# Programming for Professional Research Using R

## Session 2

October 9, 2025

# Today

- Learn how to:
    - Create a scatter plot, density plot, and bar chart using the `ggplot2` package
    - Create flexible and easy-to-read tables of any dataset using the `gt` package
    - Create simple academic-standard regression output tables using the `stargazer` package
- Practice the above!

# Data Visualization — Descriptive Statistics — Plots

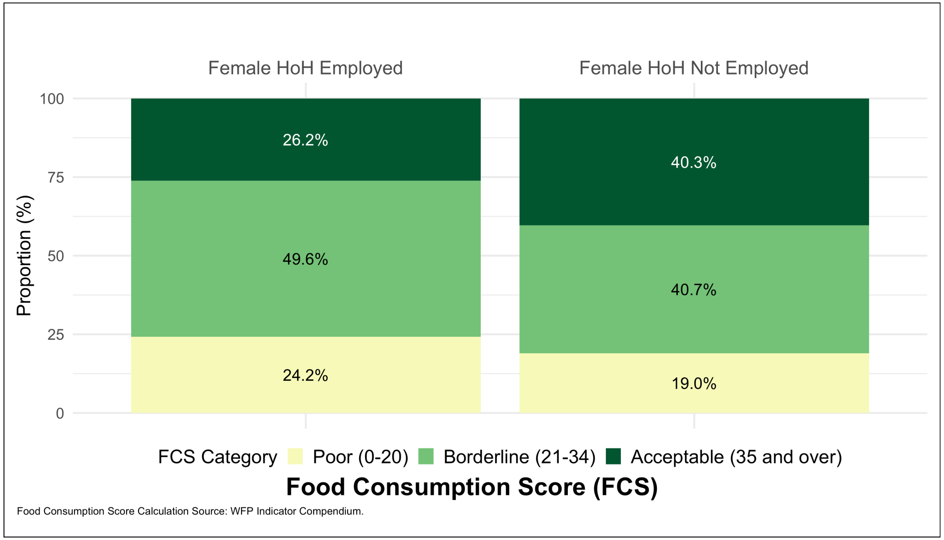
# Descriptive Stats Plots

`ggplot2` is the gold standard in data visualization in data work. It's one of the main reason that people use R over other programming languages.

Very simple syntax and allows you to add elements very easily.

You can use `ggplot2` to create any type of plot you can think of.

I've included a lot of links at the end of these slides to explore the possibilities of `ggplot2` further. Strongly recommend you use them or at least save them somewhere.



# The Magic of `ggplot2`

Using `ggplot2` to create plots is great because the **structure** it sets up makes plot creation intuitive.

```
ggplot(data = <DATA>) +
  <GEOM_FUNCTION>(
     mapping = aes(<MAPPINGS>),
     stat = <STAT>,
     position = <POSITION>
  ) +
  <SCALE_FUNCTION> +
  <FACET_FUNCTION> +
  <THEME_FUNCTION>
```

1. `Data`: The data that you want to visualize
2. `Layers`: geom_ and stat_ → The geometric shapes and statistical summaries representing the data
3. `Aesthetics`: aes() → Aesthetic mappings of the geometric and statistical objects
4. `Scales`: scale_ → Maps between the data and the aesthetic dimensions
5. `Facets`: facet_ → The arrangement of the data into a grid of plots
6. `Visual themes`: theme() and theme_ → The overall visual defaults of a plot

