Session 4 - Data visualization

R training

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The World Bank | January 2025

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Government Analytics and R Training:

Strengthening Public Sector Reporting and Data Analysis

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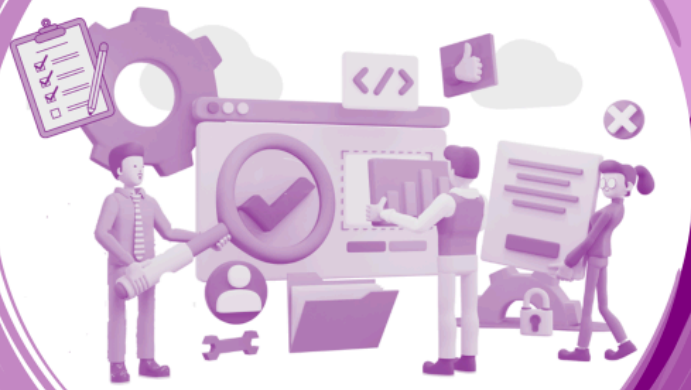


Introduction

Introduction

About this session

Input

department_staff_list.csv

Data process

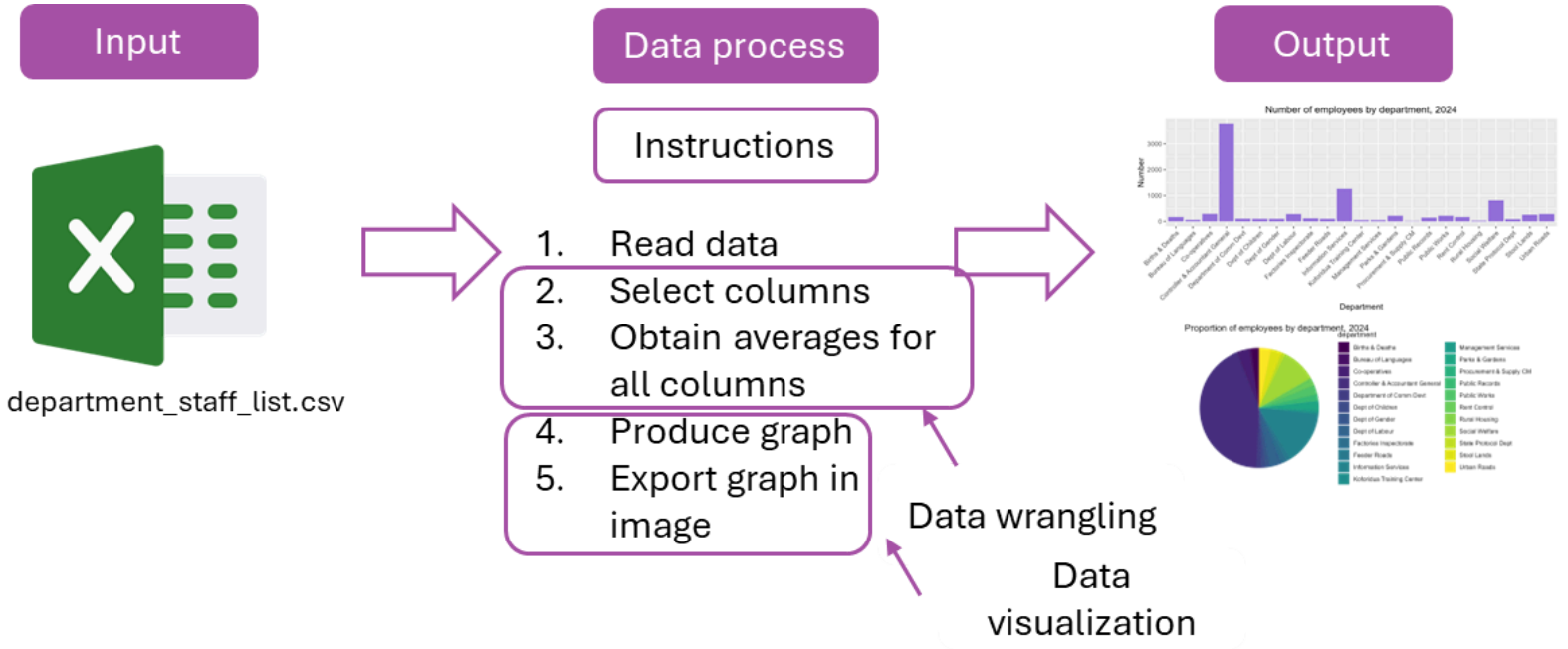
Instructions

1. Read data
2. Select columns
3. Sort
4. Filter rows
5. Create averages
6. Produce dataframe

Output

Data visualization in the data work pipeline

- Compared to other kind of outputs, data visualization involves an extra step after data wrangling: producing the visualization itself
- We also us R code to produce data visualizations
- The input for that code is a wrangled dataframe, dataframe that is ready to be used



