Visualizing distributions

INTRODUCTION TO DATA VISUALIZATION WITH JULIA

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Onion and wheat prices in Kerala, India

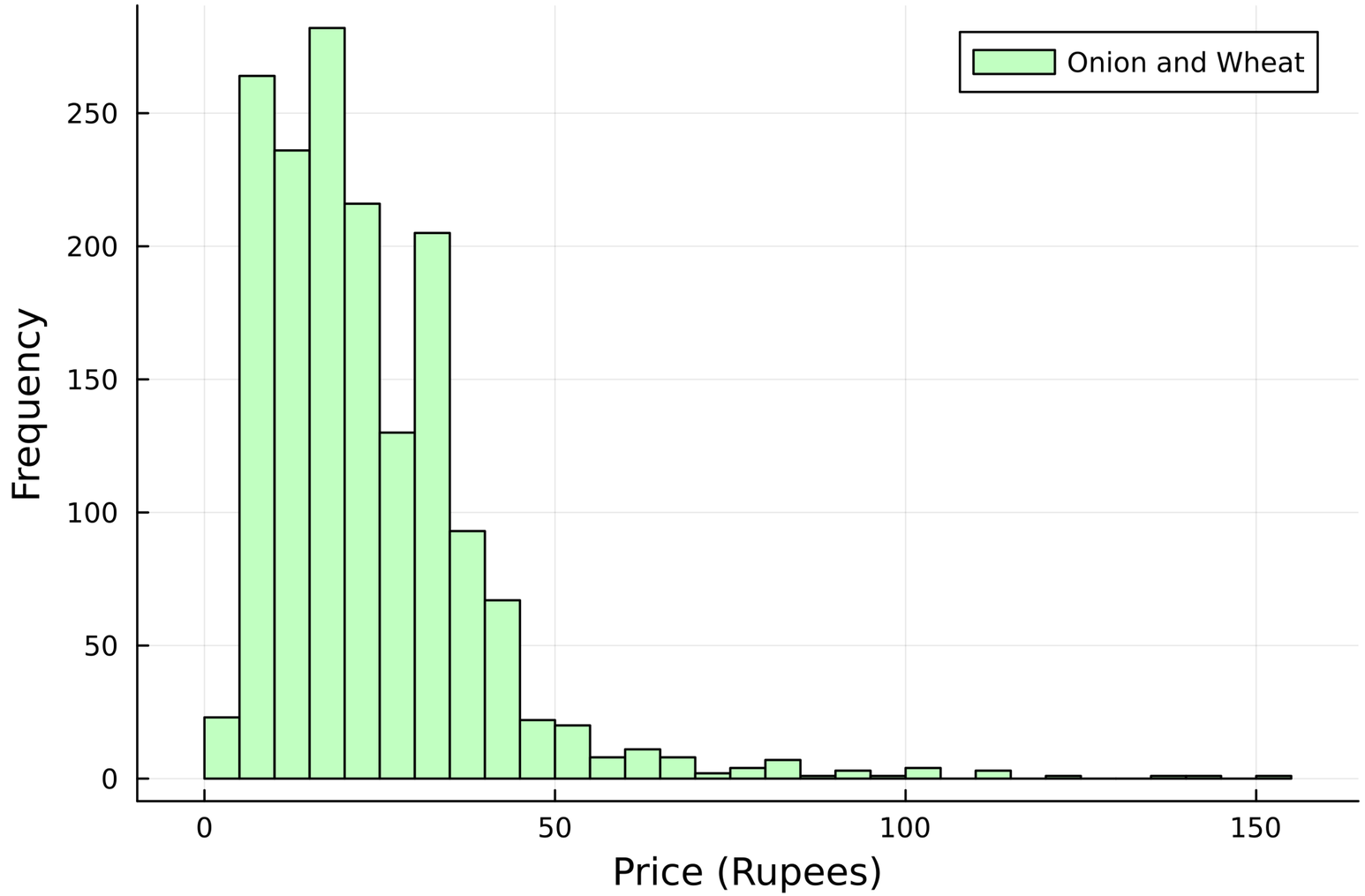
- `kerala` DataFrame:

Date	Centre	Commodity	Price
JAN-2001	Ernakulam	Onion	10.0
JAN-2001	Ernakulam	Wheat	12.5
JAN-2001	Khozhikode	Onion	9.0
JAN-2001	Khozhikode	Wheat	14.0
...	...	...	...
MAR-2021	Trivandrum	Onion	45.0
MAR-2021	Trivandrum	Wheat	34.0

- How much did the prices of onions and wheat differ?

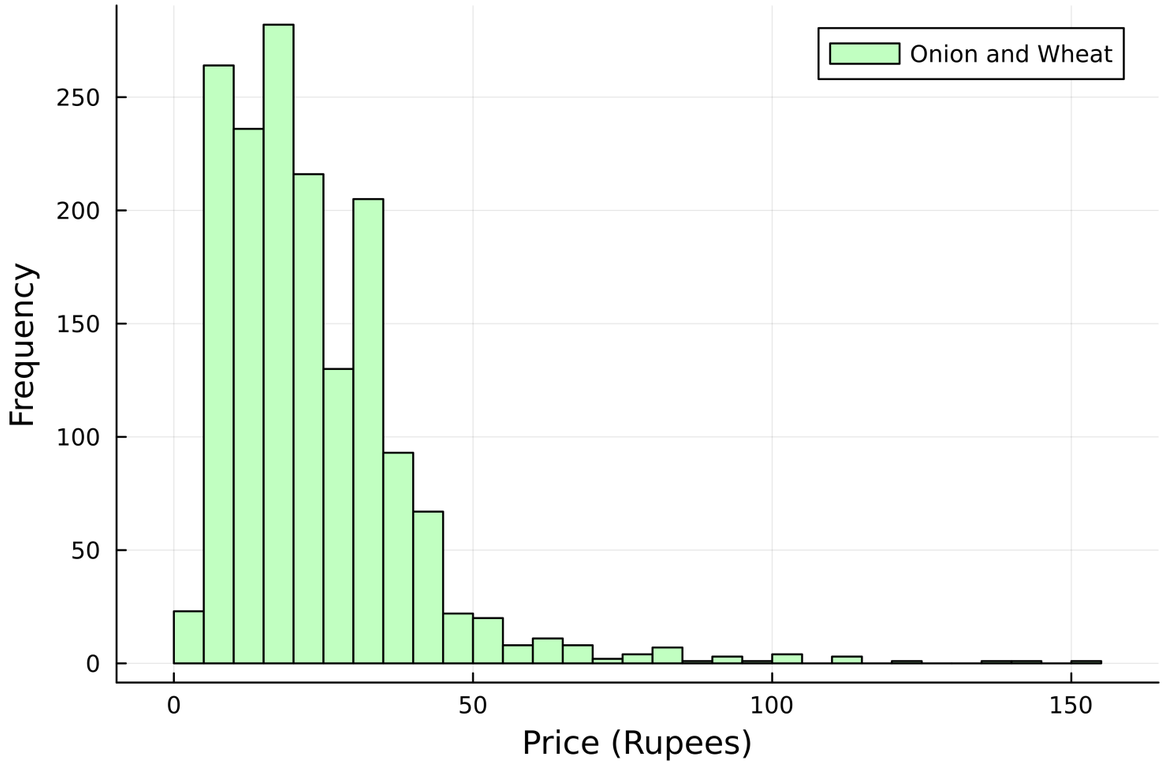
Commodity	Mean Price
Onion	25.7442
Wheat	20.6261

Visualizing distributions with histograms



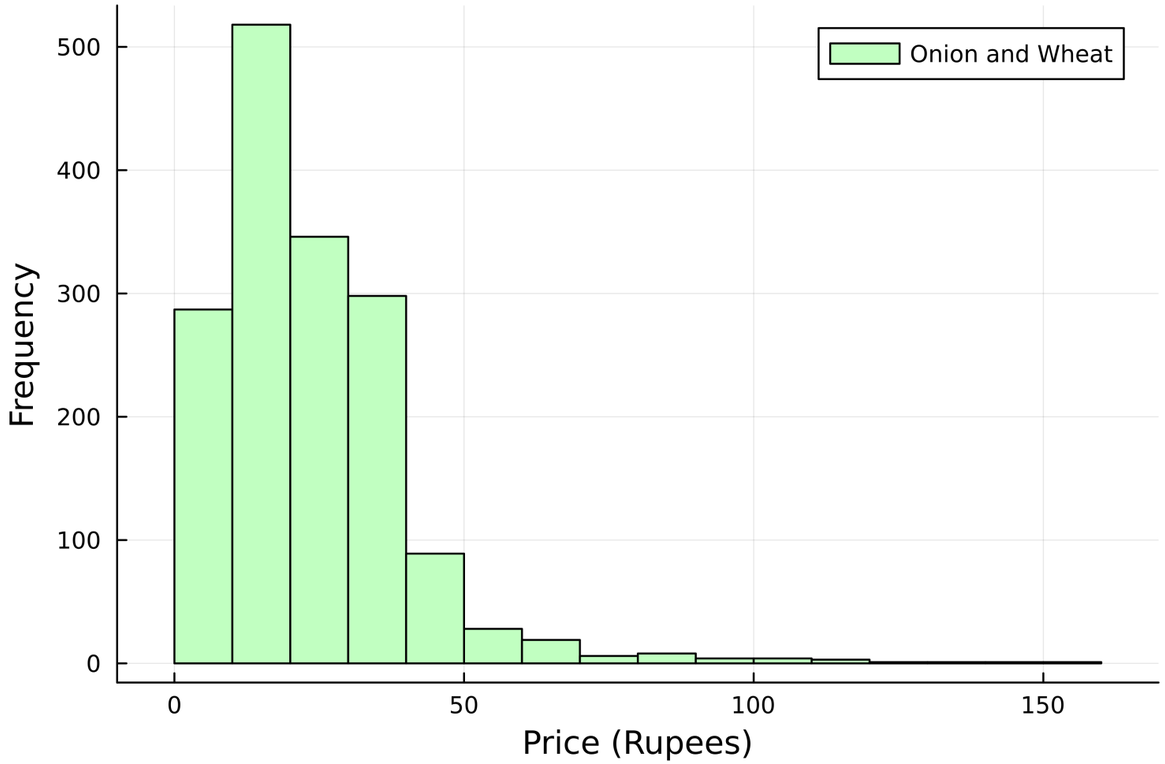
Distribution of onion and wheat prices

```
# Plot a histogram
histogram(
    kerala[:, :Price],
    # Add a label
    label="Onion and Wheat",
    # Choose bar color
    color=:darkseagreen1,
)
# Add axis labels
xlabel!("Price (Rupees)")
ylabel!("Frequency")
```



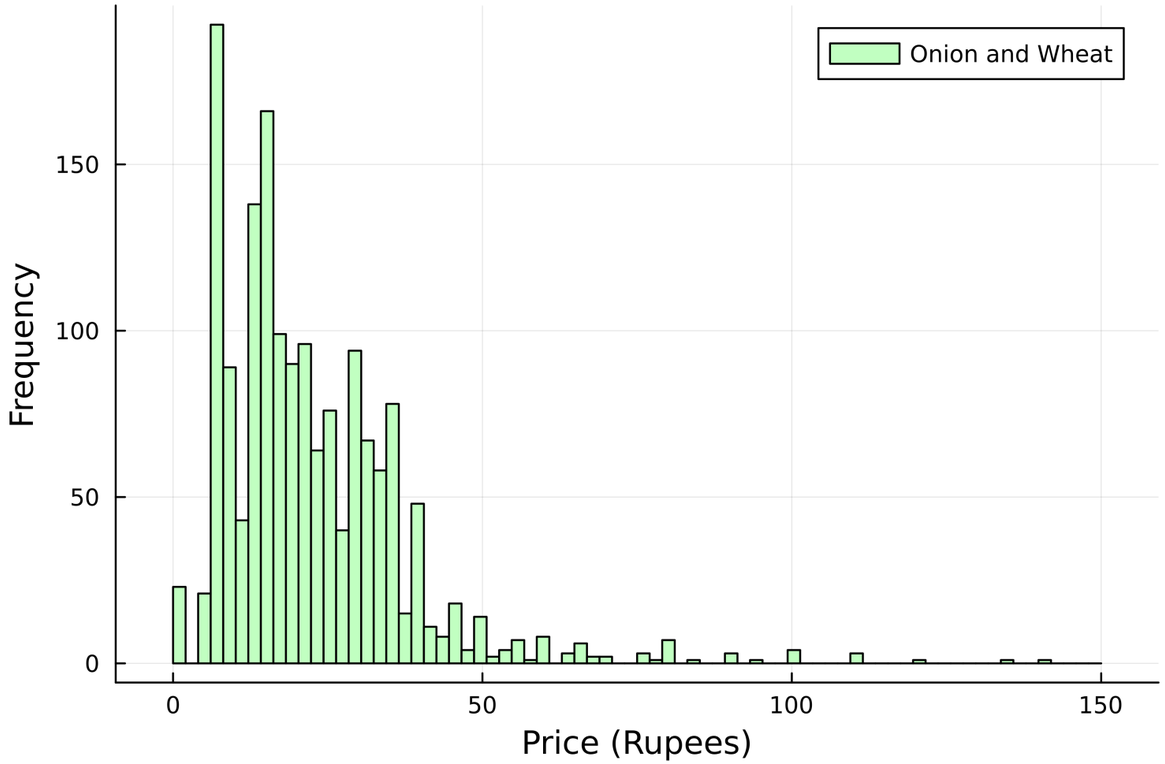
Number of bins

```
# Plot a histogram
histogram(
    kerala[:, :Price],
    # Add a label
    label="Onion and Wheat",
    # Choose bar color
    color=:darkseagreen1,
    # Number of bins
    bins=20,
)
# Add axis labels
xlabel!("Price (Rupees)")
ylabel!("Frequency")
```