# Scatter Plot — Step-by-Step

Dataset Convert to Plot Add Something

Start with a dataset you want to visualize

```r
head(mtcars)
```

```
##                    mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

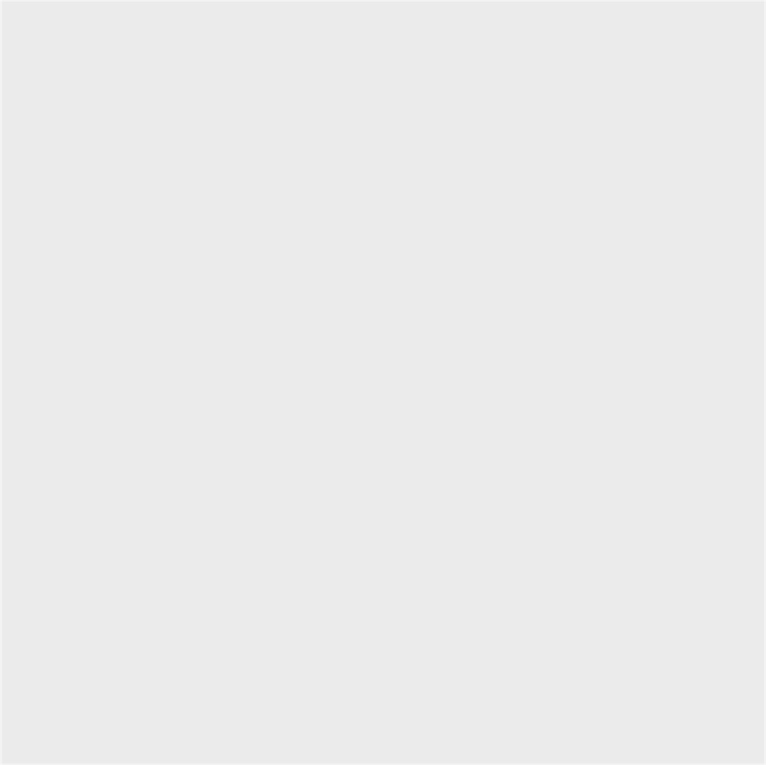
# Scatter Plot — Step-by-Step

Dataset

Convert to Plot

Add Something

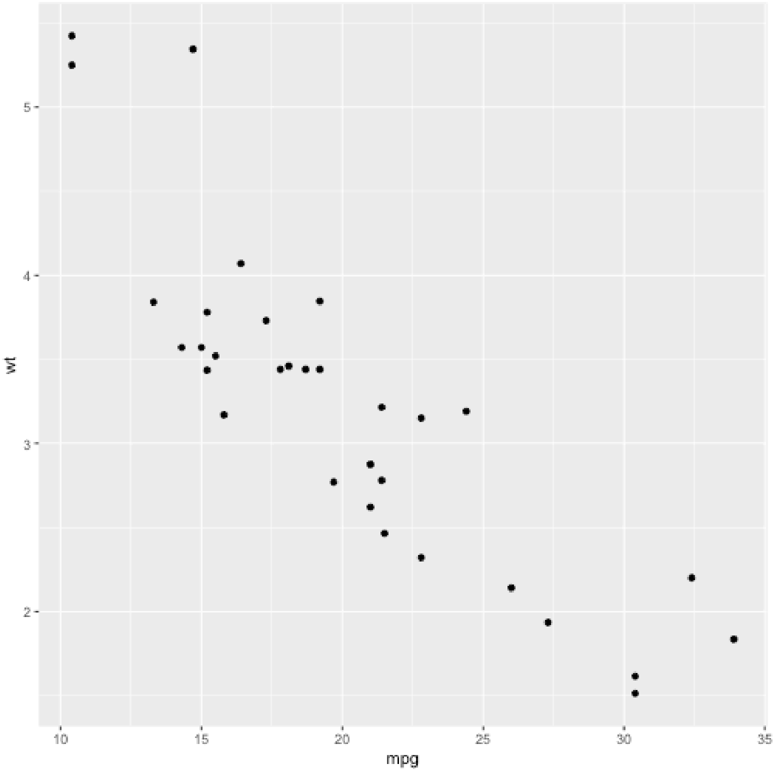
```
ggplot(mtcars)
```



# Scatter Plot — Step-by-Step

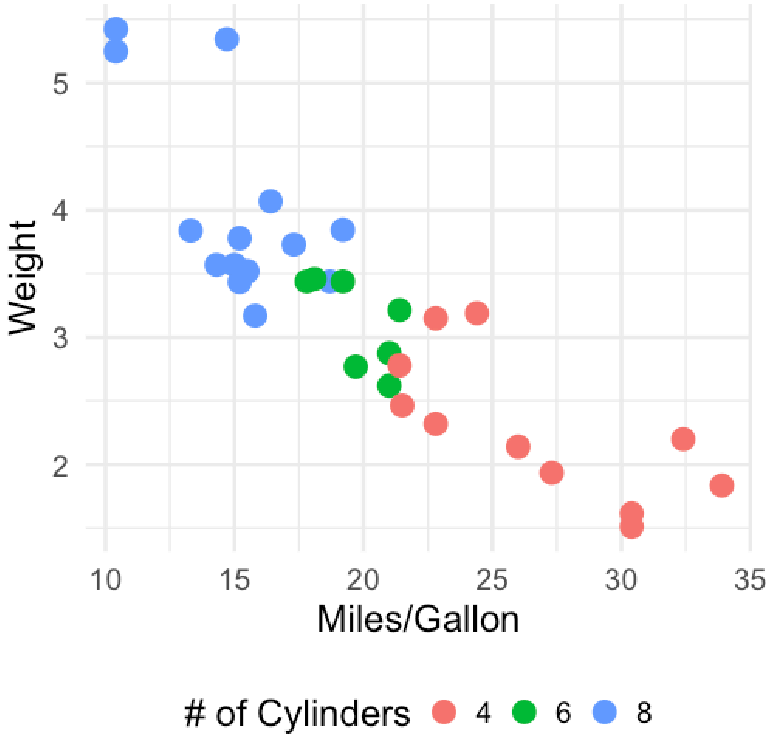
Dataset   Convert to Plot   Add Something