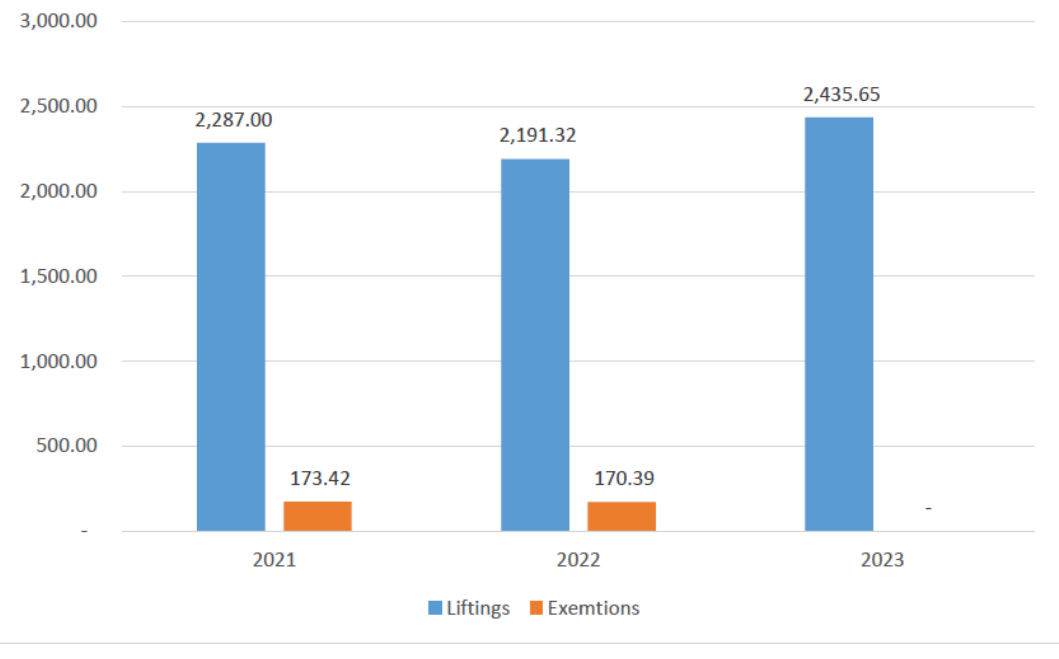
Introduction

From Your Annual Reports

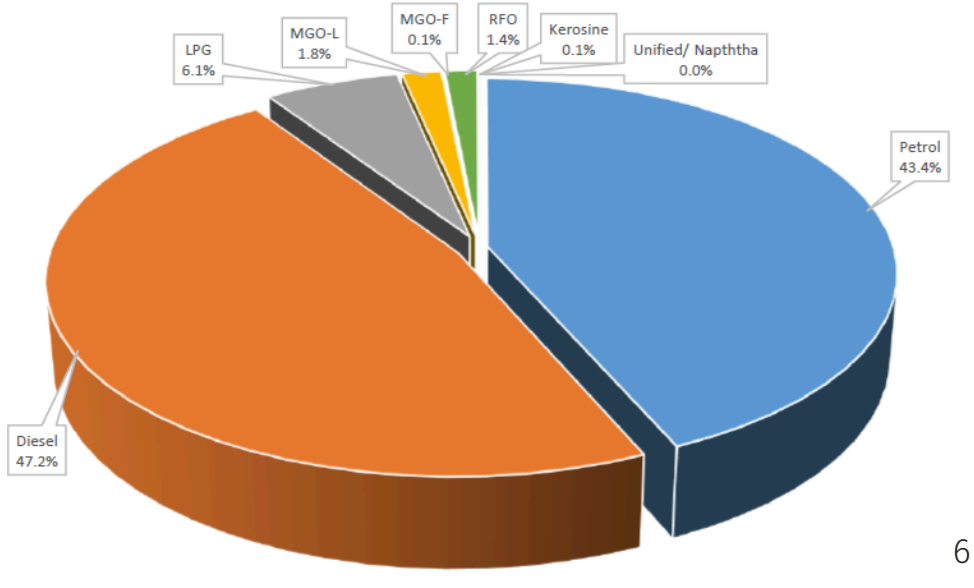
In your annual reports, the most common visualizations include:

1. **Bar Graphs**: Used to compare categories (e.g., spending across departments or revenue by month).
2. **Pie Charts**: Used to show proportions (e.g., product share, budget breakdown).

Bar Graph Example



Pie Chart Example



What You Will Learn

Today, I will teach you how to:

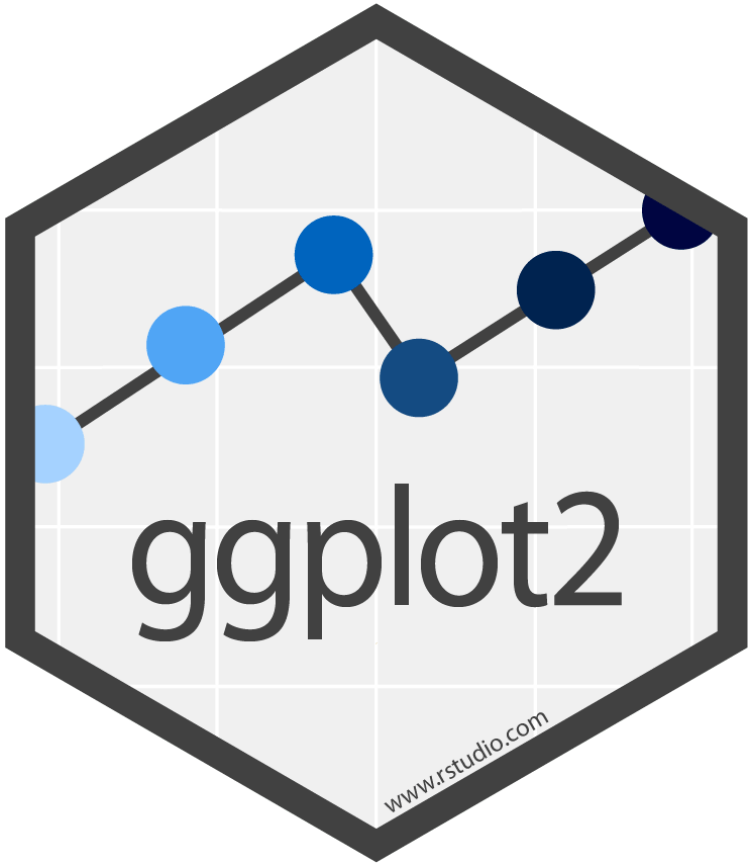
1. **Recreate these common visualizations** (and more) using code.
2. Build clean and reproducible charts that you can easily include in your annual reports.
3. Explore additional visualization techniques to make your data more impactful.

We will keep using the data we have been using from the beginning to keep this simple, but the code could be recycled to fit the data of your annual reports.

Let's get started!

Data visualization in R

- We'll use the package `ggplot2` to create data visualizations
- `ggplot2` greatly facilitates producing plots in R
  - It follows a syntax based on a description of the plot you want to obtain
  - This syntax is called **grammar of graphics**, a benchmark method of data visualization definition in statistical programming



ggplot2

The grammar of graphics

The grammar of graphics

What is ggplot2?

- **ggplot2** is a powerful and flexible tool for creating data visualizations in R.
- It combines **philosophy + functions** into a well-organized framework.

Things to Keep in Mind:

1. ggplot2 may feel like **a lot to learn**, but let's do it step by step.
2. Today, we'll cover the basics, but you'll also get resources to keep exploring on your own.

The Structure of ggplot2

Creating a plot with ggplot2 requires **three basic components**:

1. **Data**: The dataset you want to visualize.
2. **Aesthetics (aes)**: How you map your data to visual elements (e.g., x-axis, y-axis, color).
3. **Geometry (geom)**: The type of plot you want (e.g., bar graph, scatter plot).

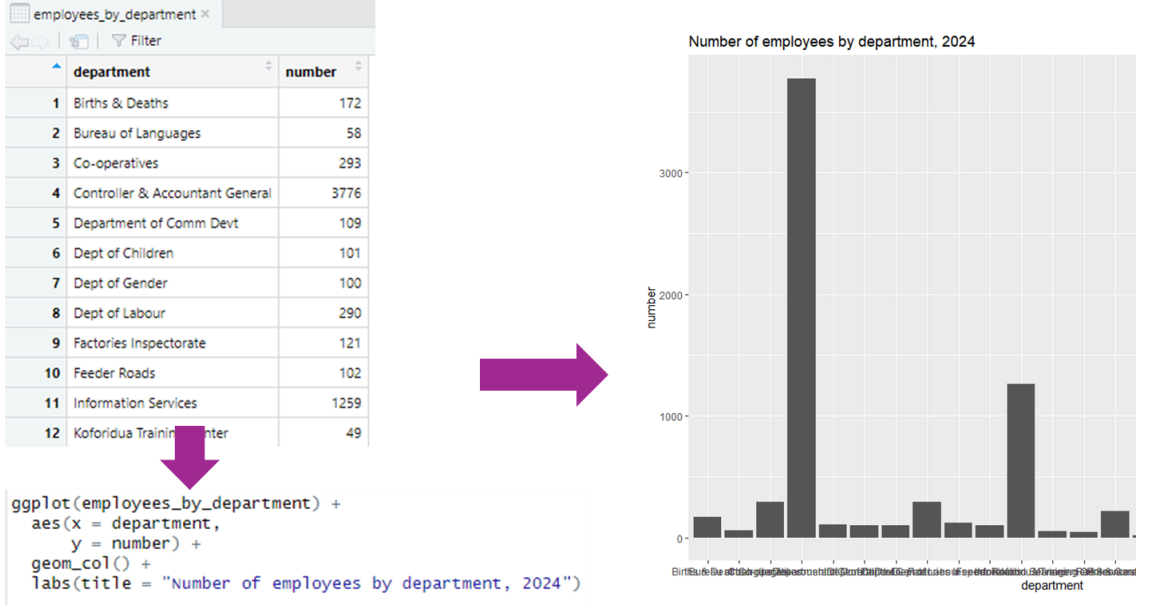
(and many more but we will keep it simple in this presentation)

The grammar of graphics in `ggplot2`

I will use the table of employees by department we created in session two to start with this.

