
+---------------+------+-----+

+---------------+----------+-----------+
| special_skills |        0 |         1 |
|---------------+----------+-----------|
|             0 | 0.940655 | 0.0593454 |
|             1 | 0.876327 | 0.123673  |
+---------------+----------+-----------+
The p-value (Chi-square test of independenc: 
1.4116163623120035e-14
```

Originally, we had the gender of the name coded in the name number, but we found it's chi-squared score p-value to be insignificant.

```
received_callback
+--------+-----+------+
| gender |  1  |  2   |
|--------+-----+------|
| f      | 309 | 3437 |
| m      |  83 | 1041 |
+--------+-----+------+

+--------+-----------+----------+
| gender |         1 |        2 |
|--------+-----------+----------|
| f      | 0.082488  | 0.917512 |
| m      | 0.0738434 | 0.926157 |
+--------+-----------+----------+
The p-value (Chi-square test of independenc:
0.3833158069979834
```

Logistic Regression

- We used Logistic Regression to predict if an applicant should get a call back or not.
- The p scores for first name, special skills, employment holes, and years experience are much more significant in determining callback in comparison to college degree and worked during college.
- Could this be due to some jobs not requiring college degree in our data sample?

```
================================================
                                         P>|z|
------------------------------------------------
Intercept                                0.000
C(firstname)[T.2]                        0.000
C(college_degree)[T.1]                   0.238
C(worked_during_school)[T.1]             0.162
C(computer_skills)[T.1]                  0.012
C(special_skills)[T.1]                   0.000
C(employment_holes)[T.1]                 0.000
C(resume_quality)[T.low]                 0.080
years_college                            0.667
years_experience                         0.000
================================================
```

Odds Ratios

- Odds ratios tell us the difference in odds of getting a callback based on one variable while holding the others constant.

- The proximity of the odds ratio to 1 tells us how more or less likely a candidate is to receive a callback based on each variable.

	Odds Ratio
Intercept	0.059681
C(firstname)[T.2]	0.631941
C(college_degree)[T.1]	1.317070
C(worked_during_school)[T.1]	1.199642
C(computer_skills)[T.1]	0.703629
C(special_skills)[T.1]	2.178542
C(employment_holes)[T.1]	1.667341