```
ggplot(mtcars) +
  geom_point(
    aes(x = mpg, y = wt)
  )
```



# Scatter Plot — Make It Better

```r
ggplot(mtcars) +
  geom_point(
    aes(
      x = mpg, y = wt,
      color = factor(cyl)
    ),
    size = 6
  ) +
  xlab("Miles/Gallon") +
  ylab("Weight") +
  scale_color_discrete(
    name = "# of Cylinders"
  ) +
  theme_minimal(base_size = 24) +
  theme(
    legend.position = "bottom"
  )
```



# Bar Plot — Step-by-Step

Dataset Convert to Plot Add Something Fix Class Issue

Start with a dataset you want to visualize

```
mtcars_summary
```

```
## # A tibble: 3 × 2
##     cyl   mpg
##   <dbl> <dbl>
## 1     4  26.7
## 2     6  19.7
## 3     8  15.1
```

# Bar Plot — Step-by-Step

Dataset

Convert to Plot

Add Something

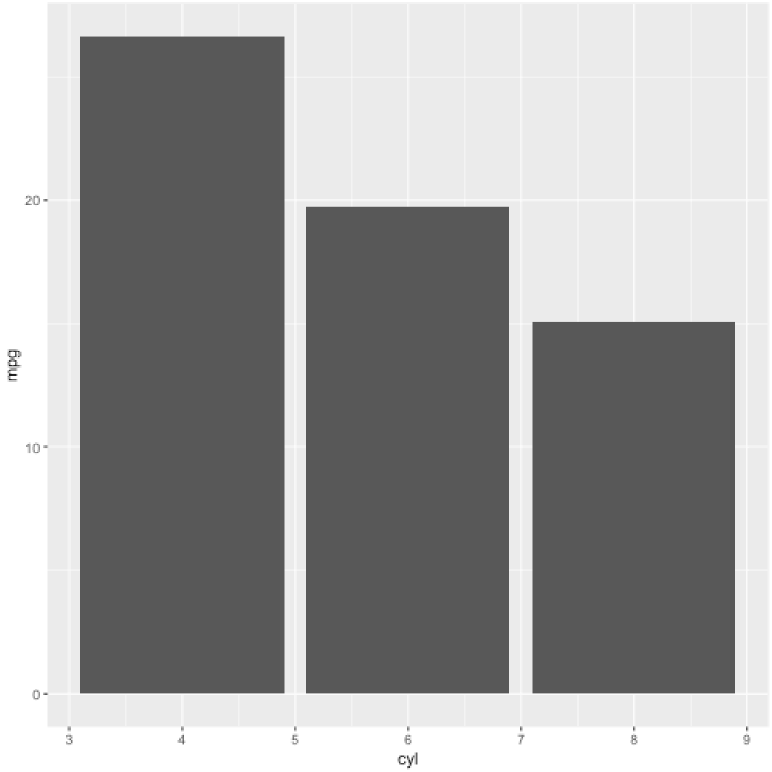
Fix Class Issue

