Bias in Facial Classification ML Models

Patrick Connelly Grace Cooper Bhavana Jonnalagadda Carl Klein
Piya (Leo) Ngamkam Dhairya Veera

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Abstract

Here is where we will put the abstract.

Features of Quarto:

How we should write this report

- See Karkkainen and Joo (2021) , that is an example on how to cite a bibliography.
- Sections/title headings are automatically numbered.
- Any changes you make, make sure to make a comment of your initials at the top of your work (INCLUDING written text) like so:

```
<!-- BJ !-->
Blah blah etc ....

OR
#BJ
r_var <- ...
```

- Make sure to add a unique name to all code cells, and to also enable the following (the quarto way) (In order for a figure to be cross-referenceable, its label must start with the fig- prefix):

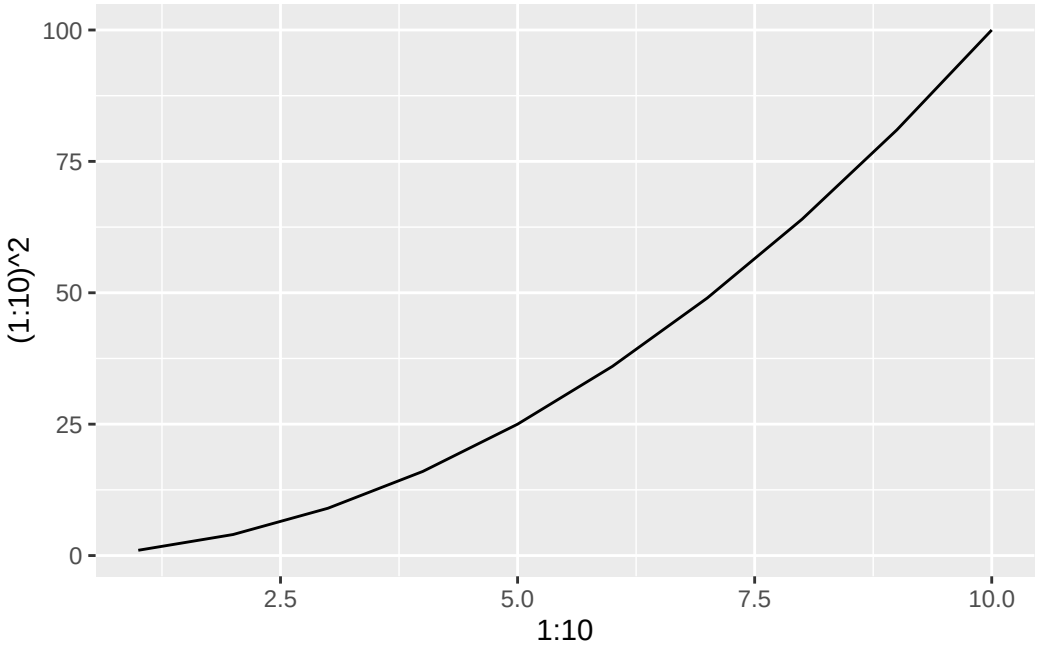


Figure 1: A caption for generated figure

- You can then refer to figures like this `@fig-sec1-unique-name` Figure 1
- Format tables doing the following Link here

- Do all your r work initially in your own custom `.rmd` file in this directory, so that it can be copy-pasted over later into the appropriate section (written descriptions/words can go straight into the `.qmd` files though). For example, Bhav's work is in `5000-final/BJ_work.rmd`.

> **i** From the report requirements
>
> A 3-5 summary of the paper. It should address the research question, the methods, and the conclusions of your analysis.
> *"A good recipe for an abstract is: first sentence: specify the general area of the paper and encourage the reader; second sentence: specify the dataset and methods at a general level; third sentence: specify the headline result; and a fourth sentence about implications."*

1 Introduction

From the report requirements

This section introduces your problem to a **non-expert** audience, describes the context and history of the problem.
For example, if your overall project topic is on Diabetes Prevention and Prediction, then you would use the Introduction to introduce what diabetes is, who it affects, why prevention is important, history on diabetes prevention, etc.
Some questions that you could answer in the introduction:

- What is the "research question"? why is it interesting or worth answering?
- What is the relevant background information for readers to understand your project? Assume that your audience
  is not an expert in the application field.
- Is there any prior research on your topic that might be helpful for the audience?

The goal of the introduction it to capture the audience's interest in your paper. An introduction that starts with "Diabetes kills over 87 thousand people each year and in many cases may be preventable" is more engaging than "This paper is about diabetes prevention".
The introduction should be 2-4 paragraphs long.

2 Data

We describe the data here. Note that the default global setting for Quarto is set to NOT output the code into the rendered document, aka only including the results of any R code.