You can also download it from here: https://osf.io/qb92t if you don't have it.

```
employees_by_department <- read.csv("data/employees_by_department.csv")
```



The grammar of graphics

The grammar of graphics in `ggplot2`

employees_by_department

Filter

	department	number
1	Births & Deaths	172
2	Bureau of Languages	58
3	Co-operatives	293
4	Controller & Accountant General	3776
5	Department of Comm Devt	109
6	Dept of Children	101
7	Dept of Gender	100
8	Dept of Labour	290
9	Factories Inspectorate	
10	Feeder Roads	
	ion Services	1259
	a Trainin nter	49

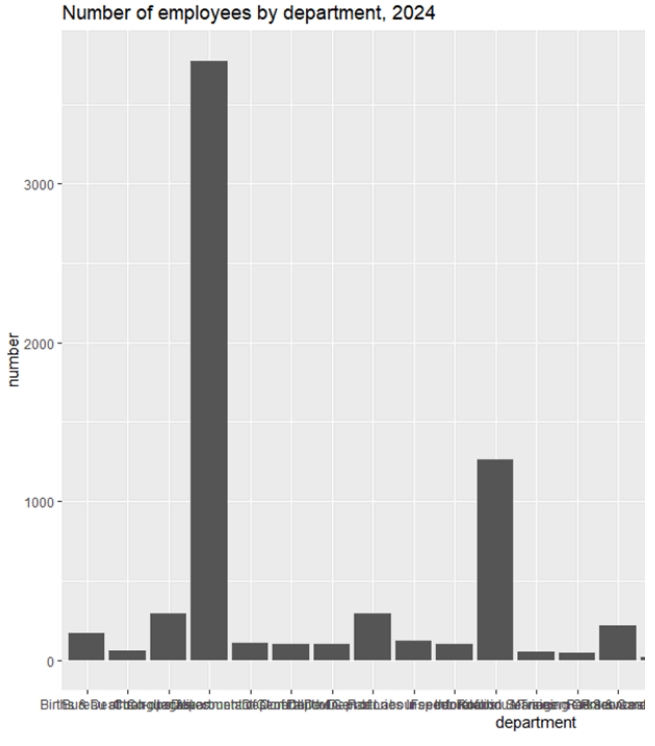
ggplot function to start the plot

1. argument = data

2. aes = define x and y axis

3. geom = type of graph I want

```
ggplot(employees_by_department) +
  aes(x = department,
      y = number) +
  geom_col() +
  labs(title = "Number of employees by department, 2024")
```



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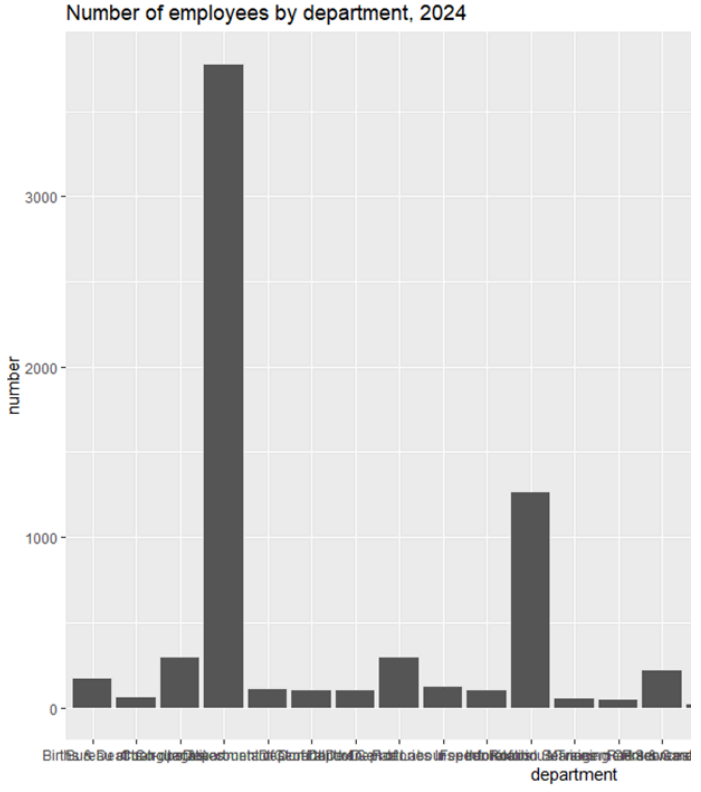
X axis (department)

```
ggplot(employees_by_department) +
  aes(x = department,
      y = number) +
  geom_col() +
  labs(title = "Number of employees by department, 2024")
```



The grammar of graphics

The grammar of graphics in `ggplot2`

employees_by_department

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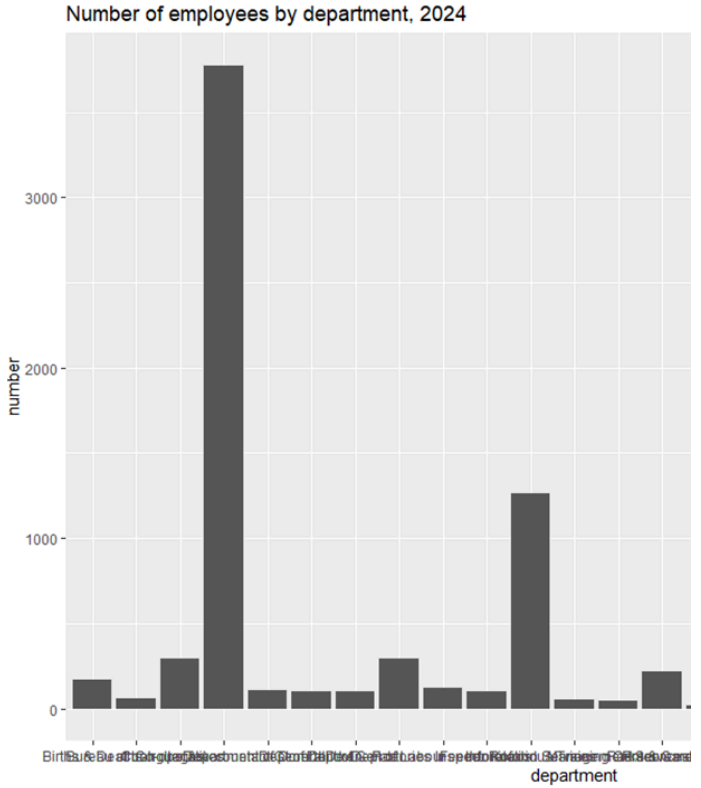
y axis (number)

```
ggplot(employees_by_department) +
  aes(x = department,
      y = number) +
  geom_col() +
  labs(title = "Number of employees by department, 2024")
```