```
ggplot(mtcars_summary)
```

# Bar Plot — Step-by-Step

Dataset | Convert to Plot | **Add Something** | Fix Class Issue

```
ggplot(mtcars_summary) +
  geom_col(
    aes(
      x = cyl,
      y = mpg
    )
  )
```

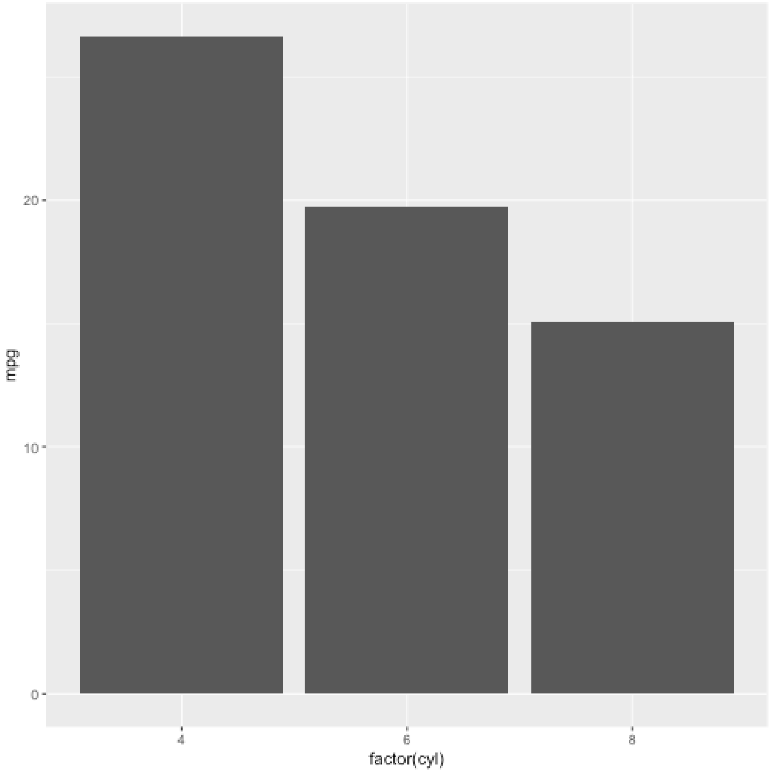


# Bar Plot — Step-by-Step

Dataset    Convert to Plot    Add Something    Fix Class Issue

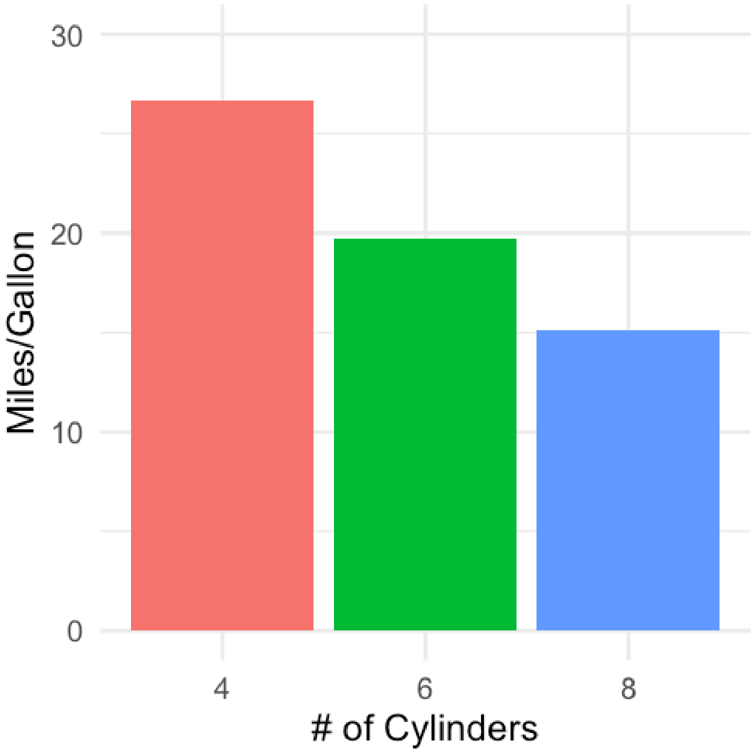
```
ggplot(mtcars_summary) +
  geom_col(
    aes(
      x = factor(cyl),
      y = mpg
    )
  )
```

`cyl` categorizes cars by number of cylinders. Although the values are numbers, it is a **categorical** variable. We communicate this to `ggplot()` using the `factor()` function.



# Bar Plot — Make It Better

