Homework 1

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Exercise 1

Portfolio deviation from benchmark return is given as follows.

year	deviation
1992	-7.1%
1993	1.6%
1994	2.5%
1995	-2.6%
1996	9.4%
1997	-0.6%
1998	-0.9%
1999	-9.2%
2000	-5.1%
2001	-0.5%
2002	6.8%
2003	3.0%

1) Binning the returns

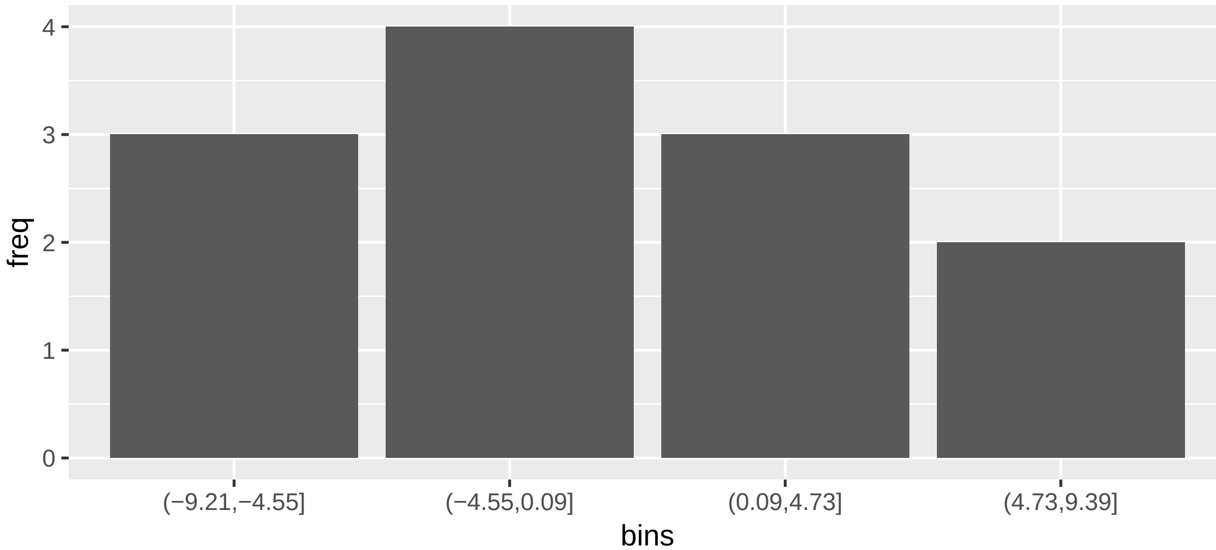
Dividing into 4 intervals.

```
binned <- portfolio_return %>%
    mutate(bins = cut(deviation * 100, breaks = 4)) %>%
    group_by(bins) %>%
    summarise(freq = n()) %>%
    mutate(cum_freq = cumsum(freq),
           rel_freq = freq / sum(freq),
           cum_rel_freq = cumsum(rel_freq))
```

bins	freq	cum_freq	rel_freq	cum_rel_freq
(-9.21,-4.55]	3	3	25.0%	25.0%
(-4.55,0.09]	4	7	33.3%	58.3%
(0.09,4.73]	3	10	25.0%	83.3%
(4.73,9.39]	2	12	16.7%	100.0%

2) Constructing a histogram

```
ggplot(binned, aes(x = bins, y = freq)) +
    geom_bar(stat = "identity")
```



3) Modal interval of the data

Modal interval is the interval with the highest frequency.

```
binned %>%
    filter(freq == max(freq)) %>%
    select(bins, freq) %>%
    kable()
```

bins	freq
(-4.55,0.09]	4

4) Tracking error

```
sd(portfolio_return$deviation) %>%
    percent()
```

[1] "5.41%"

Exercise 2

Annual returns for MSCI Germany Index.

year	return
1993	46.2%
1994	-6.2%
1995	8.0%
1996	22.9%
1997	45.9%
1998	20.3%
1999	41.2%
2000	-9.5%
2001	-17.8%
2002	-43.1%