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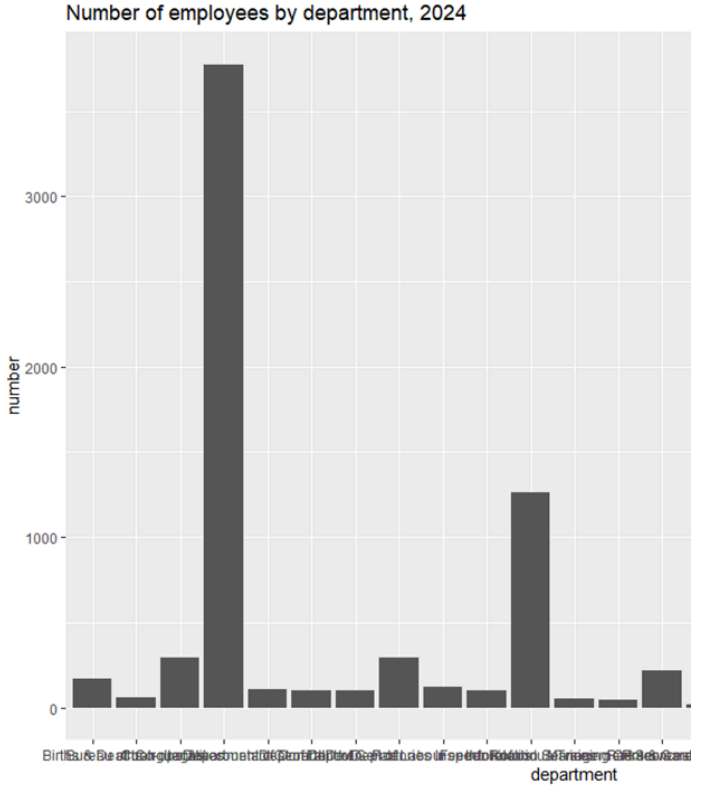
geom_ defines geometry

```
ggplot(employees_by_department) +
  aes(x = department,
      y = number) +
  geom_col() +
  labs(title = "Number of employees by department, 2024")
```



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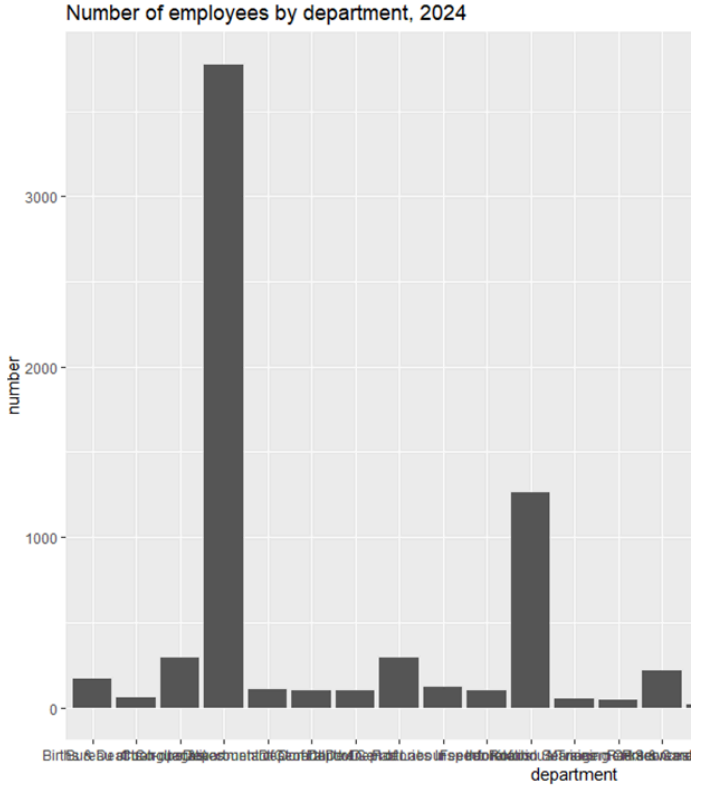
labs (labels, like title, subtitle..)

```
ggplot(employees_by_department) +
  aes(x = department,
      y = number) +
  geom_col() +
  labs(title = "Number of employees by department, 2024")
```



Bar plots

Bar plots

Exercise 1a: Create a basic bar plot

1. Open a new script for this session by clicking on `File` >> `New File` >> `R Script`
2. Load `ggplot2`

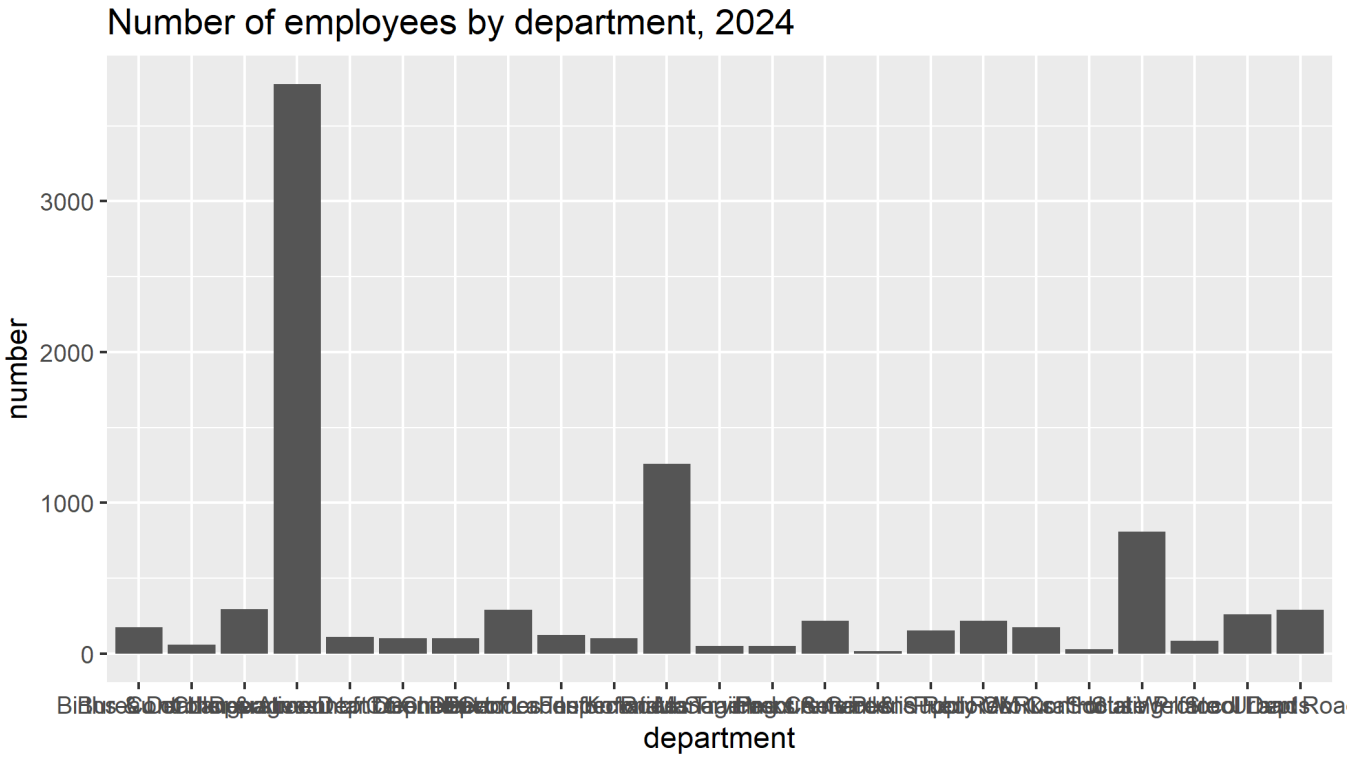
```
library(ggplot2)
```

1. Produce a basic bar plot with the following code:

```
ggplot(employees_by_department) +
  aes(x = department,
      y = number) +
  geom_col() +
  labs(title = "Number of employees by department, 2024")
```