```
ggplot(mtcars_summary) +
  geom_col(
    aes(
      x    = factor(cyl),
      y    = mpg,
      fill = factor(cyl)
    )
  ) +
  xlab("# of Cylinders") +
  ylab("Miles/Gallon") +
  scale_y_continuous(
      limits = c(0, 30)
  ) +
  theme_minimal(base_size = 24) +
  theme(
    legend.position = "none"
  )
```



# Plot Standards

1. Your plot should be **properly labeled**:
    - The plot should have a title describing its content
    - Axes should be labeled
    - Legend (if any) should have a title and labels
2. Your plot should be **properly formatted**:
    - Axis dimensions should be appropriate. What is appropriate varies depending on context, but usually you should aim to fill the plot space with data
    - Text size should be large enough for text to be legible
3. Your plot should be **self contained**. People should be able to understand your plot and its data without any other context or explanatory text. That means:
    - A caption note that includes data source and any important data construction notes
    - Title and subtitle that deliver the plot's *message*

# Data Visualization — Descriptive Statistics — Tables

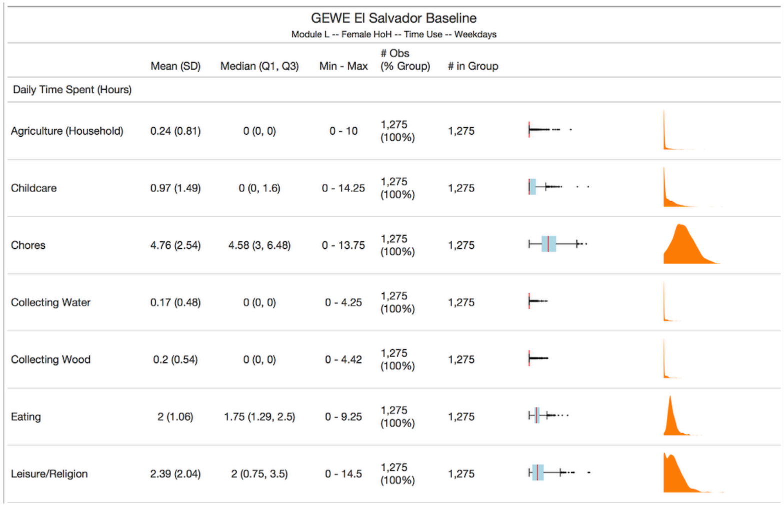
# Descriptive Statistics Tables

Thankfully, not every RA position requires academic-standard tables or use of LateX.

It is still useful, however, to be able to communicate descriptive statistics about data.

There are countless R packages to help do this. Today, we're looking at the `gt` package. It's simple to use and it's very easy to create good-looking tables using it.

`gt` exports into .png, .pdf, or .html. You can add interactive elements, plots within columns.



GEWE El Salvador Baseline

Module L -- Female HoH -- Time Use -- Weekdays

| | Mean (SD) | Median (Q1, Q3) | Min - Max | # Obs<br>(% Group) | # in Group | | |
|---|---|---|---|---|---|---|---|
| Daily Time Spent (Hours) | | | | | | | |
| Agriculture (Household) | 0.24 (0.81) | 0 (0, 0) | 0 - 10 | 1,275<br>(100%) | 1,275 | | |
| Childcare | 0.97 (1.49) | 0 (0, 1.6) | 0 - 14.25 | 1,275<br>(100%) | 1,275 | | |
| Chores | 4.76 (2.54) | 4.58 (3, 6.48) | 0 - 13.75 | 1,275<br>(100%) | 1,275 | | |