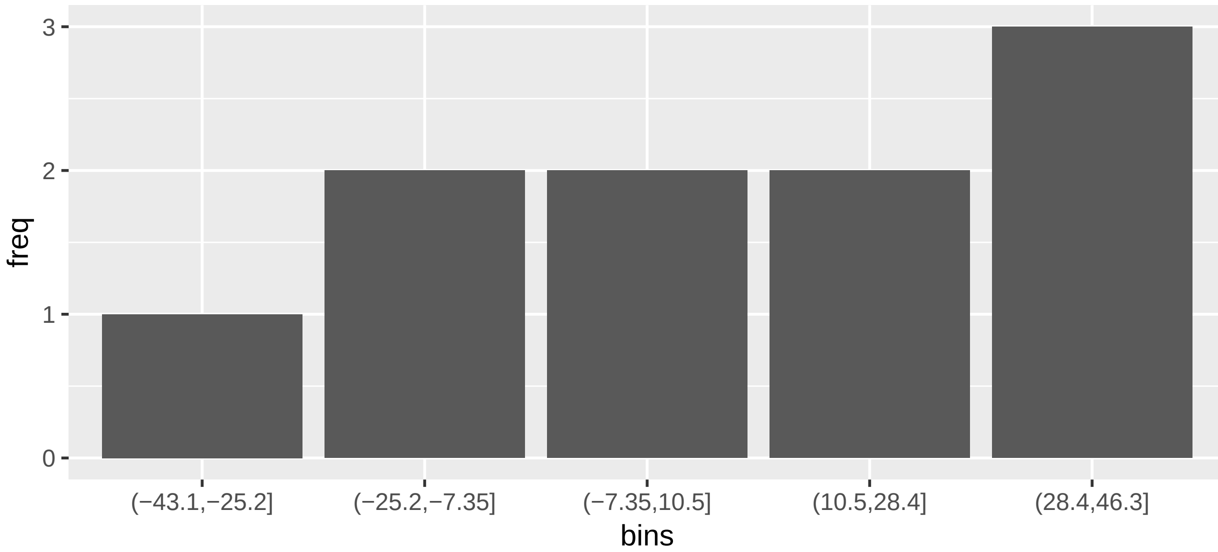
1) Frequency table

```r
binned <- msci %>%
    mutate(bins = cut(return * 100, breaks = 5)) %>%
    group_by(bins) %>%
    summarise(freq = n()) %>%
    mutate(cum_freq = cumsum(freq),
           rel_freq = freq / sum(freq),
           cum_rel_freq = cumsum(rel_freq))
```

bins	freq	cum_freq	rel_freq	cum_rel_freq
(-43.1,-25.2]	1	1	10.0%	10.0%
(-25.2,-7.35]	2	3	20.0%	30.0%
(-7.35,10.5]	2	5	20.0%	50.0%
(10.5,28.4]	2	7	20.0%	70.0%
(28.4,46.3]	3	10	30.0%	100.0%

2) Histogram

```r
ggplot(binned, aes(x = bins, y = freq)) +
    geom_bar(stat = "identity")
```



3) Modal interval of the data

```r
binned %>%
    filter(freq == max(freq)) %>%
    select(bins, freq) %>%
    kable()
```

bins	freq
(28.4,46.3]	3

4) Symmetry

The frequency distribution is not symmetric. Higher returns have a higher frequency compared to lower returns.

5-10) Statistical summaries

```
stat_list <- list(
    mean = mean(msci$return),
    median = median(msci$return),
    compound = prod(msci$return + 1) ^ (1 / length(msci$return)) - 1,
    perc30 = quantile(msci$return, probs = 0.3),
    range = max(msci$return) - min(msci$return),
    MAD = mean(abs(msci$return - mean(msci$return))),
    var = var(msci$return),
    sd = sd(msci$return),
    skewness = skewness(msci$return),
    kurtosis = kurtosis(msci$return) - 3
) %>%
    map_at(c("mean", "median", "compound", "perc30", "range", "MAD", "sd"), percent) %>%
    map_at(c("skewness", "kurtosis", "var"), partial(round, digits = 2))

tibble(stat = names(stat_list), value = stat_list) %>%
    kable()
```

stat	value
mean	10.8%
median	14.2%
compound	6.70%
perc30	-7.19%
range	89.3%
MAD	24.5%
var	0.09
sd	29.9%
skewness	-0.32
kurtosis	-0.96

Comments about Skewness and Kurtosis

The distribution is negatively skewed. It is skewed to the left. This means that the median is larger than the mean.

