Bayesian-Like Code

```
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag

The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
library(ggplot2)
library(cowplot)
```

```
source("BayesianLikeCode.R")
```

Part 1

```
theta.vals <- c(0, .1, .2, .3, .4, .5, .6, 0.667, .7, .8, .9, 1)

theta.prior.distr.df <- get_prior_distr(theta.vals)
```

```
Warning: `data_frame()` was deprecated in tibble 1.1.0.
i Please use `tibble()` instead.
```

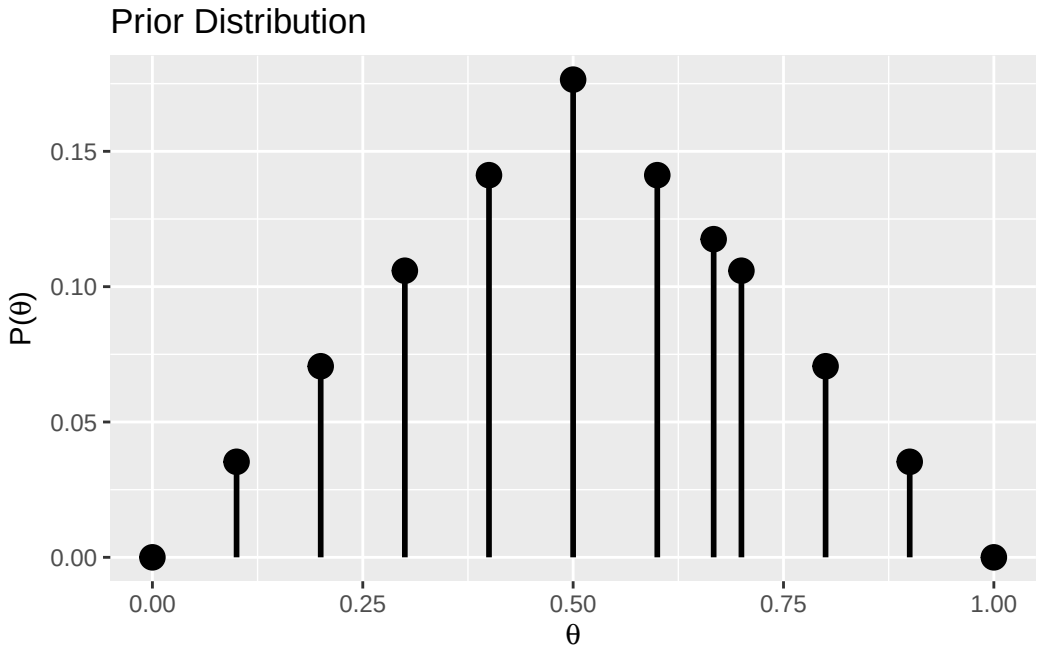
```
print(theta.prior.distr.df)
```

```
# A tibble: 12 x 2
   theta  prior
   <dbl>  <dbl>
 1 0      0
 2 0.1    0.0353
 3 0.2    0.0706
 4 0.3    0.106
 5 0.4    0.141
 6 0.5    0.176
 7 0.6    0.141
 8 0.667  0.118
 9 0.7    0.106
10 0.8    0.0706
11 0.9    0.0353
12 1      0
```

Question 1: $\theta = 0.5$ has the highest prior probability- $P(\theta = 0.5) = 0.176$. This suggests that the coin is fair- if we were to flip the coin many times, the probability of it landing on heads would converge to 0.5.

```
plot_prior_distr(theta.prior.distr.df)
```

```
Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
i Please use `linewidth` instead.
```

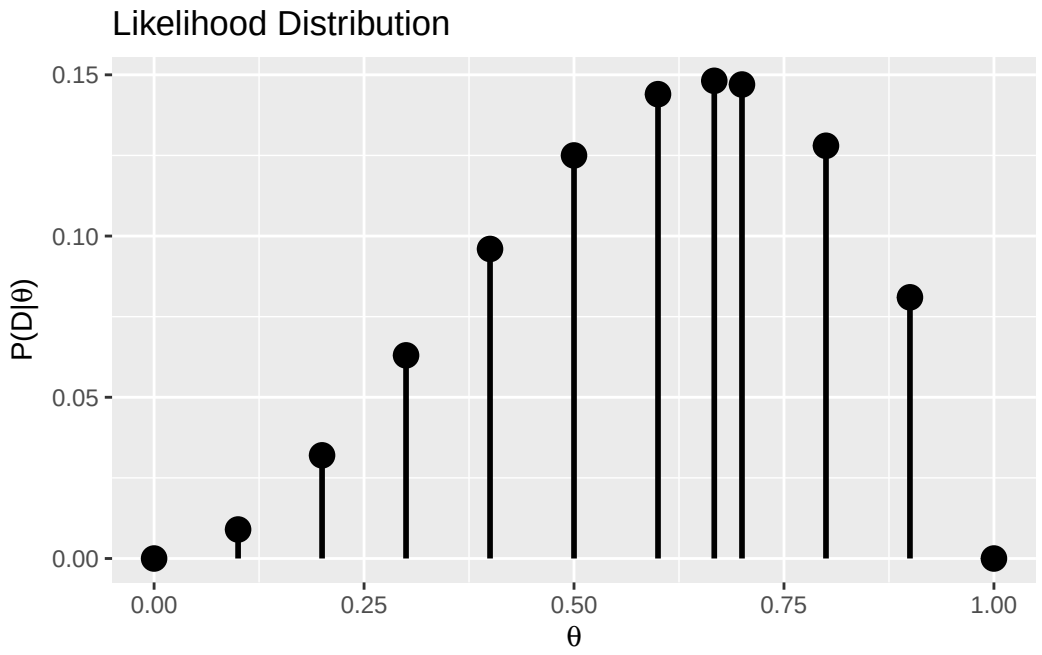



```
likelihood.df <- get_likelihood_df(theta.vals, num.heads=2, num.tails=1)
print(likelihood.df)
```

```
# A tibble: 12 x 2
   theta likelihood
   <dbl>      <dbl>
 1 0          0
 2 0.1        0.009
 3 0.2        0.032
 4 0.3        0.063
 5 0.4        0.096
 6 0.5        0.125
 7 0.6        0.144
 8 0.667      0.148
 9 0.7        0.147
10 0.8        0.128
11 0.9        0.081
12 1          0
```