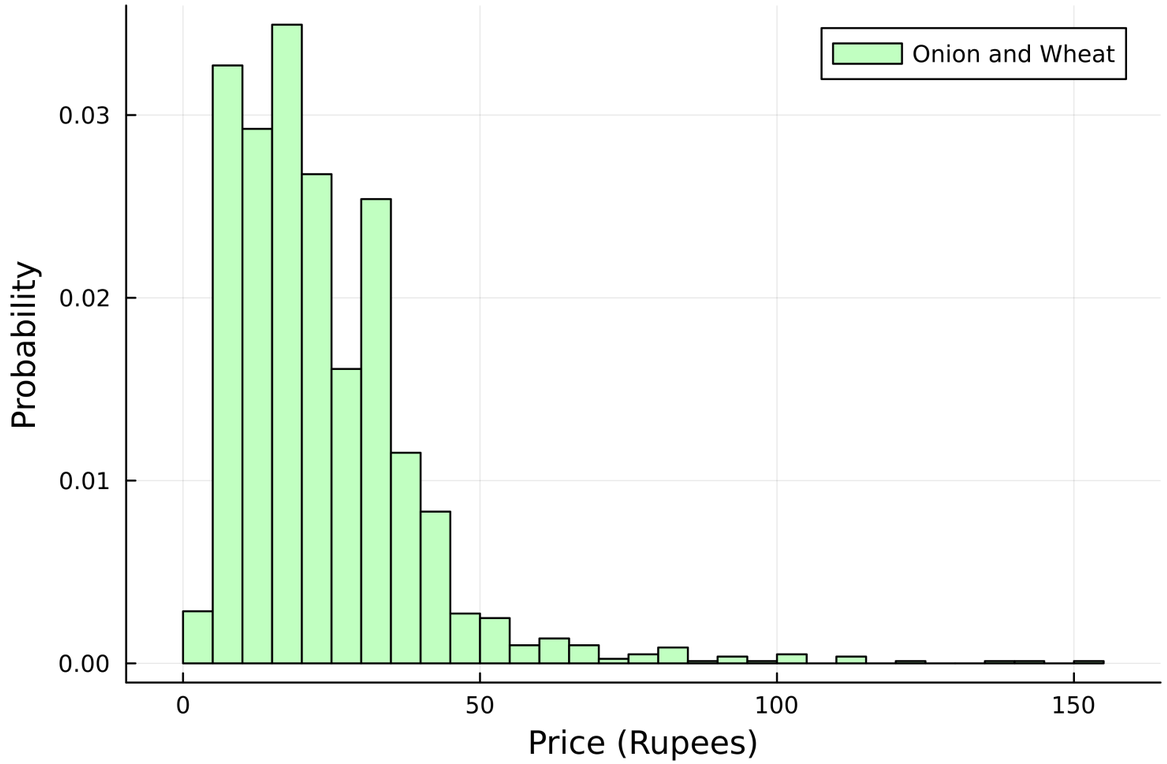
Number of bins

```
# Plot a histogram
histogram(
    kerala[:, :Price],
    # Add a label
    label="Onion and Wheat",
    # Choose bar color
    color=:darkseagreen1,
    # Number of bins
    bins=range(0, 150, 75),
)
# Add axis labels
xlabel!("Price (Rupees)")
ylabel!("Frequency")
```



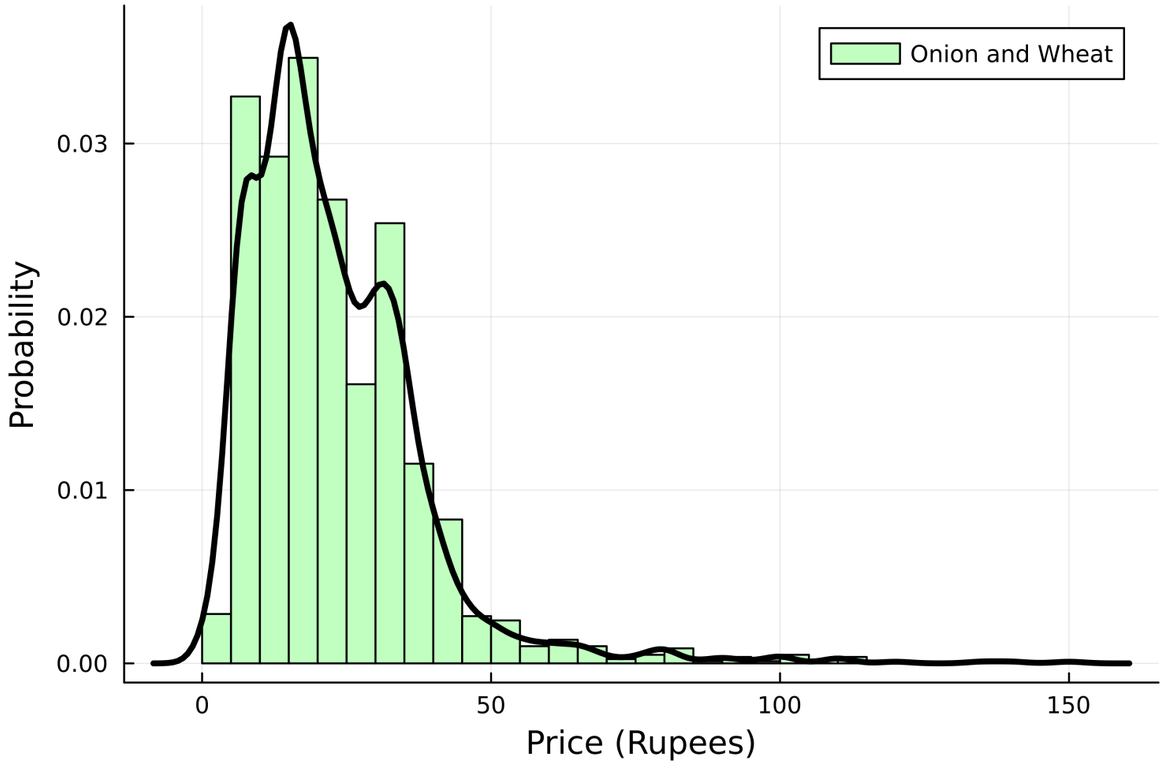
Normalized histogram

```
# Plot a normalized histogram
histogram(
    kerala[:, :Price],
    # Add a label
    label="Onion and Wheat",
    # Choose bar color
    color=:darkseagreen1,
    # Normalize it
    normalize=true,
)
# Add axis labels
xlabel!("Price (Rupees)")
ylabel!("Probability")
```



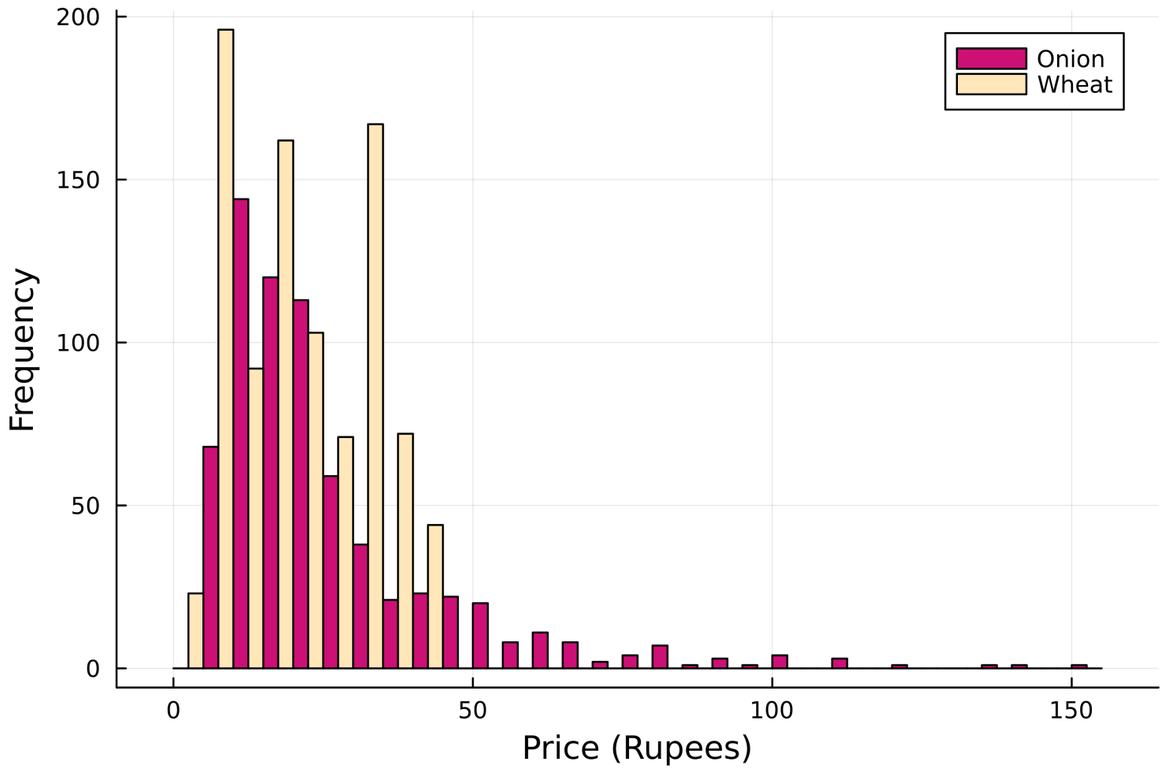
Probability distribution

```
using StatsPlots

density!(
    kerala[:, :Price],
    color=:black,
    linewidth=3,
    label=false
)
```