The kurtosis we calculate is the excess kurtosis. In this case it is negative, meaning that the distrbution is less peaked than the normal distribution.

Exercise 3

Annual returns for the MSCI Germany Index and JP Morgan government bonds index is provided as follows.

year	msci	jpm
1993	46.2%	15.7%
1994	-6.2%	-3.4%
1995	8.0%	18.3%
1996	22.9%	8.4%
1997	45.9%	6.6%
1998	20.3%	12.4%
1999	41.2%	-2.2%
2000	-9.5%	7.4%
2001	-17.8%	5.6%
2002	-43.1%	10.3%

1) Calculate portfolio return

For a porfolio of MSCI 60% and JPM 40%, returns are as follows.

```
portfolio_return <- index_return %>%
    mutate(portfolio = msci * 0.6 + jpm * 0.4) %>%
    select(year, portfolio)
```

year	portfolio
1993	34.0%
1994	-5.1%
1995	12.1%
1996	17.1%
1997	30.2%
1998	17.2%
1999	23.8%
2000	-2.7%
2001	-8.4%
2002	-21.7%

The expected value of the portfolio is:

```
percent(mean(portfolio_return$portfolio))
```

[1] “9.65%”

2-3) Coefficient of variation and Sharpe

```
portfolio <- portfolio_return$portfolio

cv_sharpe <- list(
    cv_msci = sd(index_return$msci) / mean(index_return$msci),
    cv_jpm = sd(index_return$jpm) / mean(index_return$jpm),
    cv_portfolio = sd(portfolio) / mean(portfolio),
    sharpe_msci = (mean(index_return$msci) - 0.0433) / sd(index_return$msci),
    sharpe_jpm = (mean(index_return$jpm) - 0.0433) / sd(index_return$jpm),
    sharpe_portfolio = (mean(portfolio) - 0.0433) / sd(portfolio)
)

tibble(name = names(cv_sharpe), value = as.numeric(cv_sharpe)) %>%
    kable(digits = 2)
```

name	value
cv_msci	2.77
cv_jpm	0.88
cv_portfolio	1.90
sharpe_msci	0.22
sharpe_jpm	0.52
sharpe_portfolio	0.29

Eventhough the best return per unit of risk is with JPM, portfolio manages to keep the expected returns relatively higher with less risk.

Exercise 4

Ratios for common stock in an equally weighted portfolio are given as follows.

stock	P_E	P_S	P_B
Aber.&Fitch	13.67	1.66	3.43
Albemarle	14.43	1.13	1.96
Avon	28.06	2.45	382.72
Berkshire Hathaway	18.46	2.39	1.65
Everest	11.91	1.34	1.30
FPL Group	15.80	1.04	1.70
Johnson Controls	14.24	0.40	2.13
Tenneco Auto	6.44	0.07	41.31

1) Mean and medians

```
stock %>%
    gather(ratio, value, P_E, P_S, P_B) %>%
    group_by(ratio) %>%
    summarise(mean = mean(value), median = median(value)) %>%
    kable(digits = 2)
```

ratio	mean	median
P_B	54.53	2.04
P_E	15.38	14.34
P_S	1.31	1.23

2) Comments

Price to Book ratios mean and median values have a large difference because the mean is highly susceptible to outliers. In this case, Avon and Tenneco's large P/B values distort the mean. Median gives a better sense of P/B.

It may not be a good idea to directly take the mean or median values of these ratios. Ratios don't give any information about the price and price determines the amount of shares (weight) of a stock in the portfolio even when it is equally weighted. A better measure for finding the mean P/E can be

`Total Portfolio Value / Total EPS`.