We should include a print of the head of the dataframe of our data, along with some sample images!!

```
#| standalone: true

# libraries
library(shiny)
# library(tidyverse)
library(ggplot2) # Plotting
library(readr) # read_csv
library(shinythemes)
library(dplyr) # rename, etc
library(DT)
library(shinylive)

# data
# location of data
utk_1 <- "https://raw.githubusercontent.com/CUBoulder-DS/5301-5000-Final-Report/main/data/UTK/UTKp
utk_2 <- "https://raw.githubusercontent.com/CUBoulder-DS/5301-5000-Final-Report/main/data/UTK/UTKp
utk_3 <- "https://raw.githubusercontent.com/CUBoulder-DS/5301-5000-Final-Report/main/data/UTK/UTKp
# download data
df_1 <- read_csv(utk_1, col_select = c(src_age, src_race, src_gender))
df_2 <- read_csv(utk_2, col_select = c(src_age, src_race, src_gender))
df_3 <- read_csv(utk_3, col_select = c(src_age, src_race, src_gender))
# combine data
df <- rbind(df_1, df_2, df_3)
# clean data
mydata <- df %>%
  filter(src_age != '0' & src_race != '0' & src_gender != '0') %>%
  rename(Age = src_age, Race = src_race, Gender = src_gender)

# attach allows use of column names without calling full table
attach(mydata)

# server input
server = function(input, output, session) {

  # underlying data datatable
  output$originalData <- DT::renderDataTable(DT::datatable(mydata))

  output$underlyingDownload = downloadHandler(
    filename = "underlying.csv",
```

```
  content = function(file) {
    write.csv(mydata.new(), file)
  }
)

# checkbox selection for race
output$raceSelect <- renderPrint({ input$checkGroupRace })

# checkbox selection for gender
output$genderSelect <- renderPrint({ input$checkGroupGender })

# selectbox for race, gender or none
output$subDensity <- renderPrint({ input$subDensitySelect })

# slider for age
output$ageRange <- renderPrint({ input$sliderAge })

# slider for alpha
output$alphaRange <- renderPrint({ input$sliderAlpha })

# plot
output$densityPlot = renderPlot({
  # age filter
  gdata <- mydata %>%
    filter(Age >= input$sliderAge[1] & Age <= input$sliderAge[2])

  # gender filter
  if (length(input$checkGroupGender) == 0) {
    gdata <- gdata
  } else if (length(input$checkGroupGender) == 1 & input$checkGroupGender[1] == 'Female') {
    gdata <- gdata %>%
      filter(Gender == 'Female')
  } else if (length(input$checkGroupGender) == 1 & input$checkGroupGender[1] == 'Male') {
    gdata <- gdata %>%
      filter(Gender == 'Male')
  }

  # race filter
  races <- c('Asian', 'Black', 'Indian', 'Other', 'White')
  if (length(input$checkGroupRace) == 0 | length(input$checkGroupRace) == 5) {
    gdata <- gdata
  } else {
    gdata <- gdata %>%
      filter(Race %in% races[which(races %in% input$checkGroupRace)])
  }

  # filter for just age, or add gender or race curves
  if (input$subDensitySelect == 'None') {
    ggplot(gdata) +
      geom_density(aes(Age))
  } else if (input$subDensitySelect == 'Gender') {
    ggplot(gdata) +
```

```
        geom_density(aes(Age, fill = Gender), alpha = input$sliderAlpha)
    } else {
      ggplot(gdata) +
        geom_density(aes(Age, fill = Race), alpha = input$sliderAlpha)
    }
  })
}

ui = navbarPage(
  # theme
  # theme = shinytheme("cerulean"),

  # title
  title = "Bias in Facial Classification",

  # tab - theme settings
  tabPanel("Select Theme Setting", themeSelector()),

  # tab - exploratory analysis
  tabPanel("Exploratory Analysis",
           fluidRow(
             # Race selection
             column(4,
                    checkboxGroupInput("checkGroupRace", label = h3("Race Selection"),
                                       choices = list("Asian" = 'Asian',
                                                      "Black" = 'Black',
                                                      "Indian" = 'Indian',
                                                      "Other" = 'Other',
                                                      "White" = 'White'),
                                       selected = c('Asian', 'Black', 'Indian', 'Other', 'White'))
             # Gender selection
             column(4,
                    checkboxGroupInput("checkGroupGender", label = h3("Gender Selection"),
                                       choices = list("Female" = 'Female',
                                                      "Male" = 'Male'),
                                       selected = c('Male', 'Female'))),
             # subDensity selection
             column(4,
                    selectInput("subDensitySelect", label = h3("Sub Filter"),
                                       choices = list("Race" = 'Race',
                                                      "Gender" = 'Gender',
                                                      "None" = 'None'),
                                       selected = 'None'))
             ),
           fluidRow(
             # Age selection
             column(6,
                    sliderInput("sliderAge", label = h3("Age Range"), min = 1,
                                max = 135, value = c(15, 90))),
             # Alpha selection
             column(6,
                    sliderInput("sliderAlpha", label = h3("Alpha Range"), min = 0,
```

```
                                max = 1, value = 0.2)
            )),

          # plot
          plotOutput("densityPlot")),

  # tab - statistical testing
  tabPanel("Statistical Testing"),

  # tab - feature testing
  tabPanel("Feature Testing"),

  # tab - youtube video
  tabPanel("YouTube Video",
          "Replace with our group's YouTube Video?",
          tags$iframe(src='https://www.youtube.com/embed/XZo4xyJXCak?si=Uw897KUFEtIr_QMN',
                      width = '900', height = '900')),

  # tab - underlying data
  tabPanel("Underlying Data",
          # table output
          DT::dataTableOutput("originalData"),
          # table download
          downloadButton(outputId = "underlyingDownload", label = "Download Table"))

)

shinyApp(ui = ui, server = server)
```