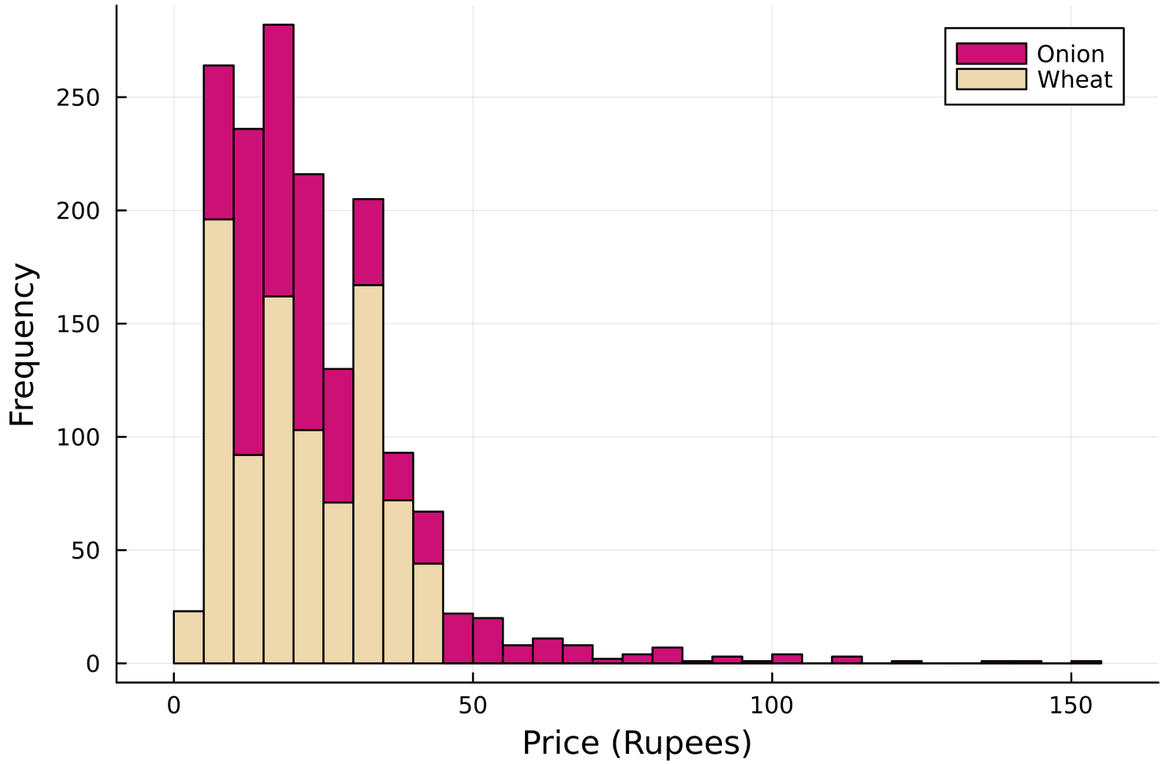
Prices per commodity

```
using StatsPlots

# Grouped histogram
groupedhist(
    kerala[:, :Price],
    # Group by commodity
    group=kerala[:, "Commodity"],
    # Select colors
    color=[:deeppink3 :wheat2]
)
xlabel!("Price (Rupees)")
ylabel!("Frequency")
```

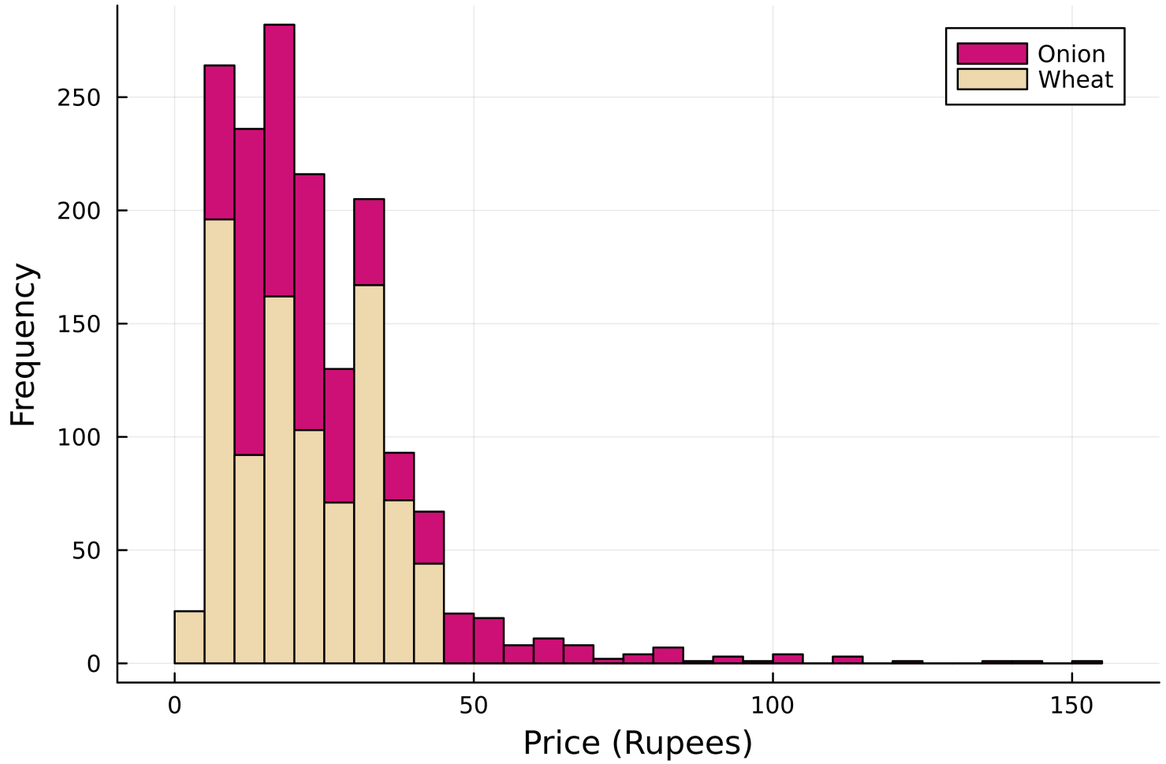


Stacked histogram

```
using StatsPlots

# Stacked histogram
groupedhist(
    kerala[:, :Price],
    # Group by commodity
    group=kerala[:, "Commodity"],
    # Select colors
    color=[:deeppink3 :wheat2]
    # Stack the bars
    bar_position=:stack,
)
xlabel!("Price (Rupees)")
ylabel!("Frequency")
```



A subtle difference



- The peak prices appear to be very similar.

Commodity	Mean Price
Onion	25.7442
Wheat	20.6261

- Onion prices exhibit a long tail.
- Median prices are almost the same.

Commodity	Median Price
Onion	20.0
Wheat	19.5

- Difference in means is cause by the tail!

Let's practice!

INTRODUCTION TO DATA VISUALIZATION WITH JULIA

Dropping Bars

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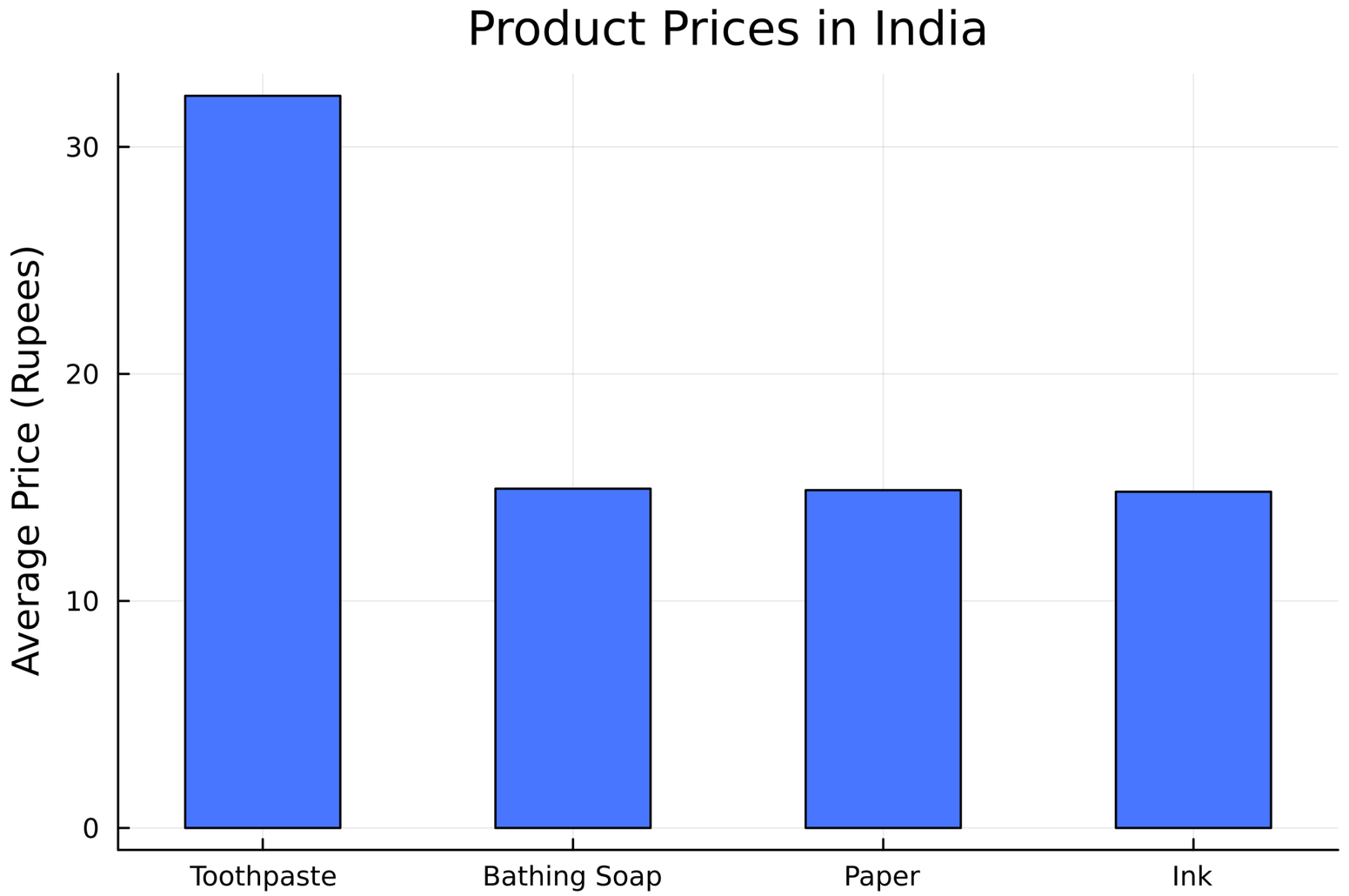
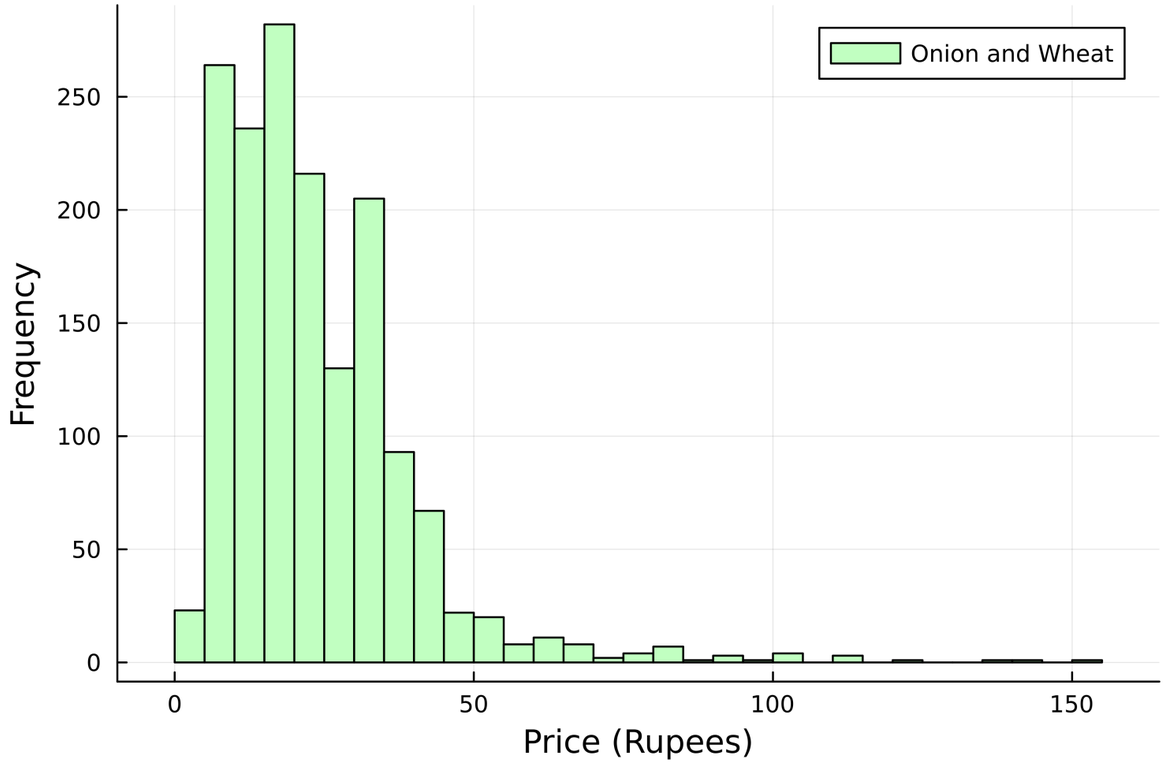
Bar charts