| Collecting Water | 0.17 (0.48) | 0 (0, 0) | 0 - 4.25 | 1,275<br>(100%) | 1,275 | | |
| Collecting Wood | 0.2 (0.54) | 0 (0, 0) | 0 - 4.42 | 1,275<br>(100%) | 1,275 | | |
| Eating | 2 (1.06) | 1.75 (1.29, 2.5) | 0 - 9.25 | 1,275<br>(100%) | 1,275 | | |
| Leisure/Religion | 2.39 (2.04) | 2 (0.75, 3.5) | 0 - 14.5 | 1,275<br>(100%) | 1,275 | | |

# Descriptive Statistics Table — Step-by-Step

We will mainly use the example in the script for this. To summarize, the steps are:

- Create a dataset you want to export
- Run the dataset through the `gt()` function to create a gt object
- Customize the table using functions from the `gt` package (see online for further things you can do). Examples of what you can do include:
    - Modify column names — `cols_label()`
    - Modify borders — `tab_style()`, `cell_borders()`
    - Add colors conditional on cell value — `data_color()`
    - Add title/subtitle — `tab_header()`
- Export the table using `gtsave()`

# Data Visualization — Simple Regression Table

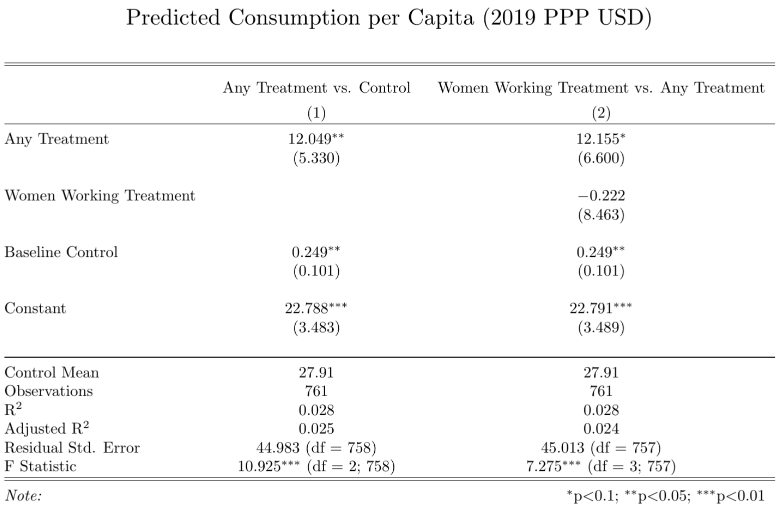
# Regression Tables

Regression tables are very common in economic/policy analysis.

They're very simple to create using R and a software called **LateX** (pronounced latek).

Unless you're getting into academic research, you don't need to know how to properly use LateX. Just enough to:

- Export the LateX script from R
- Copy/paste it into a LateX-reading software, e.g. Overleaf
- Export the pdf or png to share



Predicted Consumption per Capita (2019 PPP USD)

| | Any Treatment vs. Control | Women Working Treatment vs. Any Treatment |
|---|---|---|
| | (1) | (2) |
| Any Treatment | 12.049**<br>(5.330) | 12.155*<br>(6.600) |
| Women Working Treatment | | −0.222<br>(8.463) |
| Baseline Control | 0.249**<br>(0.101) | 0.249**<br>(0.101) |
| Constant | 22.788***<br>(3.483) | 22.791***<br>(3.489) |
| Control Mean | 27.91 | 27.91 |
| Observations | 761 | 761 |
| R$^2$ | 0.028 | 0.028 |
| Adjusted R$^2$ | 0.025 | 0.024 |
| Residual Std. Error | 44.983 (df = 758) | 45.013 (df = 757) |
| F Statistic | 10.925*** (df = 2; 758) | 7.275*** (df = 3; 757) |
| *Note:* | | *p<0.1; **p<0.05; ***p<0.01 |

# Regression Table — Step by Step

Run Regression in R

Convert to Exportable Table