C(resume_quality)[T.low]	0.811780
years_college	0.940131
years_experience	1.039441

Odds Ratio Continued

Predictors with 95% Confidence Intervals
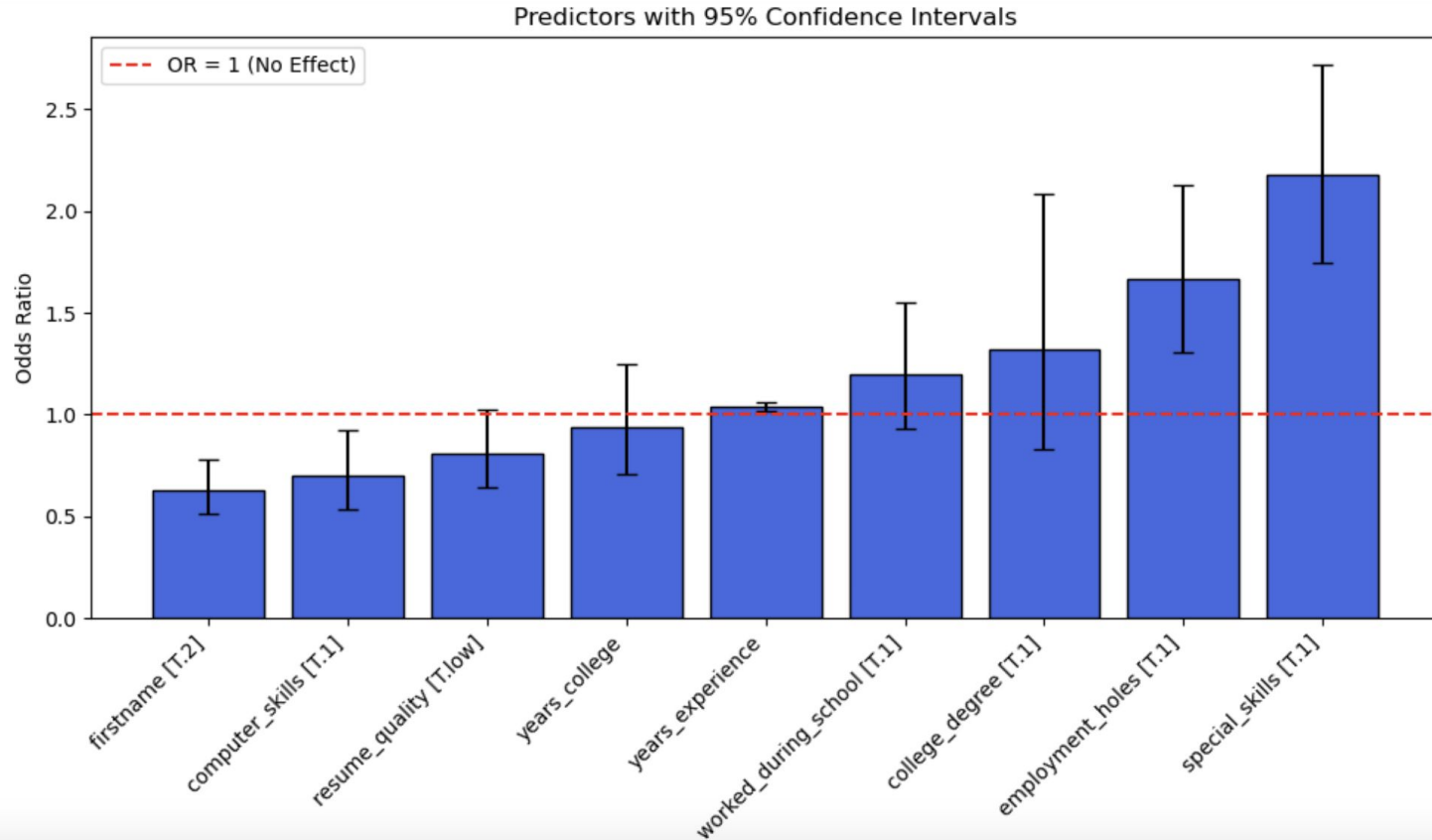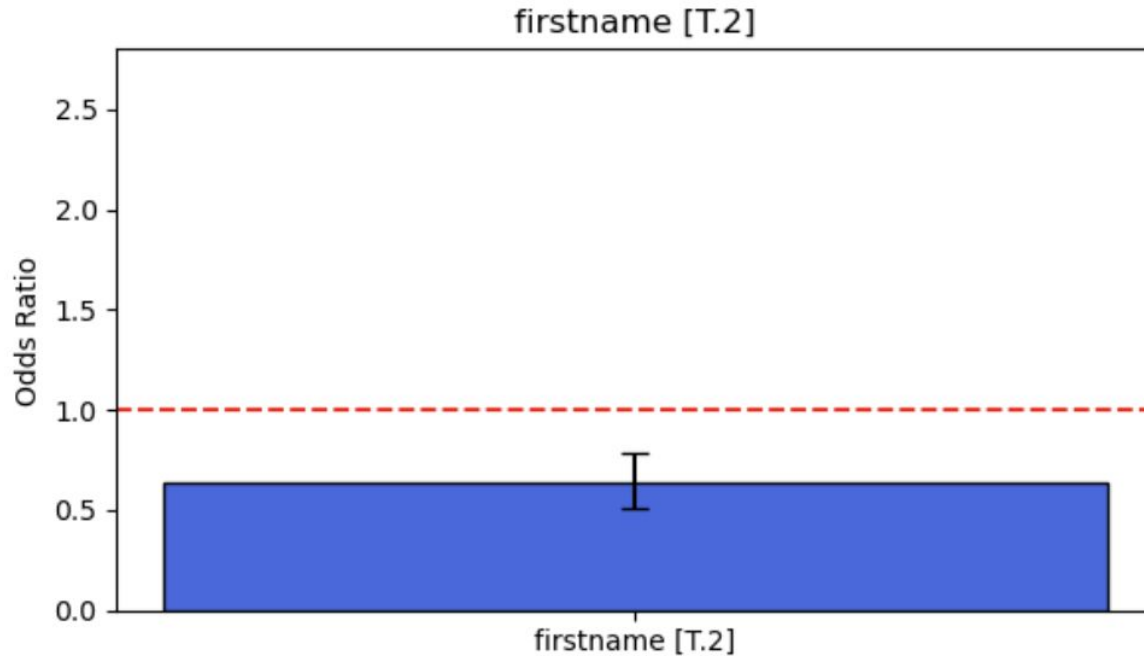
First name:

- Candidates with Black-sounding first names were 36.8% less likely to receive a callback

- Could be due to bias or discrimination based on the perceived race/ethnicity of the name
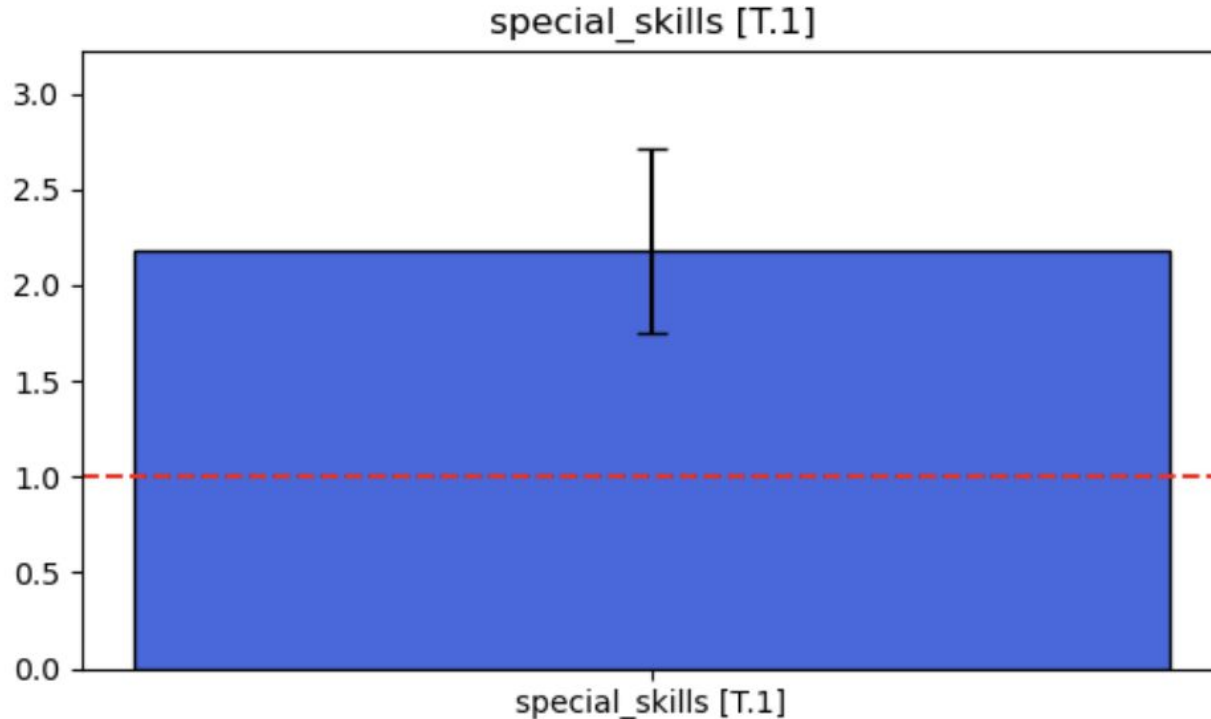
Computer Skills:
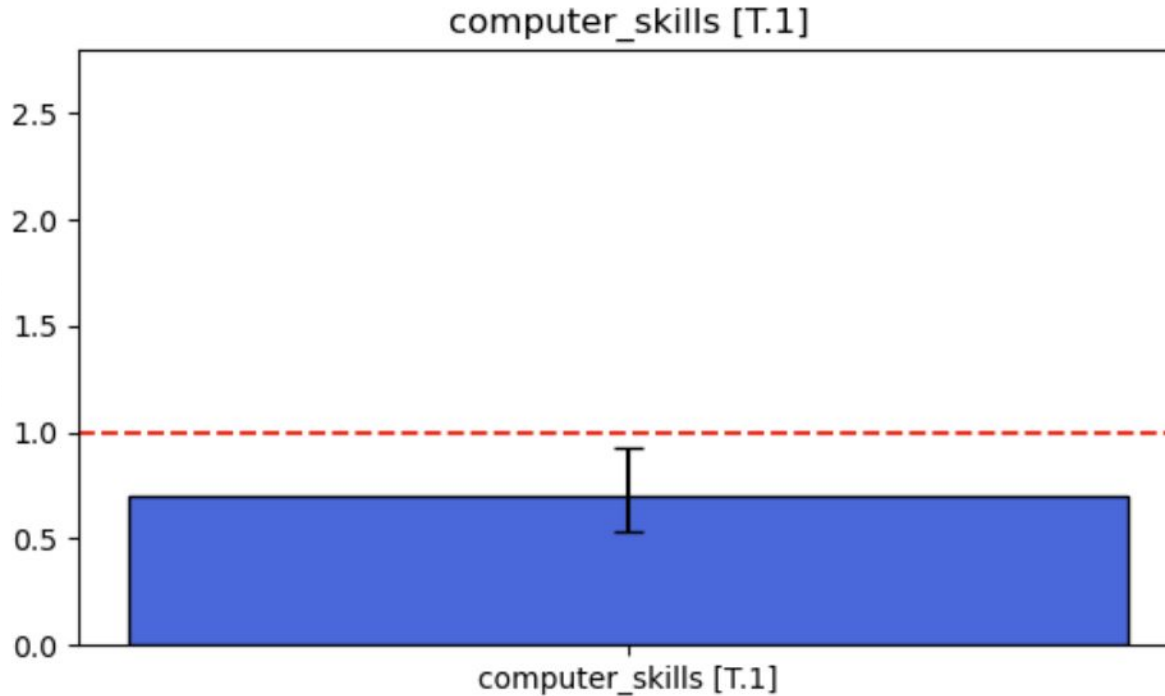
computer_skills [T.1]

- Listing computer skills slightly reduces the odds of getting a callback (29.6%)

- Could be perceived as a basic skill that doesn't add value (if listed as "proficient in Microsoft Word", Exel, etc.)

- Possibly be seen as filler info as opposed to substantial experience or achievements

<u>Employment Holes:</u>

employment_holes [T.1]
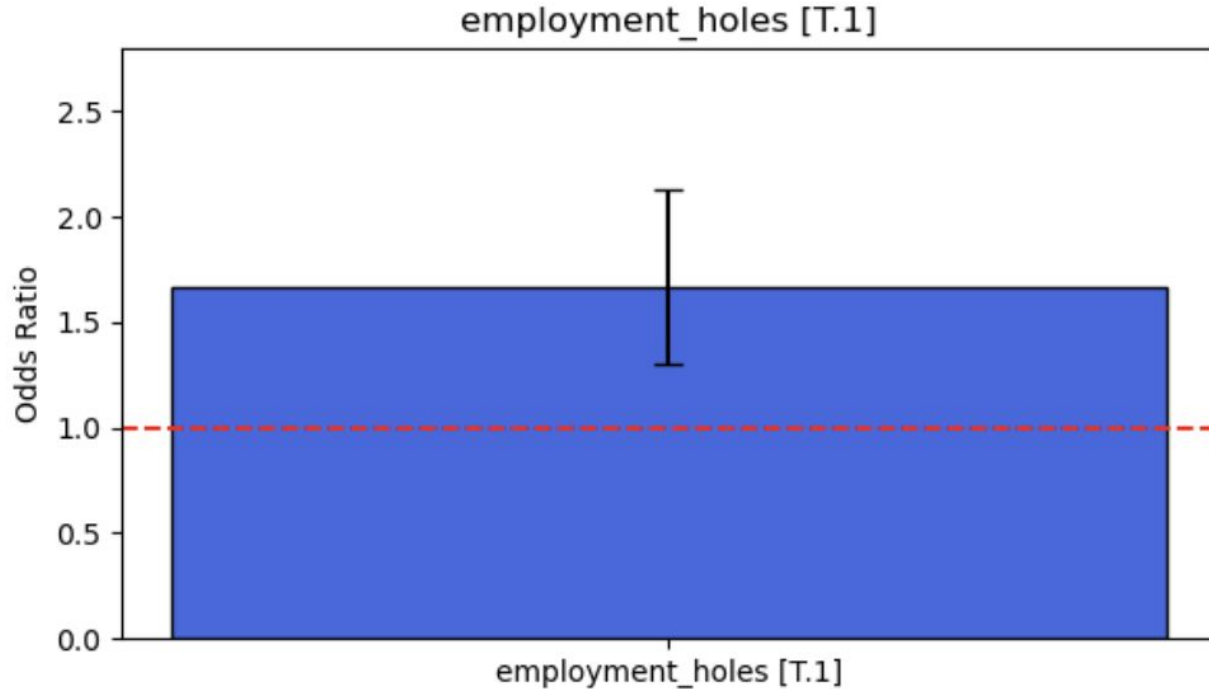
- Candidates with gaps in their employment are more likely (66.7%) to receive a callback

- The nature of the gap (family, travel, extra education, startups, creative fields, etc.) could be viewed positively by employers

- Could also reflect a shift in hiring practices where employment gaps are less stigmatized