Bar plots

This result should be displayed in the lower right panel of your RStudio window

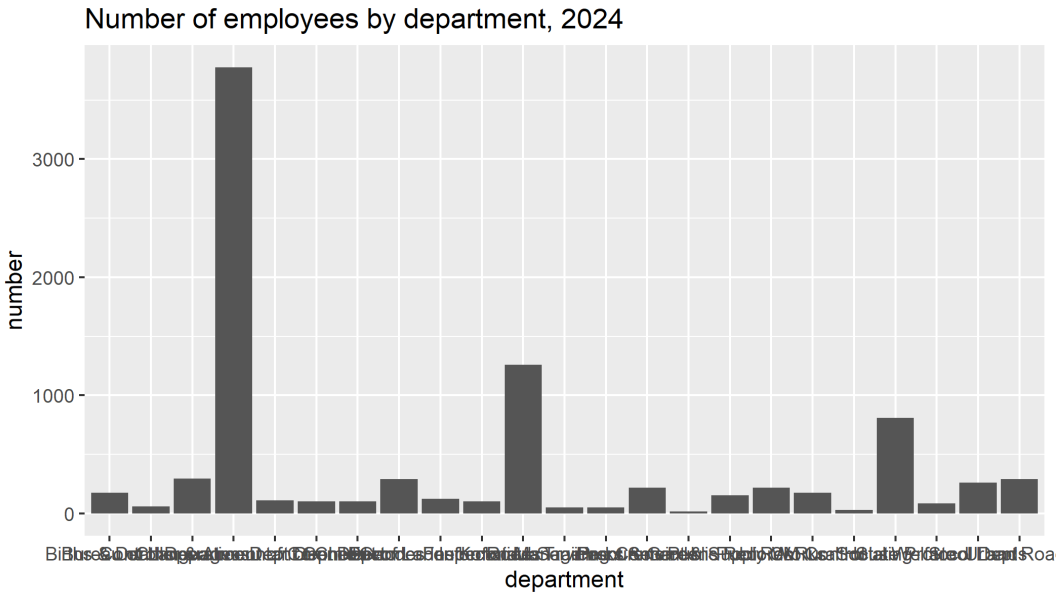


In Excel ❎ you would select the data and insert bar graph.

Bar plots

This plot doesn't look great yet!

- `department` is too crowded as the names are long, but R does not know this. We need to tell R that those labels should be rotated
- We can center the title
- We should add axis labels (instead of just variable names)
- We can add color



Bar plots

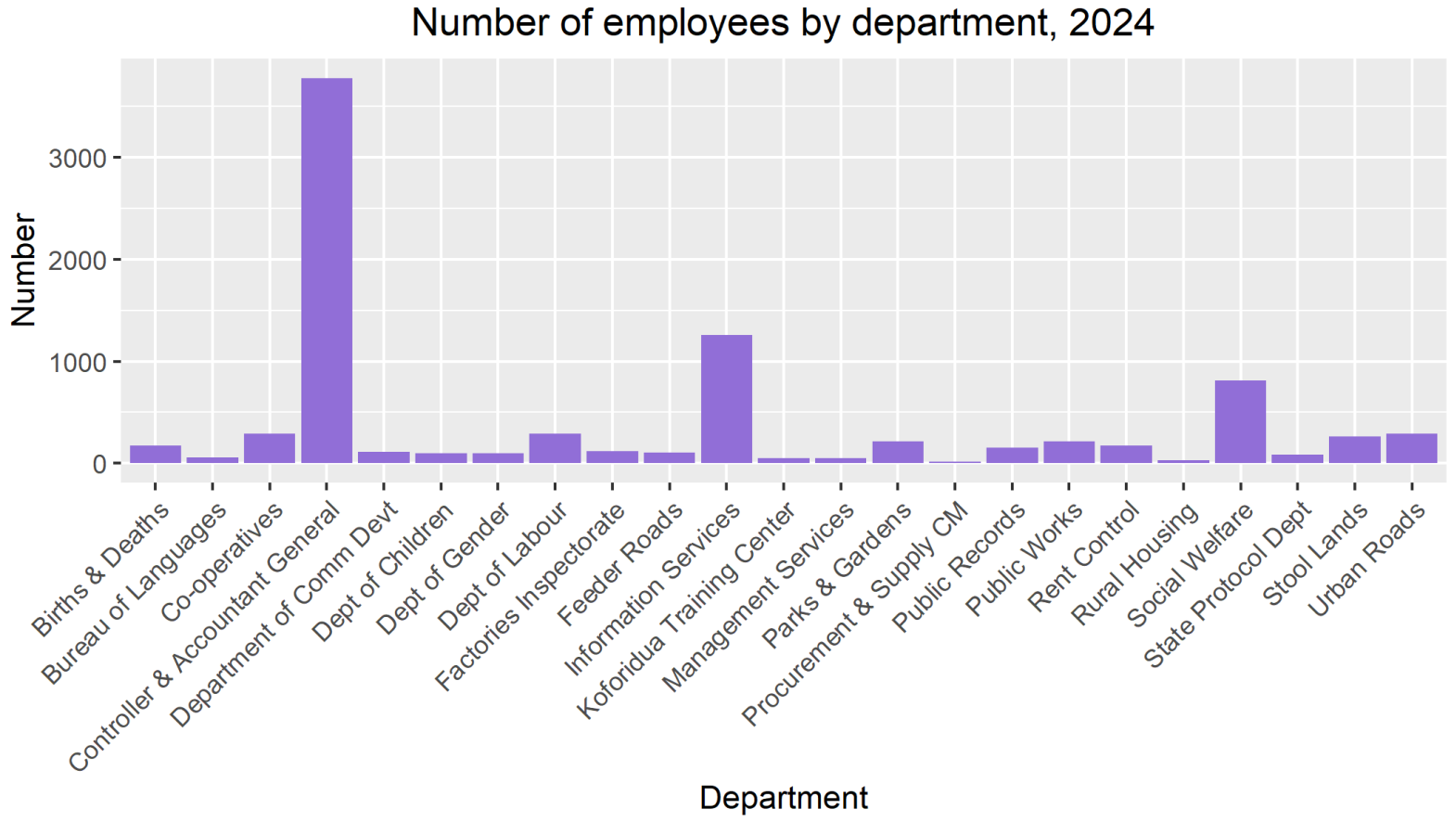
Exercise 1b: Improve your bar plot

1. Use the following code to improve the aesthetics of your plot

```
ggplot(employees_by_department) +
  aes(x = department,
      y = number) +
  geom_col(fill = "#9370DB") +
  labs(
    title = "Number of employees by department, 2024", # title
    x = "Department",
    y = "Number"
  ) +
  # Title and subtitles
  theme(
    plot.title = element_text(hjust = 0.5),
    axis.text.x = element_text(angle = 45, hjust = 1)
  )
```

Bar plots

Now this looks better:



Bar plots

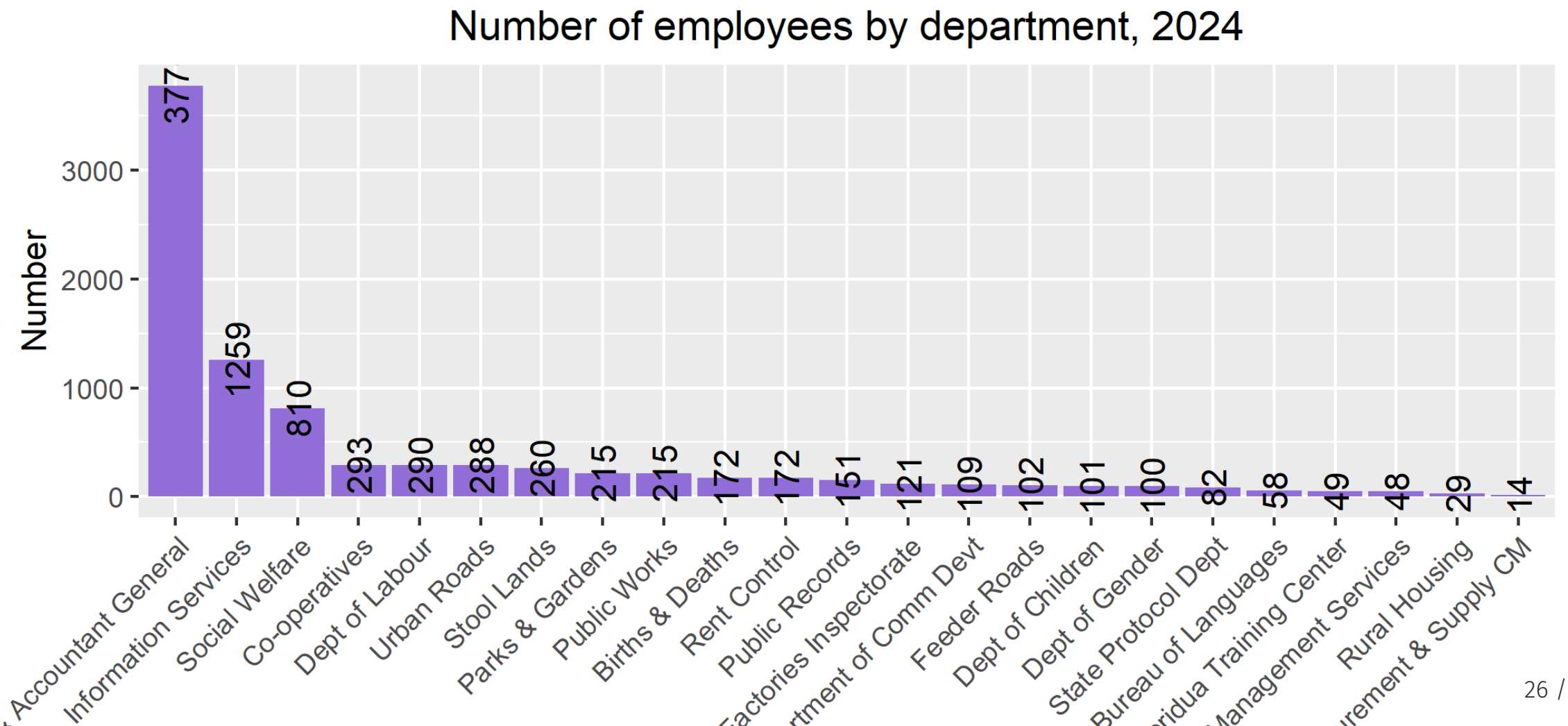
Exercise 1c: Improve your bar plot

But we can actually make this even better. I would reorder by amount of employees, and add labels.

```
# Create the bar plot
ggplot(employees_by_department) +
  aes(x = reorder(department, -number), y = number) + #<<  # Reorder bars by `number`
  geom_col(fill = "#9370DB") +
    geom_text(
    aes(label = number),
    angle = 90
  ) +
  labs(
    title = "Number of employees by department, 2024",
    x = "Department",
    y = "Number"
  ) +
  theme(
    plot.title = element_text(hjust = 0.5),
    axis.text.x = element_text(angle = 45, hjust = 1) # Rotate x-axis labels
  )
```

Bar plots

Now this is ready to be in one of your reports.



Bar plots

Exercise 1d: save your plot

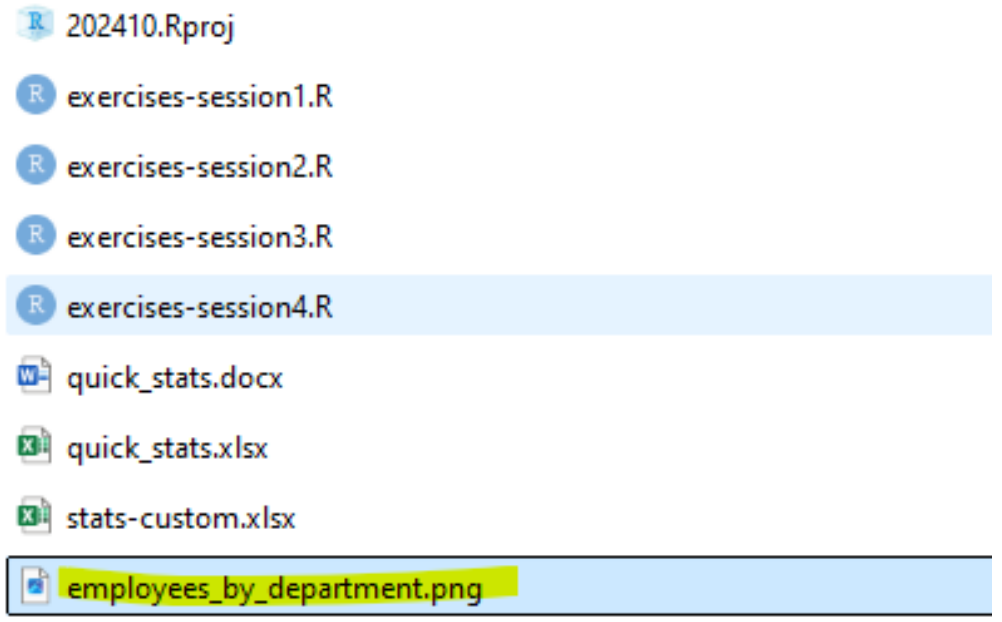
Now that your plot looks good, you can save it into an output with `ggsave()`

1. Use this code to save your plot:

```
ggsave("employees_by_department.png",
       width = 20,
       height = 10,
       units = "cm")
```

Bar plots

- `ggsave()` by default saves the last plot your produced
- The first argument in `ggsave()` is the name of the file we save the plot into. We can also use file paths here
- The rest are optional arguments that define the dimensions of the image you export, it's better to define them so the image has the correct proportions and text size



You Did Your First Plot! 🎉

The Possibilities Are Endless

- Congratulations on creating your **first plot**!
- From here, you can explore countless options to visualize your data:
  - Bar graphs, line plots, scatterplots, pie charts, and more.
- Experimentation is key! Don’t be afraid to try new things or make mistakes.

You Have the Power 💪

- Data visualization is a skill that grows with practice.
- Use online resources and communities like:
  - ggplot2 Documentation
  - ggplot presentation

Now the sky is the limit! 🎉

Pie charts

Pie charts

From Bar Plots to Pie Charts

- We just created a **bar plot** to visualize the number of employees by department.
- Let's now use the **same data** to create a **pie chart**, a common way to show proportions.

Geoms and Graph Types

Remember: The **geom** controls the type of graph we create.

- `geom_col()`: Creates bar plots.
- `geom_bar()` with **coord_polar()**: Converts data into a pie chart.