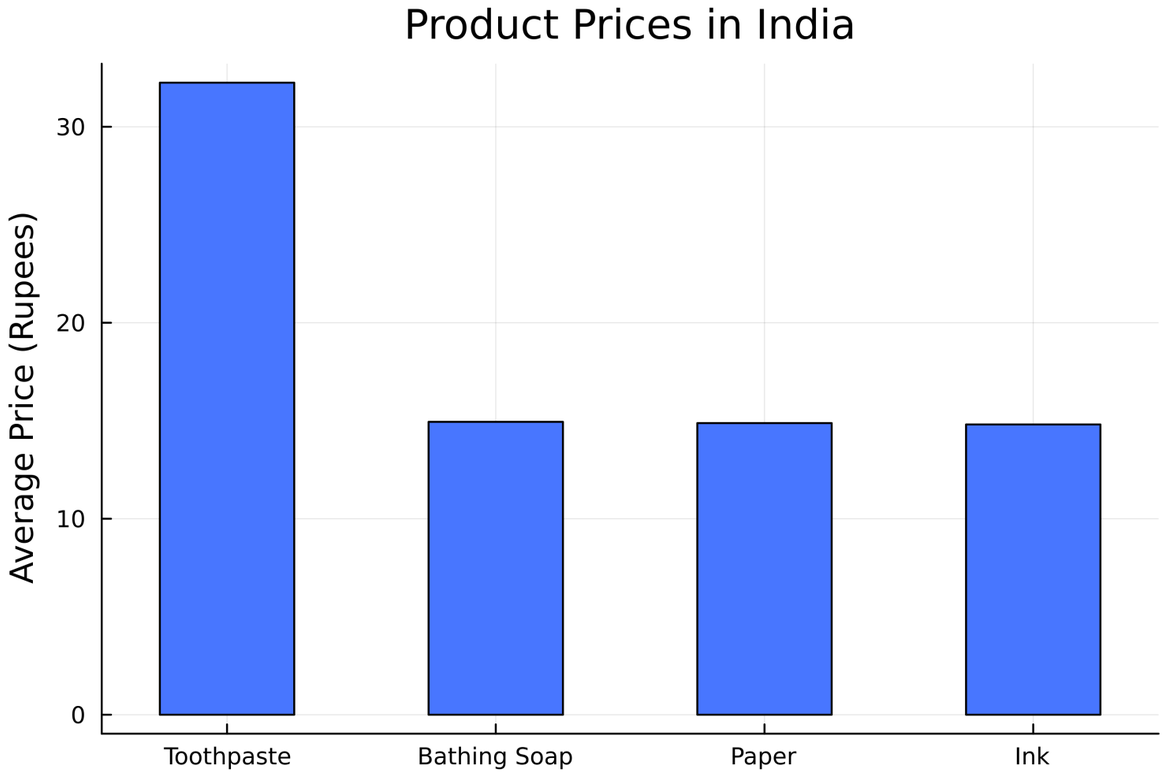

Product Prices in India
Average Price (Rupees)
0
10
20
30
Toothpaste
Bathing Soap
Paper
Ink

Bar charts vs histograms

- Distributions of numerical data



- Comparison of categories



Our dataset

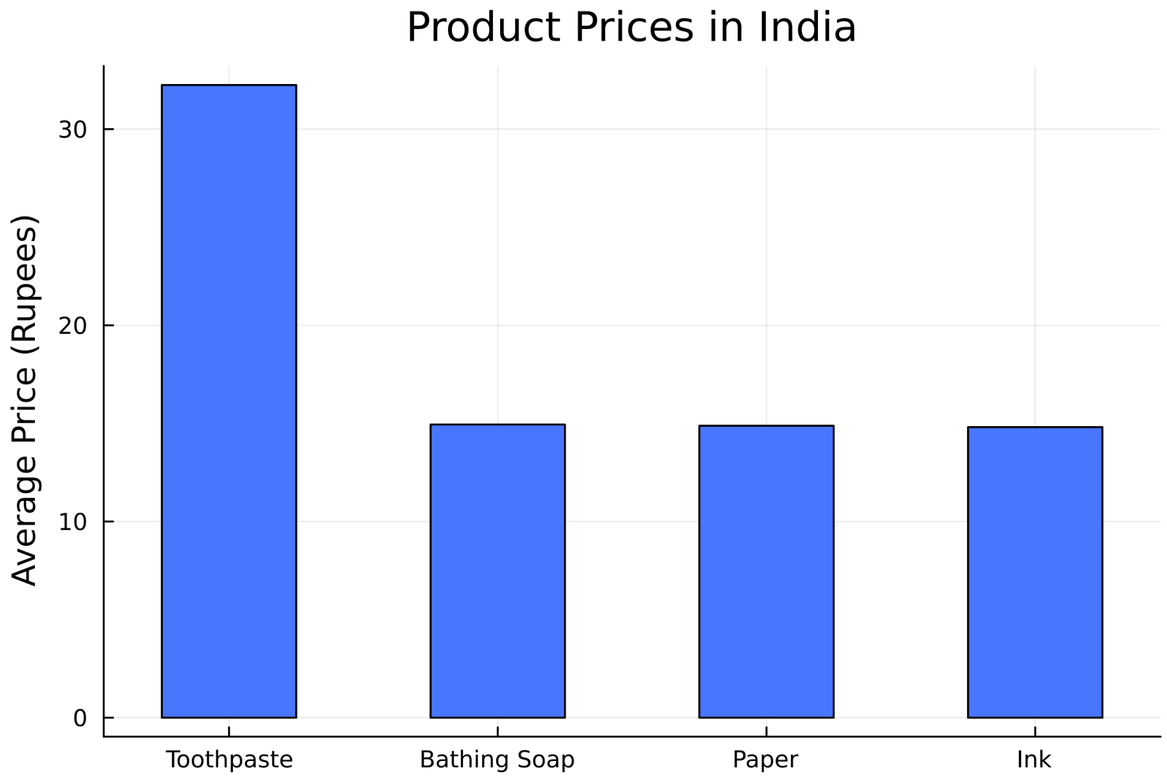
Date	State	Centre	Product	Price
APR-2001	Andhra Pradesh	Chittoor	Bathing Soap	10.0
APR-2001	Andhra Pradesh	Chittoor	Ink	10.0
...	...	...	...	...
SEP-2016	Bihar	Patna	Paper	38.0
SEP-2016	Bihar	Patna	Toothpaste	50.0

- Mean prices (`using Statistics`)

```
# Group by each product
grouped = groupby(product, :Product)
# Calculate average prices
mean_prices = combine(
    grouped,
    :Price => mean
)
# Sort from higest to lowest
sorted_mean_prices = sort(
    mean_prices,
    :Price_mean,
    rev=true
)
```

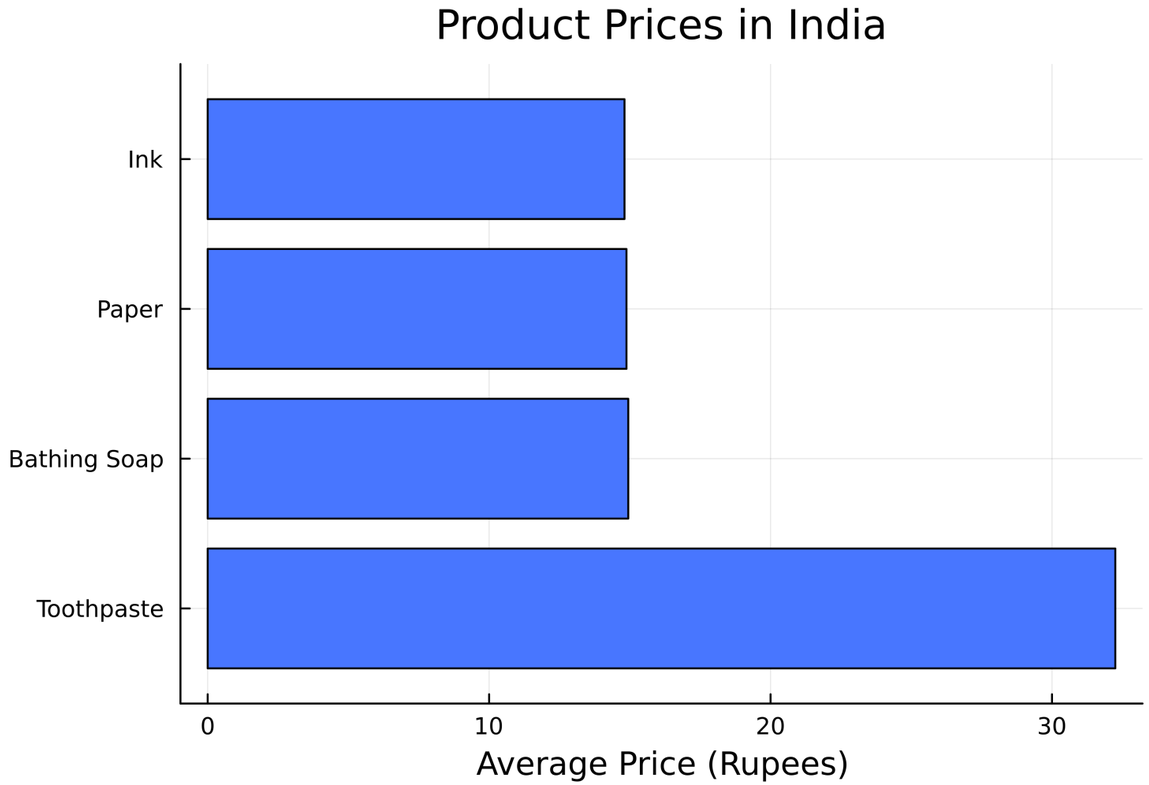
Creating bar charts

```
# Create bar chart
bar(
    # Categories in x-axis
    sorted_mean_prices.Product,
    # Values in y-axis
    sorted_mean_prices.Price_mean,
    # Set bar width
    bar_width=0.5
    label=false,
    color=:royalblue1,
 )
title!("Product Prices in India")
ylabel!("Average Price (Rupees)")
```



Horizontal bar charts

```
# Create bar chart
bar(
    # Values in the y-axis
    sorted_mean_prices.Product,
    # Values in x-axis
    sorted_mean_prices.Price_mean,
    # Set orientation to horizontal
    permute=(:x, :y),
    label=false,
    color=:royalblue1,
)
title!("Product Prices in India")
xlabel!("Average Price (Rupees)")
```



Products by state

- Filter for selected states

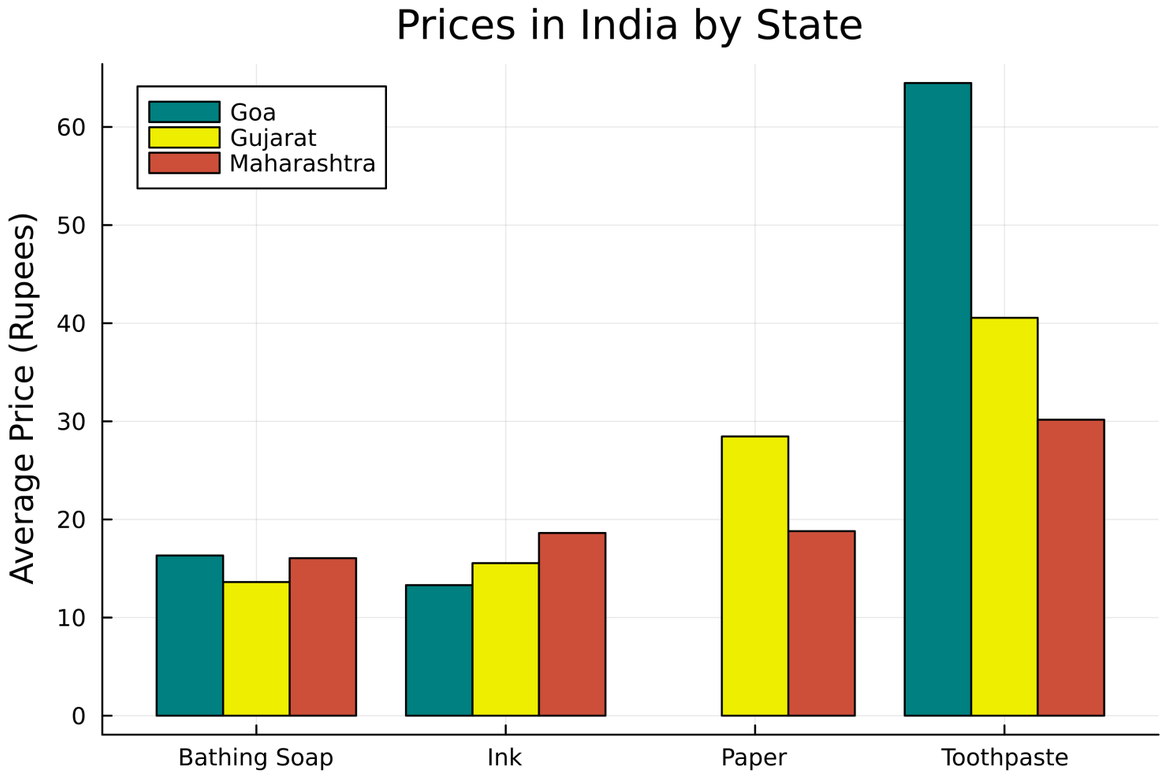
```
filtered_product = filter(
    row -> row.State in ["Maharashtra", "Goa", "Gujarat"],
    product)
```