Question 2: $\theta = 0.667$ has the highest likelihood. This suggests that the coin is biased- if we were to flip the coin many times, the probability of it landing on heads would converge to 0.667.

```
plot_likelihood_prob_distr(likelihood.df)
```




```
posterior.df <- get_posterior_df(likelihood.df, theta.prior.distr.df)
```

```
Joining with `by = join_by(theta)`
```

```
print(posterior.df)
```

```
# A tibble: 12 x 5
   theta likelihood  prior marg_likelihood post_prob
   <dbl>      <dbl>  <dbl>           <dbl>     <dbl>
 1 0          0     0                0.973  0
 2 0.1        0.009 0.0353           0.973  0.000326
 3 0.2        0.032 0.0706           0.973  0.00232
 4 0.3        0.063 0.106            0.973  0.00686
 5 0.4        0.096 0.141            0.973  0.0139
 6 0.5        0.125 0.176            0.973  0.0227
 7 0.6        0.144 0.141            0.973  0.0209
 8 0.667      0.148 0.118            0.973  0.0179
 9 0.7        0.147 0.106            0.973  0.0160
10 0.8        0.128 0.0706           0.973  0.00929
```

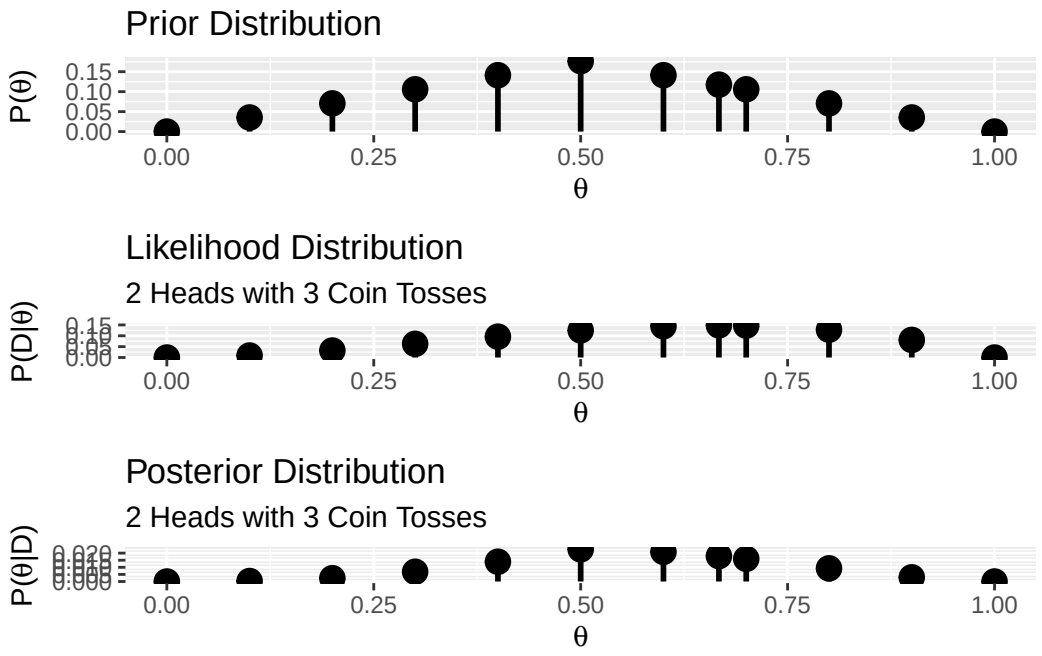
```
11 0.9         0.081 0.0353            0.973  0.00294
12 1           0     0                 0.973  0
```