Special Skills:

- Including special skills more than doubles (117.9%) the odds of receiving a call back

- Seen as evidence of unique skills

- Shows that the candidate goes beyond basic job requirements (like computer skills), making them more qualified/competitive

Key Findings

- Our logistic regression odds ratios tell us that resume screenings are the most biased when it comes to special skills, employment holes, and first name (perceived race).
- We can see additional slight biases in computer skills and college degree

- Since p values for years experience, employment holes, special skills, computer skills, and first name are < .05 we can be confident that these features have a statistically significant influence on receiving a callback. This is suggesting that the observed relationship between each variable and "receiving a callback" is unlikely due to chance or other factors.

- The odds of an applicant who first name is Black sounding are 36.8% less likely to receive a callback than an applicant with a White sounding name
- The odds of an applicant with a special skill receiving a callback are more than twice the odds of someone without a special skill

Interpretation/Implementation
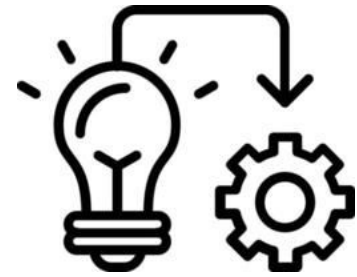
- Would see a shift where companies/screening algorithms assign an ID number or something similar to reduce any bias caused by the perceived race of someone's name
- This data helps candidates decide what is truly important to put on resumes and what employers are actually looking for and what they value
- Special skills could mean many different things on resumes depending on job type. It makes sense that special skills are a big contributor to callback as they inform potential experience for the job. Other contributors like race should not be playing a significant role in callback

Limitations

- In the real world there are more races than just Black and White. It could be interesting to see how this data would differ if more races were included.

- The data we used was from 2004. It may not be an accurate representation of resume screenings done 20 years later. Perhaps if we were to train a model with more current data, then the model would be less biased.

Ways to Improve a Biased Model

- Drop names and race and see if the model improves

- Find more current data and get a larger sample size

- Potentially create artificial samples to move this model in the right direction