Pie Charts

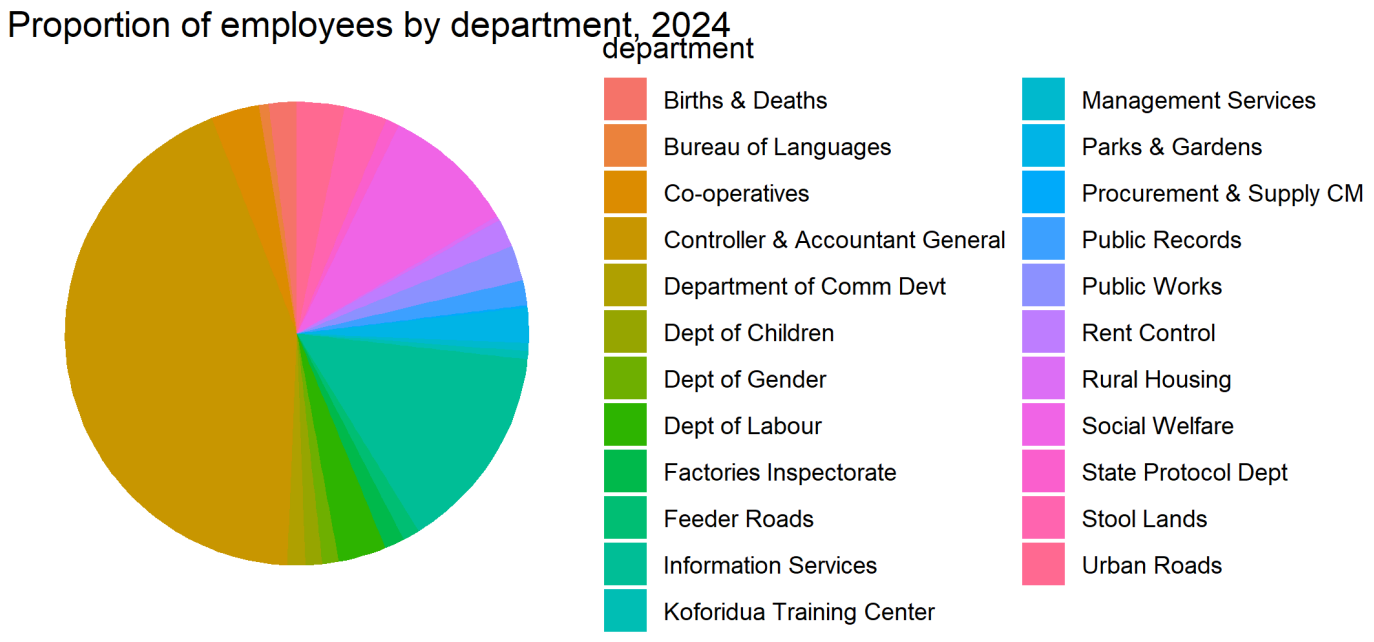
Exercise 2a: Create a Pie Chart

1. Use the following code to create a pie chart:

```
ggplot(employees_by_department) +
  aes(x = "", y = number, fill = department) +
  geom_bar(stat = "identity", width = 1) +
  coord_polar(theta = "y") +
  labs(
    title = "Proportion of employees by department, 2024"
  ) +
  theme_void()
```

Pie chart

You should see this on your Plots panel.



Pie chart

Exercise 2b

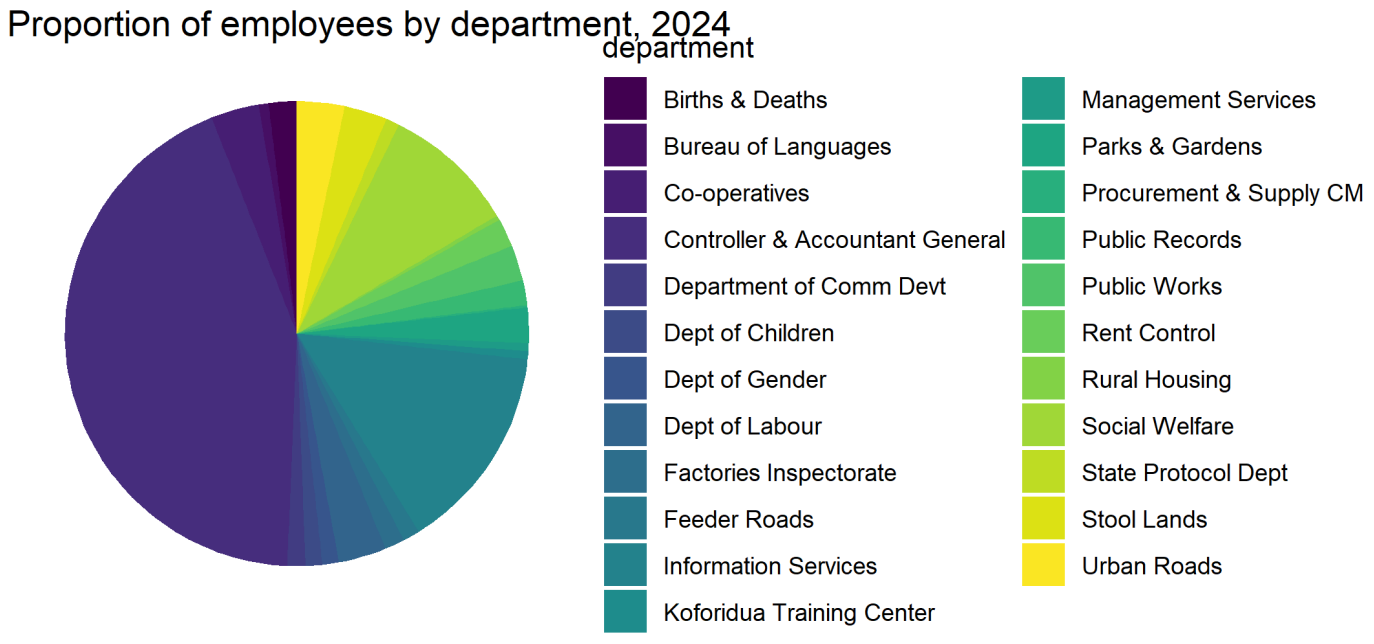
The chart is alright, but we can customize it further.. What about changing the colors?

```
ggplot(employees_by_department) +
  aes(x = "", y = number, fill = department) +
  geom_bar(stat = "identity", width = 1) +
  coord_polar(theta = "y") +
  labs(
    title = "Proportion of employees by department, 2024"
  ) +
  theme_void() +
  scale_fill_viridis_d(option = "D")
```

Pie chart

Exercise 2c

Now this is ready to go into our report, so let's save it.

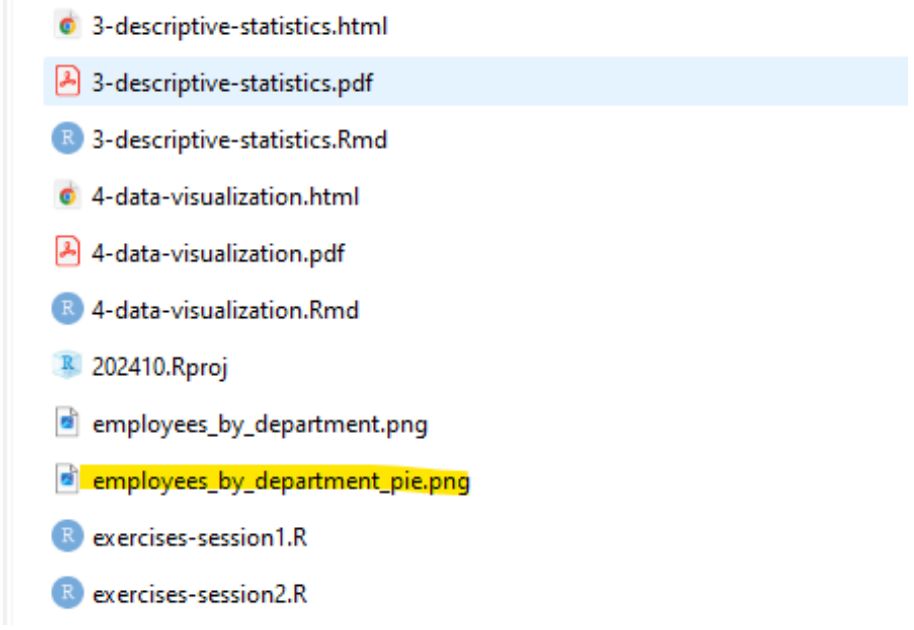


Pie chart

Exercise 2c

Now this is ready to go into our report, so let's save it.

```
ggsave("employees_by_department_pie.png")
```



Line plots

Line plots

Another Common Plot: Line Plots

- **Line plots** are commonly used to show **trends over time** or changes across a sequence.
- Examples include visualizing **monthly sales**, **yearly growth**, or **temperature changes**.