- Average prices of each product by state

```
# Group by state and product
filtered_grouped = groupby(filtered_product, [:State, :Product])
# Calculate average prices
filtered_mean_prices = combine(
    filtered_grouped, :Price => mean
)
```

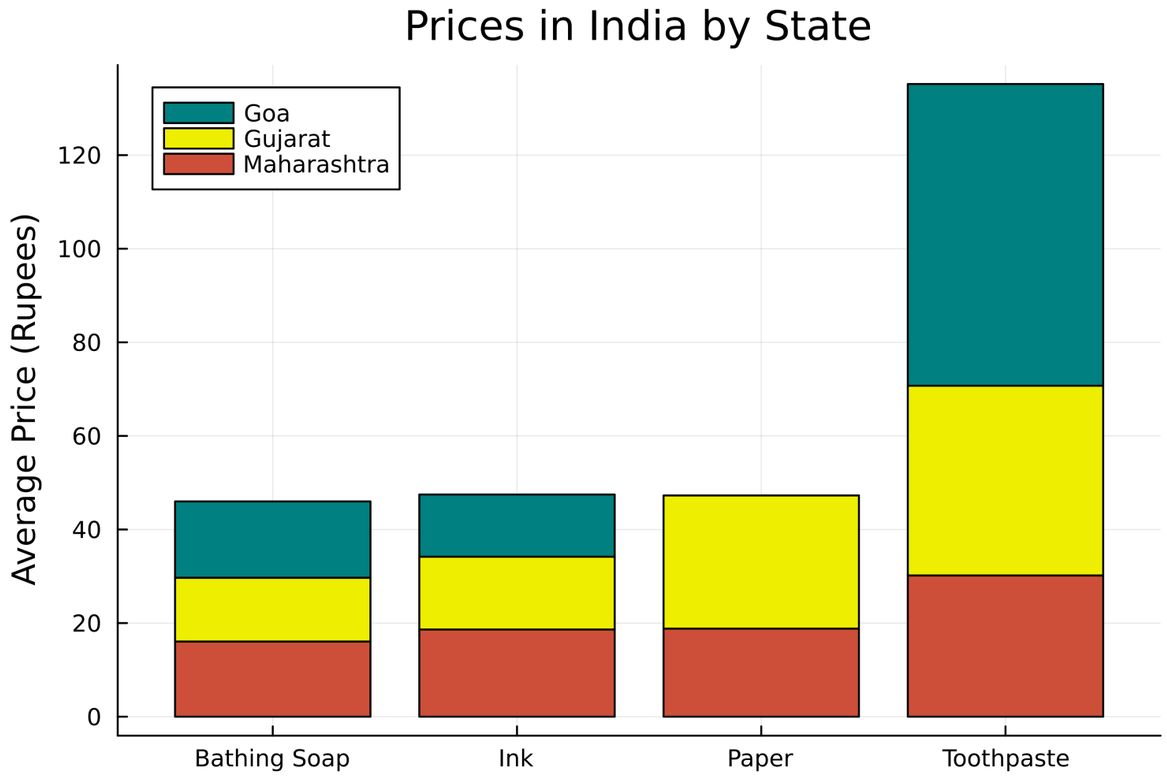
Grouped bar charts

```
# Create grouped bar chart
groupedbar(
    # Categories in x-axis
    filtered_mean_prices.Commodity,
    # Values in y-axis
    filtered_mean_prices.Price_mean,
    # Define groups
    group=filtered_mean_prices.State,
    color=[:teal :yellow2 :tomato3]
)
title!("Prices in India by State")
ylabel!("Average Price (Rupees)")
```



Stack the bars

```
# Create grouped bar chart
groupedbar(
    # Categories in x-axis
    filtered_mean_prices.Commodity,
    # Values in y-axis
    filtered_mean_prices.Price_mean,
    # Define groups
    group=filtered_mean_prices.State,
    color=[:teal :snow2 :tomato3],
    # Stack the bars
    bar_position=:stack
)
title!("Product Prices in India by State")
ylabel!("Average Price (Rupees)")
```



Let's practice!

INTRODUCTION TO DATA VISUALIZATION WITH JULIA

Visualizing time series

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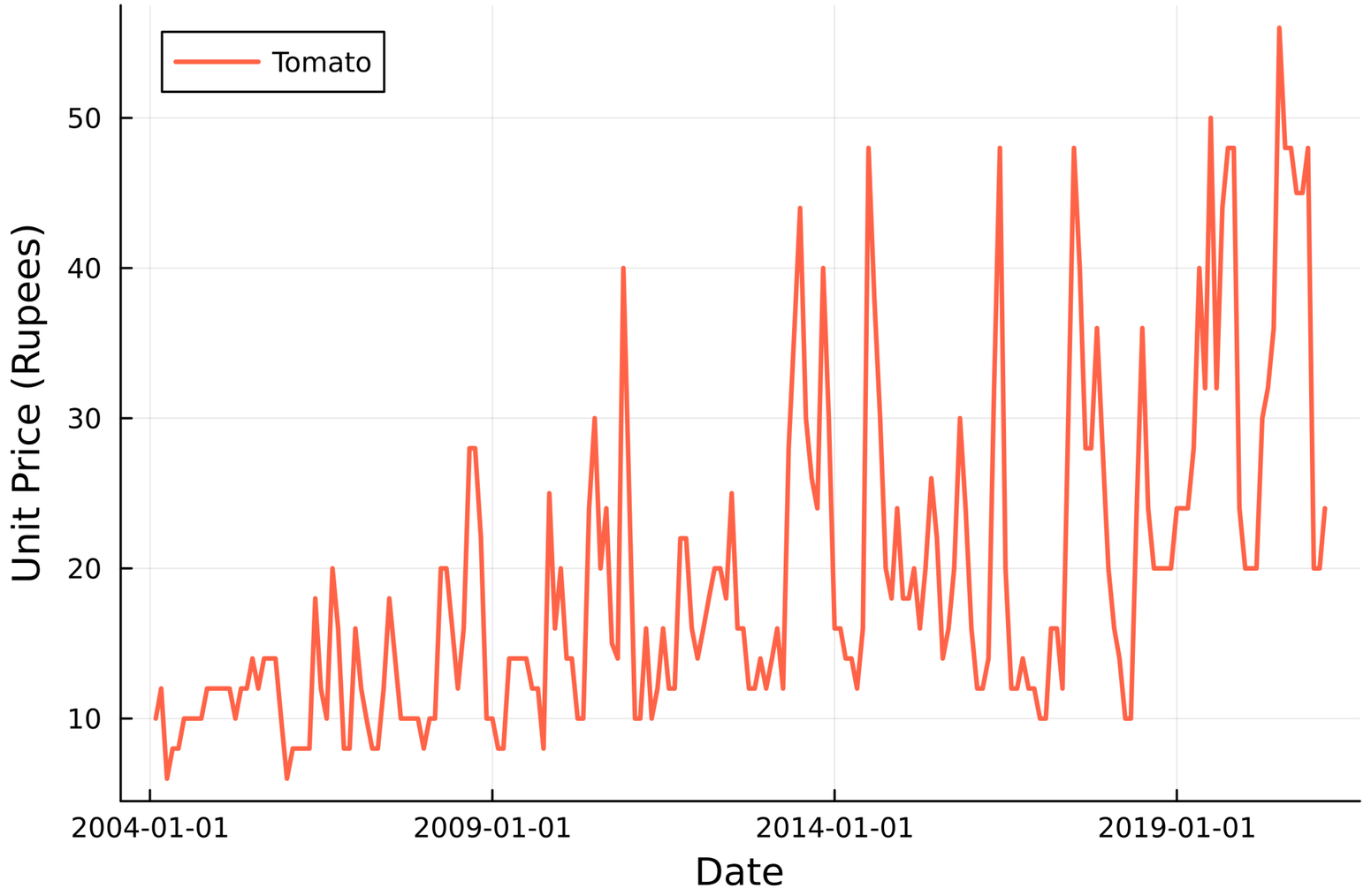
Time series


Tomato
Unit Price (Rupees)
10
20
30
40
50
2004-01-01
2009-01-01
2014-01-01
2019-01-01
Date

Tomato prices

- `tomato` DataFrame

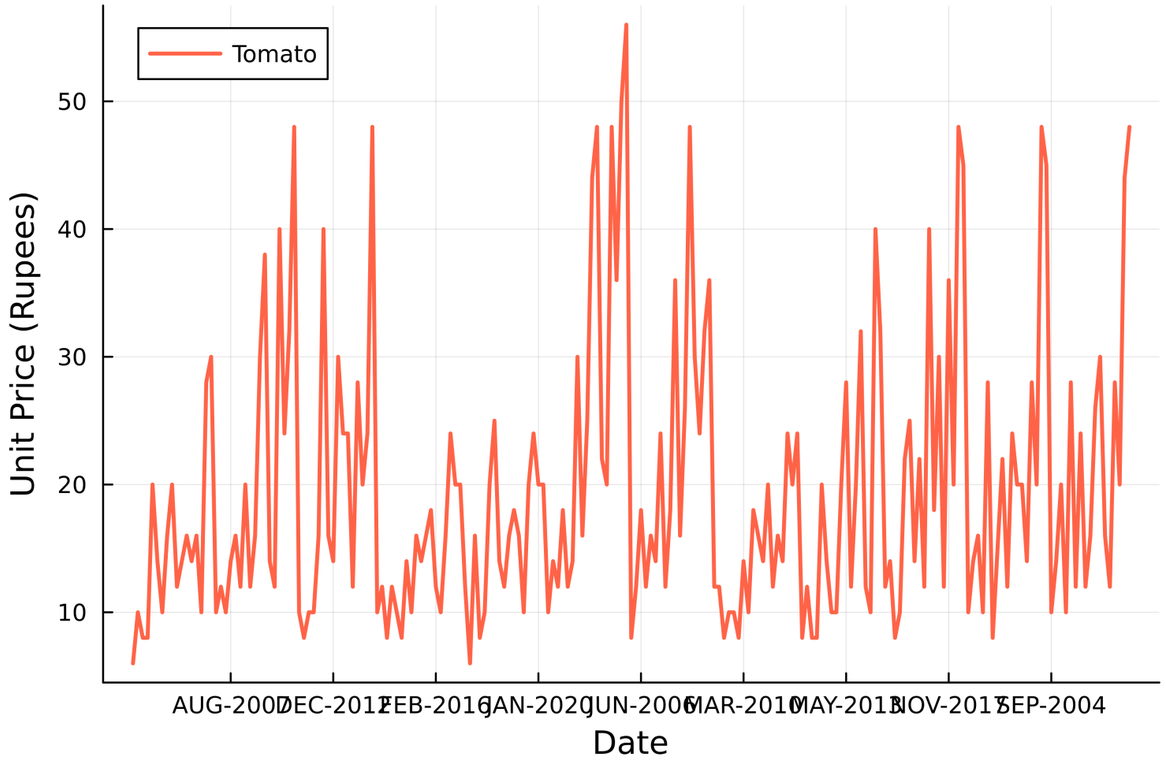
Date	Price (Rupees)
FEB-2004	10.0
MAR-2004	12.0
APR-2004	6.0
MAY-2004	8.0
...	...