> **i** From the report requirements
>
> This section should describe the data you'll be using. Answer **at least all** of the following questions:
>
> - How was the data collected?
> - What are the sources and influences of bias in the data?
> - What are the important features (=columns) that you are using in your analysis? What do they mean?
>
> Feel free to add anything else that you think is necessary for understanding the paper and the context of the problem.

3 Methods

3.1 A Subsection

3.2 Another subsection

3.2.1 Sub-sub section

From the report requirements

Also can be called "Analyses"
This section might contain several subsections as needed.

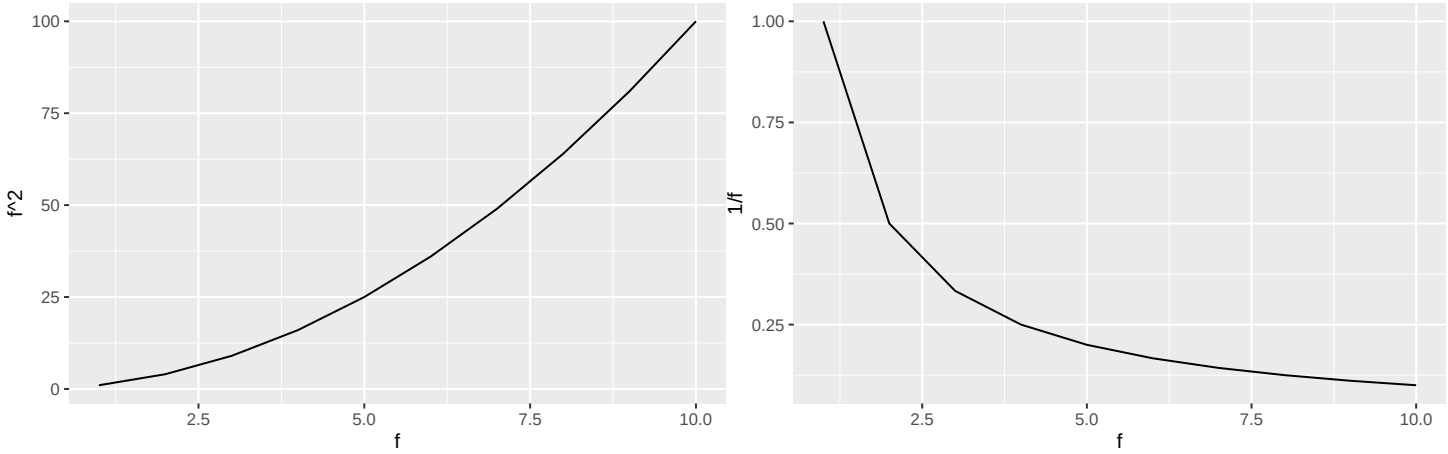
- At least one subsection should describe the exploratory data analysis you did.
- What modifications were necessary to make the dataset ready for analysis? (e.g. dealing with missing values, removing certain rows, replacing/cleaning text values, binning, etc)
- Describe the analyses you did to answer the question of interest. **Explain why you believe these methods are appropriate.**

Some methods we learn in this class include distribution comparison, correlation analysis, and hypothesis testing. You are required to include hypothesis tests into the project, but feel free to use additional methods to tell a good story about the data.

4 Results

This is where all the plots will go!!!! Here are some examples of plot layout:

4.1 Tabbed example output



(a) Subcap

(b) Subcap 2

Figure 4.1: ANother example caption

4.2 Example outout

```
[1]  1  2  3  4  5  6  7  8  9 10
```

> **From the report requirements**
>
> Describe the results of your analysis using visualizations, descriptive statistics, tables and similar.
> Don't focus too much on the implications in this section – that's what the next section is for. Just present the numbers/graphs.

5 Conclusions

From the report requirements

- Summarize what the paper has done, and discuss the implications of your Results.
- Explicitly connect the results to the research question.
- Discuss how you would you extend this research

Like the introduction, this section should be written with a **non-expert** in mind. A person should be able to read Introduction+Conclusion and get a rough idea of the meaning and significance of your paper

References

Karkkainen, Kimmo, and Jungseock Joo. 2021. "FairFace: Face Attribute Dataset for Balanced Race, Gender, and Age for Bias Measurement and Mitigation." In *Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision*, 1548–58.