Description

- Each point represents a value at a specific time.
- Lines connect the points to show a continuous trend.

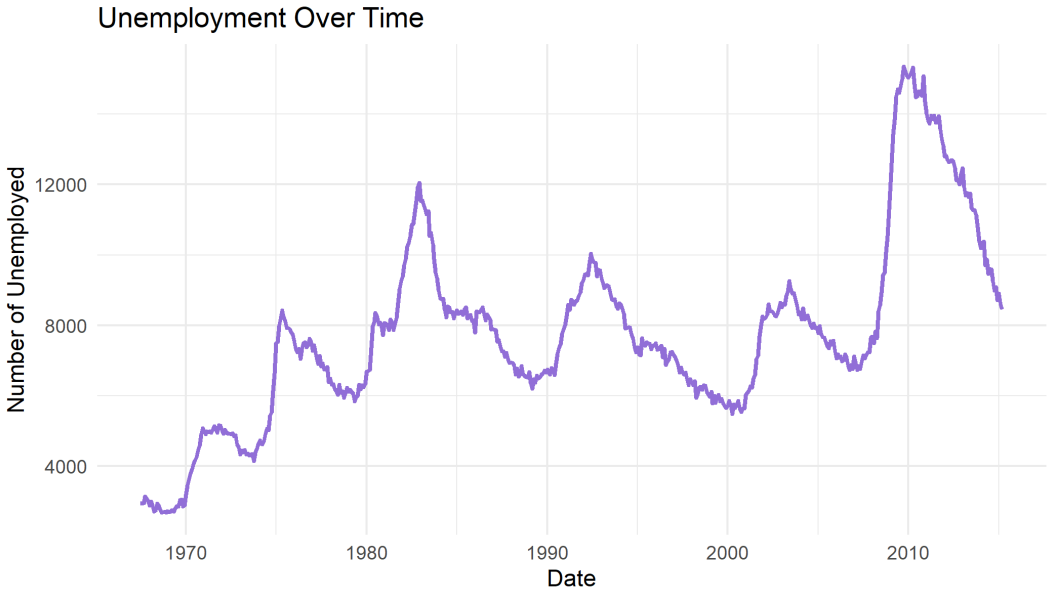
Line plots

Code Example

```
library(ggplot2)

# Using built-in `economics` dataset from ggplot2
ggplot(economics) +
  aes(x = date, y = unemploy) +
  geom_line(color = "#9370DB", size = 1) +
  labs(
    title = "Unemployment Over Time",
    x = "Date",
    y = "Number of Unemployed"
  ) +
  theme_minimal()
```

Output Example



Wrapping up

Wrapping up

More in `ggplot2`

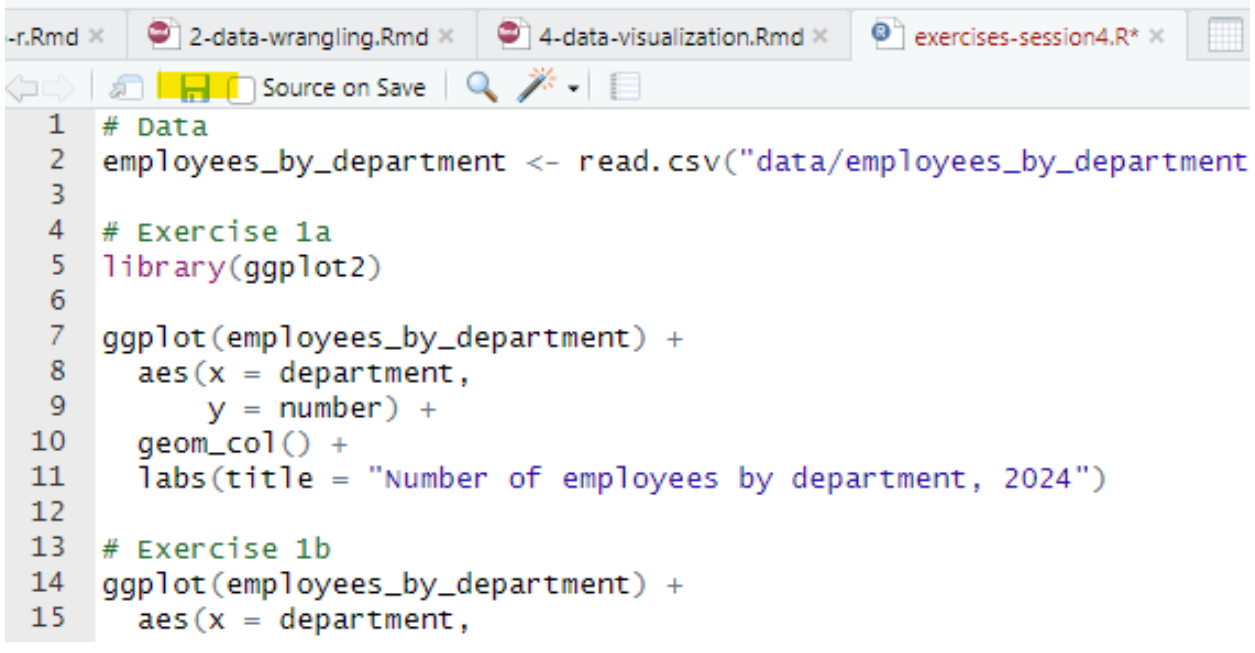
This table lists several of the most popular encoding types in `ggplot2`. Also see more here

Encoding	Function in `ggplot2`
Bars	`geom_col()`
Lines	`geom_line()`
Points (scatterplot)	`geom_point()`
Area	`geom_area()`
Histogram	`geom_histogram()`
Floating labels (texts)	`geom_text()`
Box plot	`geom_boxplot()`
Pie chart	`geom_bar() + coord_polar()`
Smoothed line	`geom_smooth()`

Wrapping up

Save your code!

Click on the floppy disk to save your code in a location that you will remember.



Wrap-Up: Looking Ahead 🚀

Key Takeaways

- Today, you learned how **data + code** can create powerful visualizations and tables for your annual reports.
- **Why this matters:**
  - Code is **reusable**: Use it for next quarters or years without starting from scratch.
  - Code is **transparent**: Everyone can see and verify all the calculations.

Wrap-Up: Looking Ahead 🚀

From Data to Annual Reports

Data + Code → Annual Report

Reproducible workflows save time and improve accuracy.

What's Next?

- **Tomorrow**: Bring your own data, graphs, or tables.
  - We'll have a **long hands-on session** where you can:
    - Ask questions about how to code specific visualizations or tables.
    - Work with your own data to make real progress.

Wrap-Up: Looking Ahead 🚀

Final Thoughts 💡

- This is **new and challenging**, but it's also incredibly **powerful** and **useful**.
- The only way to get better is to **keep practicing**.
- Experiment, google, ask questions, and remember—this will make your reports and your work clearer, faster, and less error-prone!

Keep going—you've got this!

Thanks! // ¡Gracias! //

Resources for Data Visualization 📚

Learn More About ggplot2

- **ggplot2 Documentation**
  ggplot2.tidyverse.org
- **R Graphics Cookbook** (Online resource for practical examples)
  r-graphics.org
- **R for Data Science**: Chapter on Data Visualization
  r4ds.had.co.nz
- **ggplot2 Cheatsheet** (Quick reference for all functions)
  Download the cheatsheet here