- Sort dates

```
tomato.Date = sort(
  tomato.Date, :Date
)
```

```
# Plot time series
plot(
    tomato.Date,
    tomato.Price,
    # Customize the plot
    linewidth=2,
    linecolor=:tomato,
    label="Tomato"
)
xlabel!("Date")
ylabel!("Unit Price (Rupees)")
```

Tomato prices



- `tomato` DataFrame

Date	Price (Rupees)
APR-2004	6.0
APR-2005	10.0
APR-2006	8.0
APR-2007	8.0
...	...

- Date column has strings!

Dates with Julia

```
using Dates

birthday = Date("1989-12-04")
```

- Other formats

```
birthday = Date(
    "1989/DEC/04", dateformat"y/u/d"
)
birthday = Date(
    "Dec 4, 1989", dateformat"u d, y"
)
```

Code	Match	Examples
Y/y	Year (YYYY)	1989, 2023
m	Month (MM)	1, 10
u	Abbreviated Month	Jan, DEC
U	Month Name	January, DECEMBER
d	Day (DD)	4, 28
H	Hour (HH)	12, 22
M	Minute (MM)	05, 25
S	Second (SS)	10, 59

[1] https://docs.julialang.org/en/v1/stdlib/Dates/#Period-Types

Tomato prices with Dates

- Convert strings to Dates

```
tomato.Date = Date.(
    tomato.Date, dateformat"u-y"
)
```

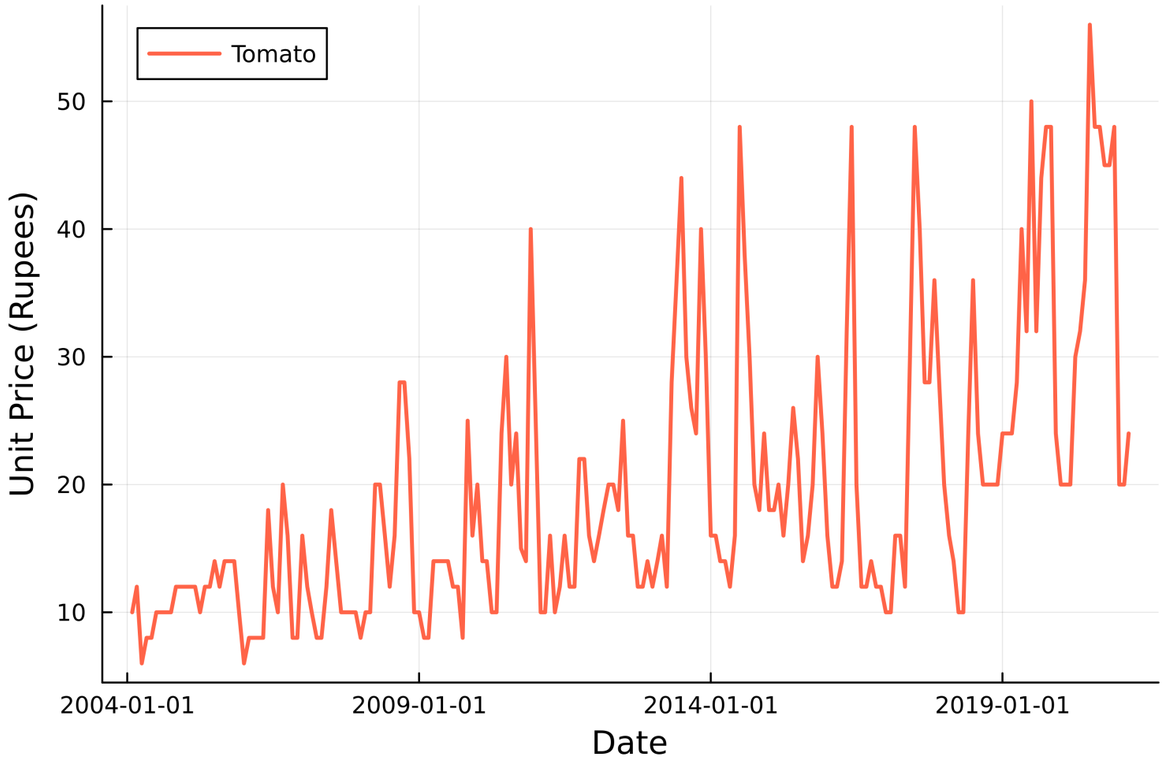
- Sort by date

```
tomato.Date = sort(
    tomato.Date, :Date
)
```

Date	Price (Rupees)
2004-02-01	10.0
2004-03-01	12.0
2004-04-01	6.0
2004-05-01	8.0
...	...

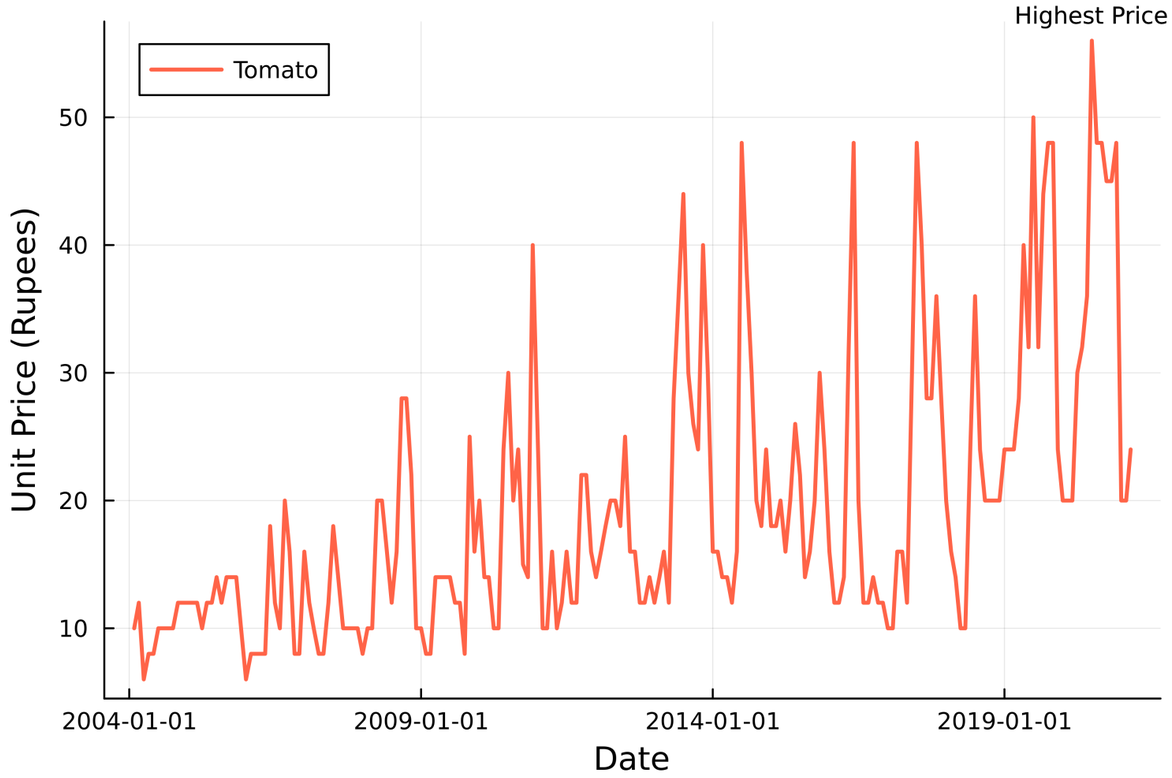
Tomato price time series

```
# Plot time series
plot(
    tomato.Date,
    tomato.Price,
    # Customize the plot
    linewidth=2,
    linecolor=:tomato,
    label="Tomato"
)
xlabel!("Date")
ylabel!("Unit Price (Rupees)")
```



Annotating a plot

```
# Row with highest price
maximum_price = tomato[
    argmax(tomato.Price), :]
# Annotate the plot
annotate!(
    # Coordinates
    maximum_price.Date,
    maximum_price.Price + 2,
    # Annotation text
    "Highest Price",
    annotationfontsize=8
)
```



Let's practice!