Question 3: $\theta = 0.5$ has the highest posterior probability. This indicates that the coin is fair, we just experienced an extreme fluctuation in likelihood due to our small sample size ($n = 3$).

```
plot_grid(plot_prior_distr(theta.prior.distr.df),

          plot_likelihood_prob_distr(likelihood.df) +
            labs(subtitle = "2 Heads with 3 Coin Tosses"),

          plot_posterior_prob_distr(posterior.df, theta.vals) +
            labs(subtitle = "2 Heads with 3 Coin Tosses"), nrow = 3, align = "v")
```



Part 2

```
likelihood.df <- get_likelihood_df(theta.vals,
                                   num.heads = 8,
                                   num.tails = 12)
posterior.df <- get_posterior_df(likelihood.df, theta.prior.distr.df)
```

```
Joining with `by = join_by(theta)`
```

```
print(posterior.df)
```

```
# A tibble: 12 x 5
   theta likelihood  prior marg_likelihood     post_prob
   <dbl>      <dbl>  <dbl>           <dbl>         <dbl>
 1 0       0        0           0.00000385 0
 2 0.1     2.82e- 9 0.0353      0.00000385 0.0000259
 3 0.2     1.76e- 7 0.0706      0.00000385 0.00322
 4 0.3     9.08e- 7 0.106       0.00000385 0.0250
 5 0.4     1.43e- 6 0.141       0.00000385 0.0523
 6 0.5     9.54e- 7 0.176       0.00000385 0.0437
 7 0.6     2.82e- 7 0.141       0.00000385 0.0103
 8 0.667   7.28e- 8 0.118       0.00000385 0.00222
 9 0.7     3.06e- 8 0.106       0.00000385 0.000842
10 0.8     6.87e-10 0.0706      0.00000385 0.0000126
11 0.9     4.30e-13 0.0353      0.00000385 0.00000000394
12 1       0        0           0.00000385 0
```

Question 4: $\theta = 0.4$ has the highest posterior probability. This suggests the coin is slightly biased towards tails.

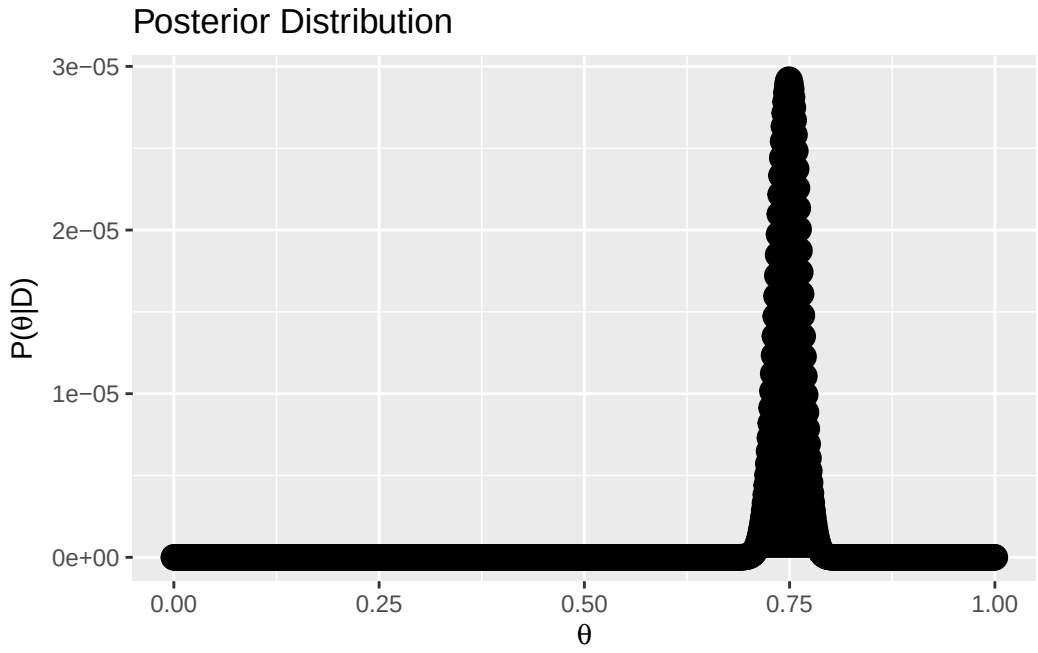
Part 3

```
theta.vals <- seq(0, 1, 0.001)
theta.prior.distr.df <- get_prior_distr(theta.vals)
```

```
likelihood.df <- get_likelihood_df(theta.vals,
                                   num.heads = 750,
                                   num.tails = 250)
posterior.df <- get_posterior_df(likelihood.df, theta.prior.distr.df)
```

```
Joining with `by = join_by(theta)`
```

```
plot_posterior_prob_distr(posterior.df, theta.vals)
```



Question 5: $\theta = 0.75$ has the highest posterior probability. This indicates that the coin is heavily biased towards heads.

Question 6: The prior is most effective when you have a large, true/fair sample. As n increases, θ will converge towards its "true" value, and biases caused by random fluctuations in the number of heads will be eliminated.