```r
# Simplest regression format in R

reg_example ← lm(
    outcome_variable ~ independent_variable + control_variables,
    data = dataset
)

# Observe results

summary(reg_example)
```

# Regression Table — Step by Step

Run Regression in R

Convert to Exportable Table

Simply do one of these!

```r
reg_example_ht <- huxtable::huxreg(reg_example)
```

OR

```r
reg_example_sg <- stargazer::stargazer(reg_example)
# Many options to make prettier
```

# Regression Table — Step by Step

Export Huxtable Table

Export Stargazer Table

Some simple options for the Huxtable table:

```r
huxtable::quick_latex(
    reg_example_ht,
    file = "filepath/filepath/filepath/reg_example_ht.tex"
)

huxtable::quick_pdf
    reg_example_ht,
    file = "filepath/filepath/filepath/reg_example_ht.pdf"
)

huxtable::quick_html(
    reg_example_ht,
    file = "filepath/filepath/filepath/reg_example_ht.html"
)
```

# Regression Table — Step by Step

Export Huxtable Table | Export Stargazer Table

```
# You can export a LateX script using the 'writeLines' function

writeLines(
    reg_example_sg,
    "filepath/filepath/filepath/reg_example_sg.tex"
)
```

To visualize your table, the easiest solution is to:

- Create a free Overleaf account on overleaf.com
- Open a new document
- Copy/paste your .tex output in between the `begin{document}` and `end{document}` lines
- Click compile and then save!

You can also install the `tinytex` package and use `pdftolatex` to save a PDF file.

# Practical Exercise — Using the World Values Survey Dataset

# World Values Survey

## Background

*"The survey, which started in 1981, seeks to use the most rigorous, high-quality research designs in each country. The WVS consists of nationally representative surveys conducted in almost 100 countries which contain almost 90 percent of the world's population, using a common questionnaire. [...] WVS seeks to help scientists and policy makers understand changes in the beliefs, values and motivations of people throughout the world."*

## Survey Contents

- Social values, attitudes & stereotypes
- Societal well-being
- Social capital, trust and organizational membership
- Economic values
- Corruption
- Migration
- Post-materialist index
- Science & technology
- Religious values
- Security
- Ethical values & norms
- Political interest and political participation
- Political culture and political regimes
- Demography

# Today's practical component

1. Download the required data for this session from this Dropbox folder

2. Successfully run the code in the `session_2.R` script

3. Attempt the challenges at the bottom of the script!

# Links

**Tables**

Marek Hlavac, “stargazer: beautiful LATEX, HTML and ASCII tables from R statistical output”

Thomas Mock, “gt - a (G)rammar of (T)ables”

**Plots**

Alicia Horsch, “A quick introduction to ggplot2”

RStudio, RStudio Cheatsheets