INTRODUCTION TO DATA VISUALIZATION WITH JULIA

Boxes and violins

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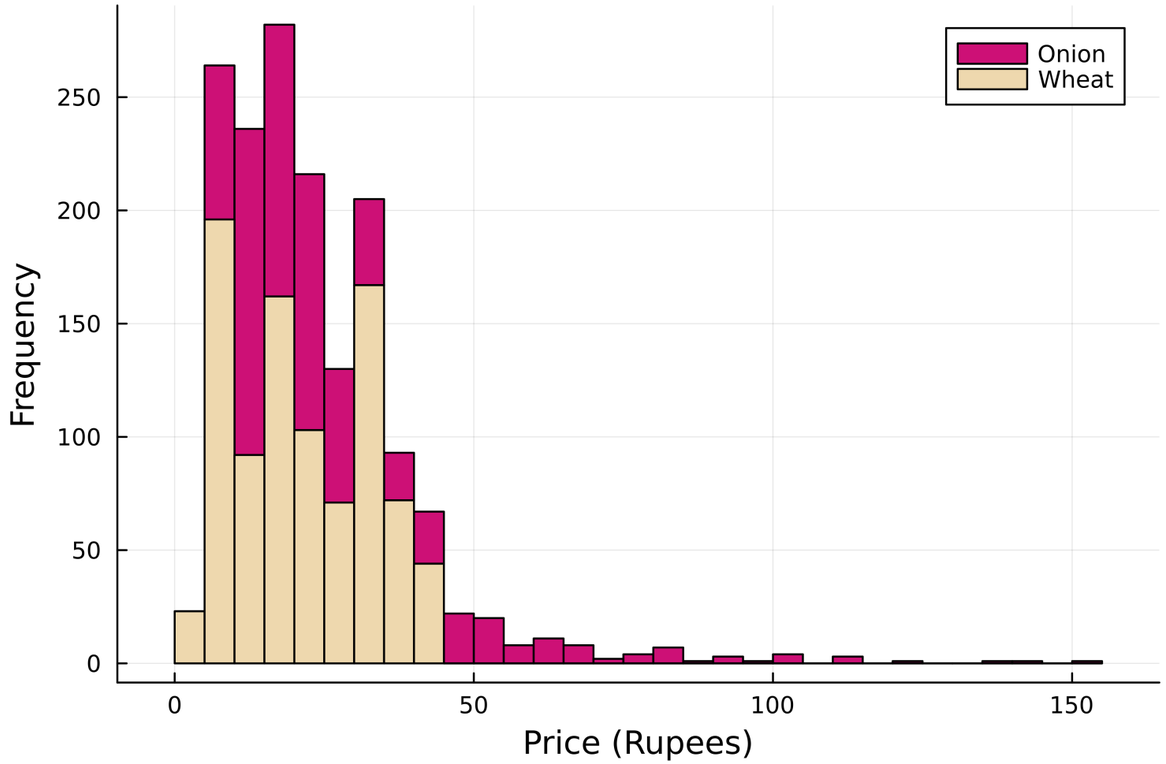
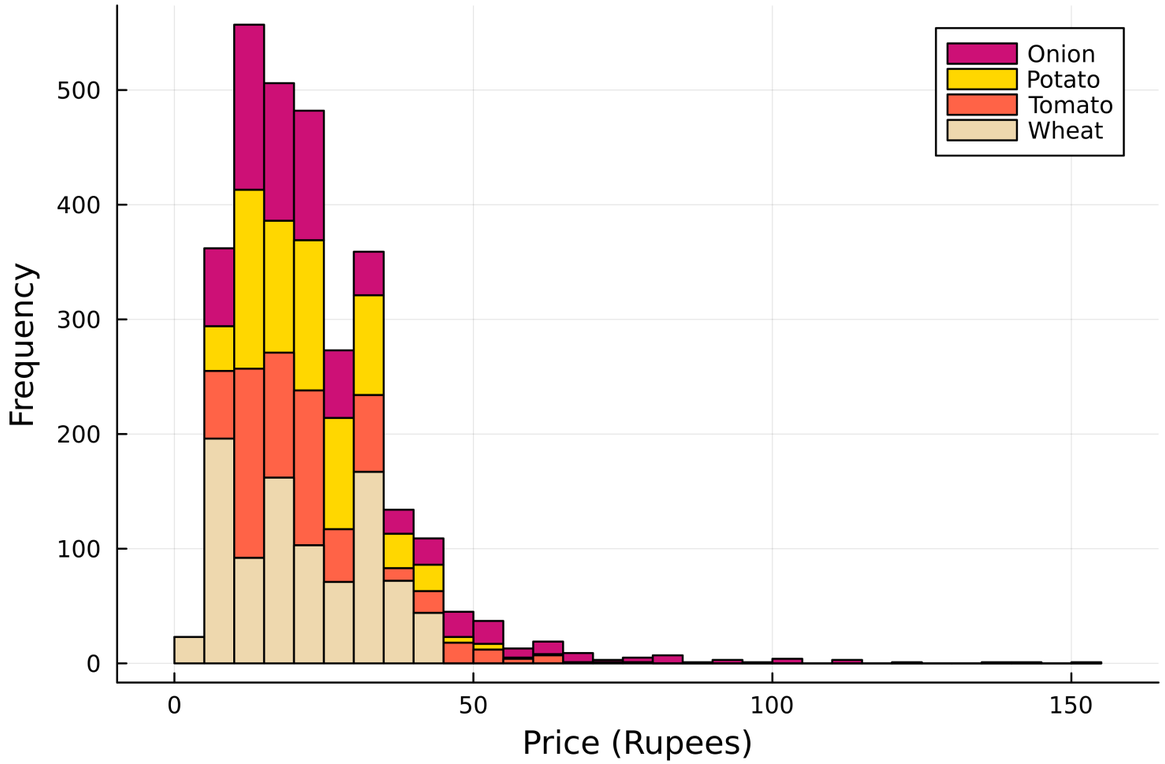
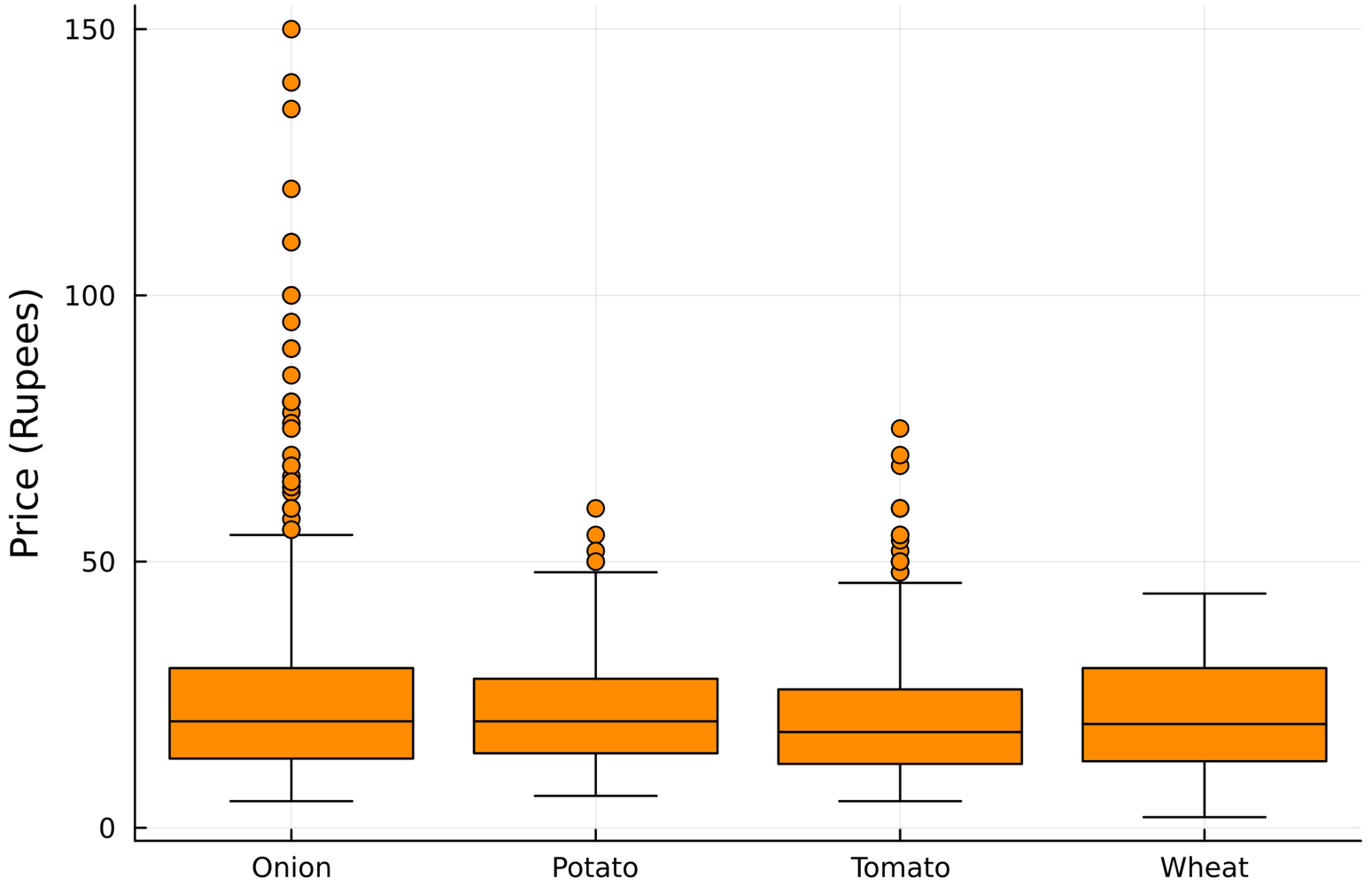
Histograms with many categories





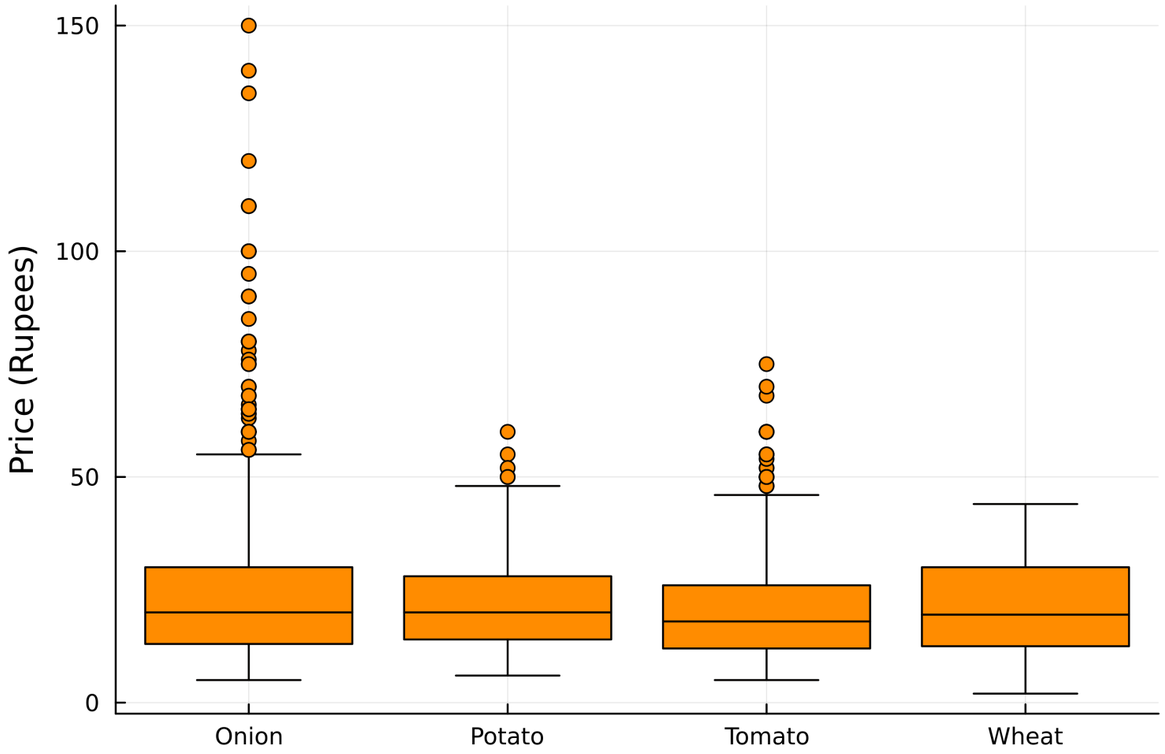
- Hard to compare many categories

Box plots



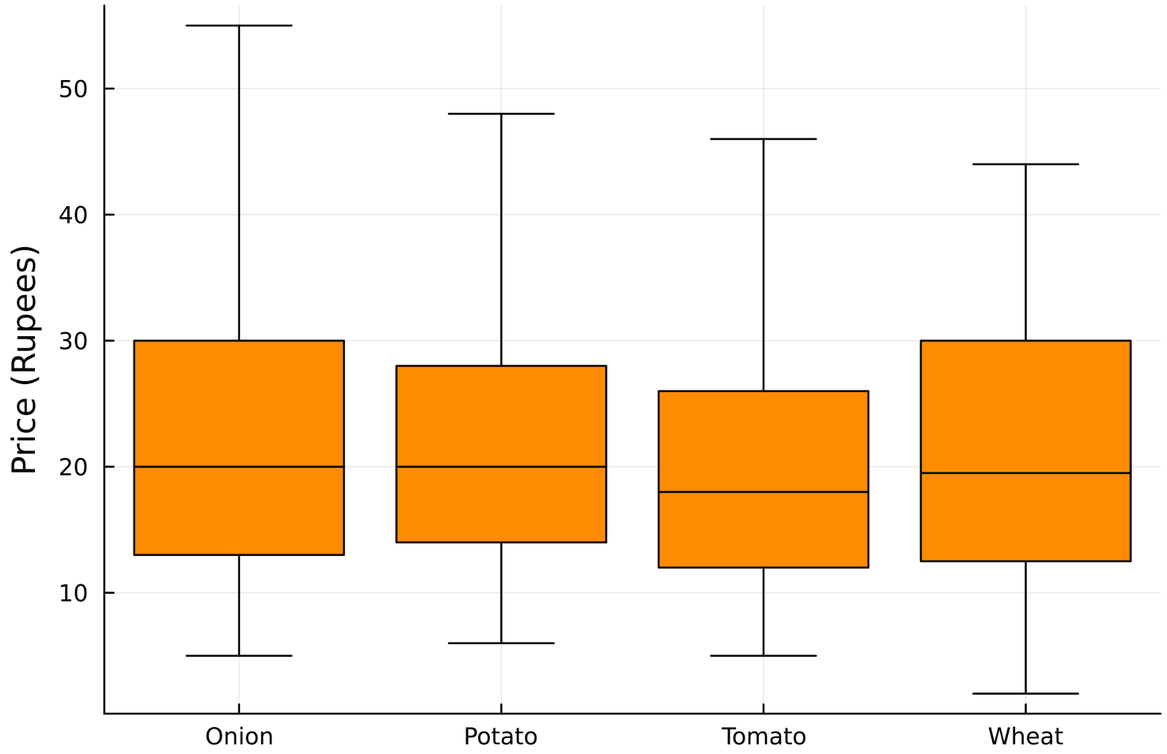
Boxes of product

```
using StatsPlots


boxplot(
    # Categories in x-axis
    kerala[:, :Commodity],
    # Values in y-axis
    kerala[:, :Price],
    color=:darkorange,
    label=false,
)
ylabel!("Price (Rupees)")
```

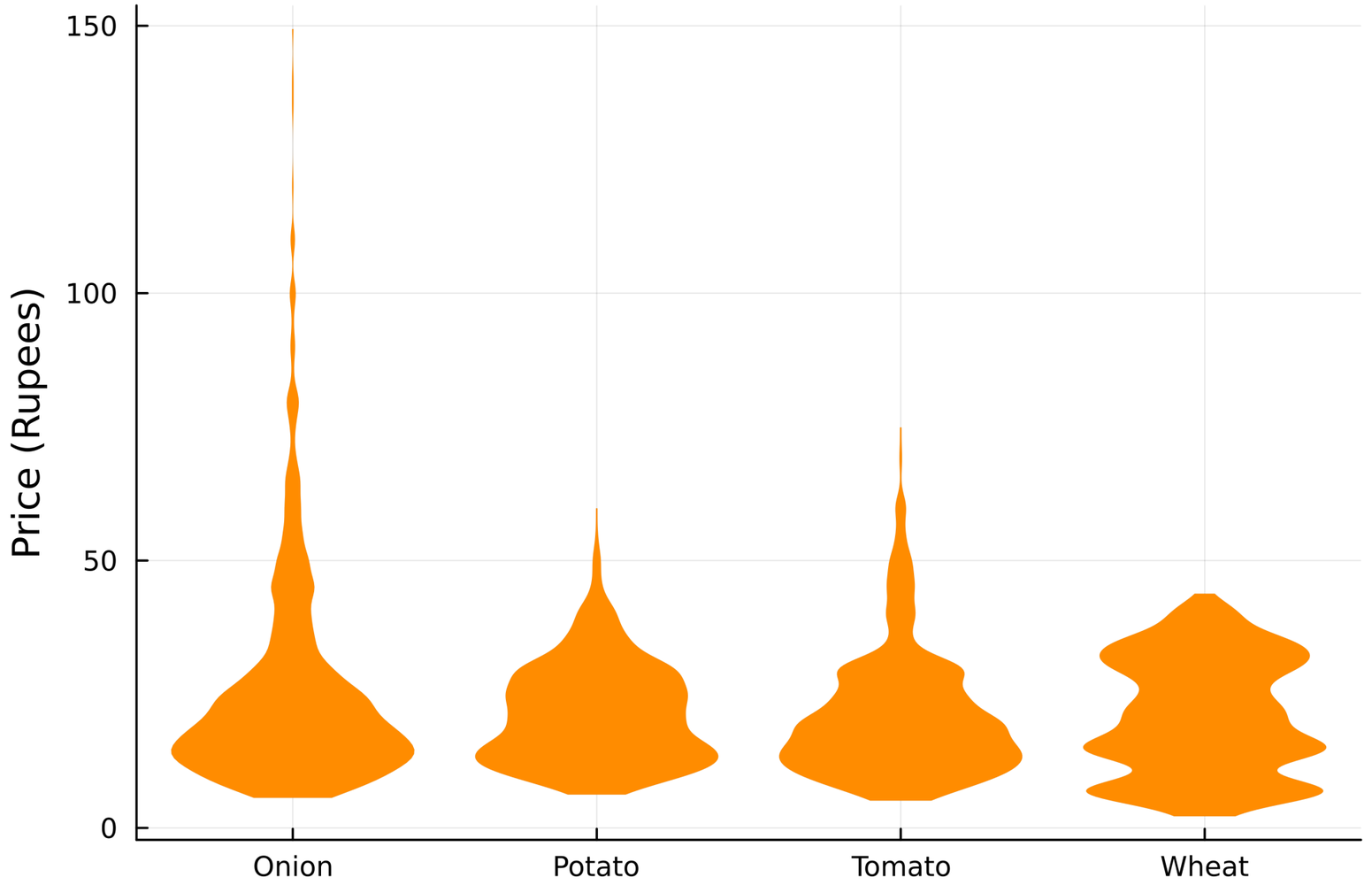


Hiding outliers

```
using StatsPlots

boxplot(
    # Categories in x-axis
    kerala[:, "Commodity"],
    # Values in y-axis
    kerala[:, :Price],
    color=:darkorange,
    label=false,
    # Hide outliers
    outliers=false,
)
ylabel!("Price (Rupees)")
```

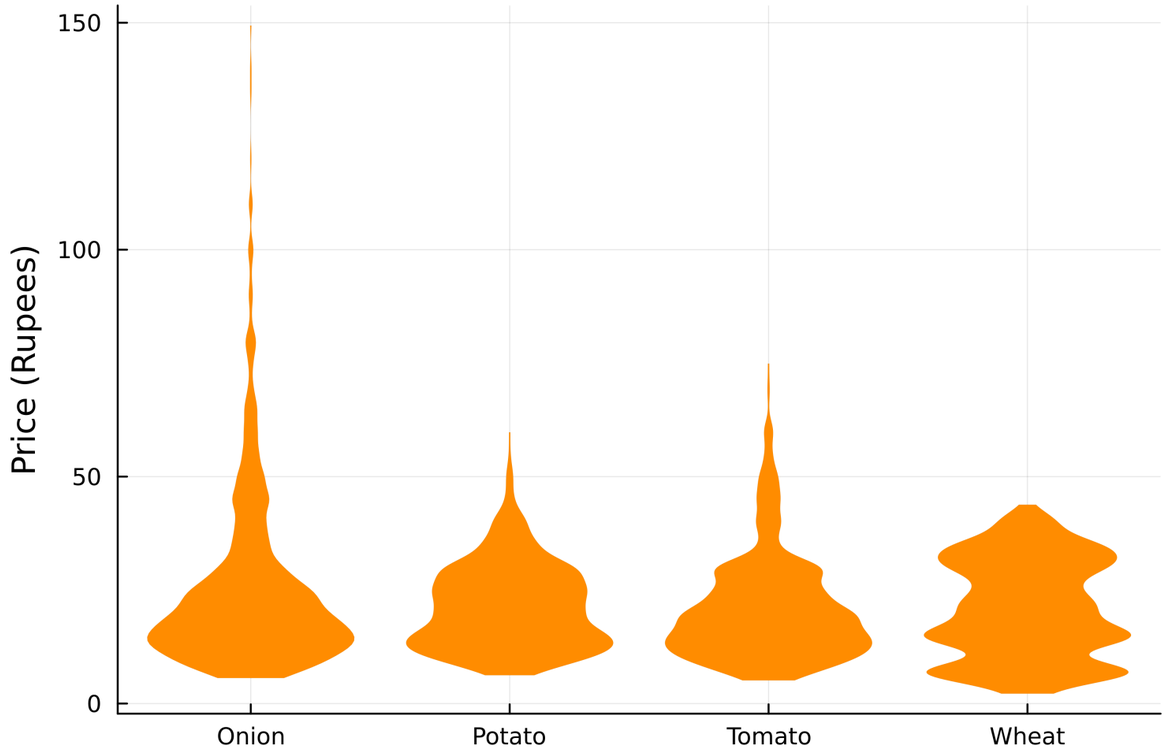


Violin plots



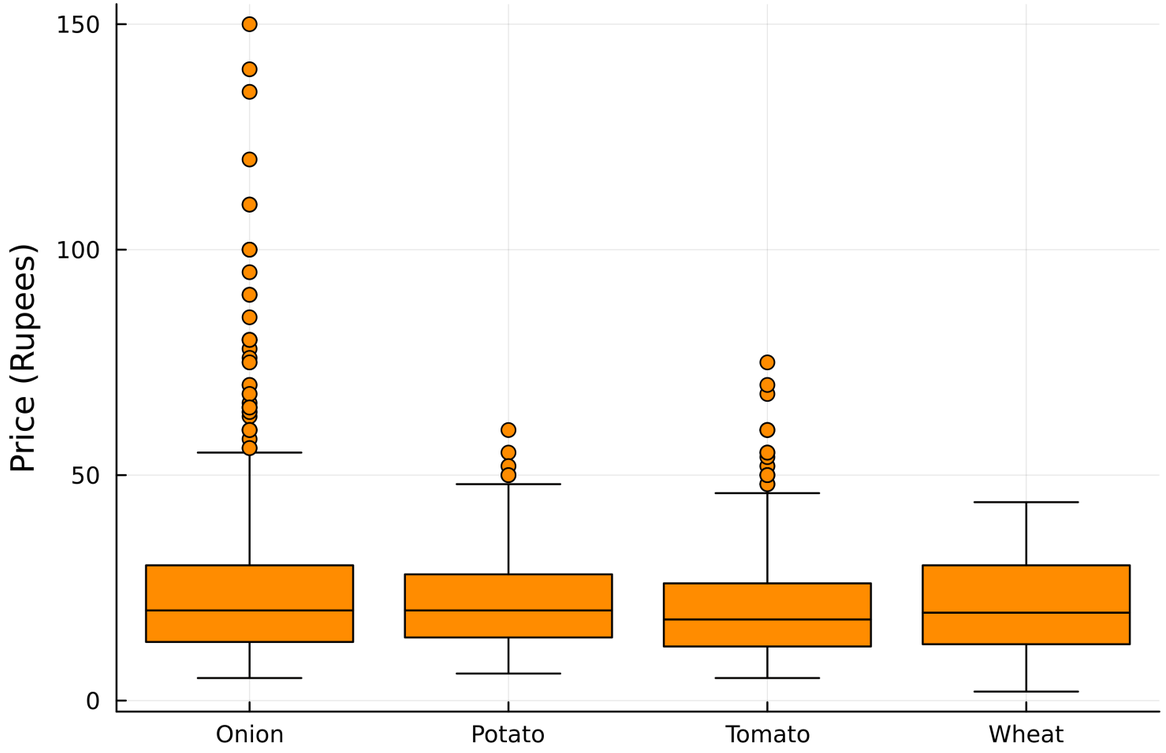
Distributions with violin plot

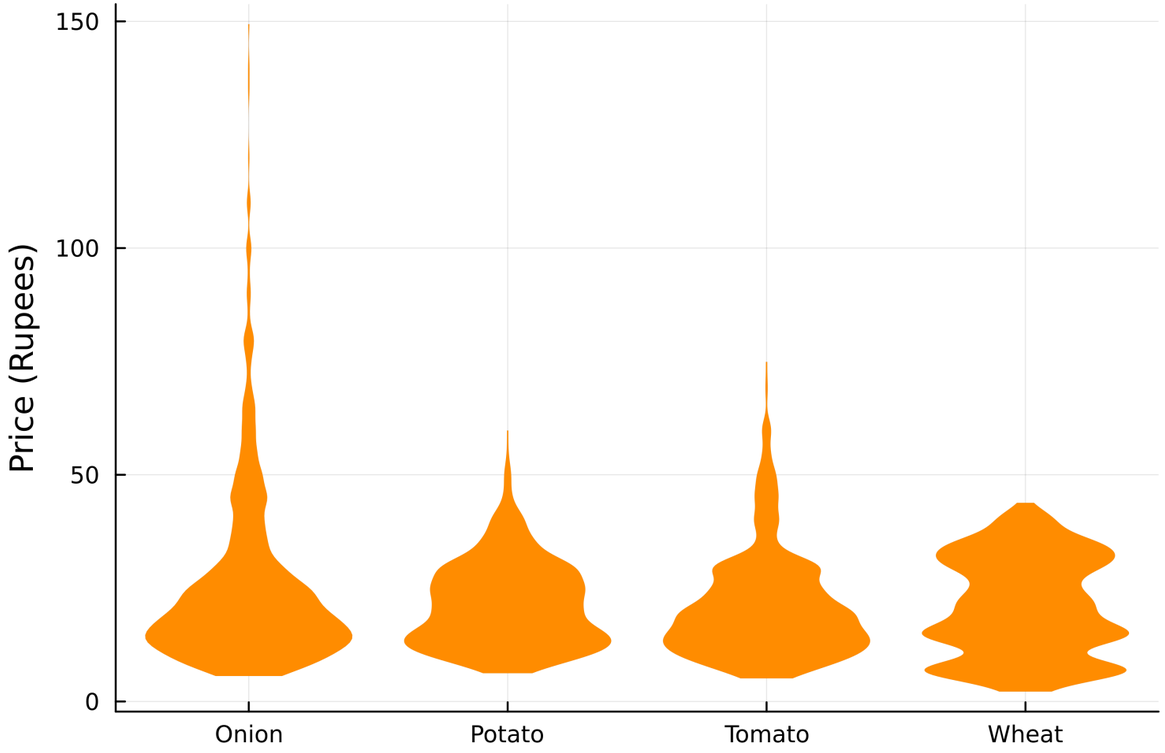
```
# Create violin plot
violin(
    # Categories in x-axis
    kerala[:, :Commodity],
    # Values in y-axis
    kerala[:, :Price],
    # Remove lines
    linewidth=0,
    color=:darkorange,
    label=false,
)
ylabel!("Price (Rupees)")
```



Boxes or violins?

- Box plots
  - Central tendency, spread & skewness
  - Emphasize outliers
- Violin plots
  - Details of distribution
  - Shape is relevant (e.g., multimodal)





Let's practice!

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