Goodness of fit

```r
library(knitr)
library(dplyr)
library(ggplot2)

load("data/goodness_of_fit_dc.RData")
```

```r
for(i in 2:19) {
  tab_results[i,] = tab_results[i,] - tab_results[1,]
}
kable(tab_results, digits = 4)
```

	Home	Draw	Away
Observed	0.4882	0.2686	0.2433
Model 0 (min 0)	-0.0055	-0.0077	0.0132
Model 3 (min 0)	-0.0036	0.0103	-0.0067
Model 8 (min 0)	-0.0029	0.0079	-0.0051
Model 0 (min 15)	-0.0122	-0.0016	0.0137
Model 3 (min 15)	-0.0071	0.0113	-0.0042
Model 8 (min 15)	-0.0064	0.0090	-0.0026
Model 0 (min 30)	-0.0211	0.0079	0.0132
Model 3 (min 30)	-0.0127	0.0145	-0.0018
Model 8 (min 30)	-0.0117	0.0119	-0.0002
Model 0 (min 45)	-0.0140	0.0083	0.0057
Model 3 (min 45)	-0.0055	0.0120	-0.0065
Model 8 (min 45)	-0.0042	0.0093	-0.0052
Model 0 (min 60)	-0.0117	0.0114	0.0003
Model 3 (min 60)	-0.0050	0.0129	-0.0080
Model 8 (min 60)	-0.0039	0.0105	-0.0066
Model 0 (min 75)	-0.0091	0.0114	-0.0022
Model 3 (min 75)	-0.0036	0.0105	-0.0069
Model 8 (min 75)	-0.0028	0.0088	-0.0060

```r
for(i in 2:19) {
  tab_home_goals[i,] = tab_home_goals[i,] - tab_home_goals[1,]
}
kable(tab_home_goals, digits = 4)
```

	0	1	2	3	4	5+
Observed	0.2282	0.3617	0.2465	0.1173	0.0350	0.0113
Model 0 (min 0)	0.0289	-0.0318	-0.0163	-0.0024	0.0109	0.0107
Model 3 (min 0)	0.0105	-0.0191	0.0001	-0.0004	0.0059	0.0030
Model 8 (min 0)	0.0066	-0.0106	-0.0003	-0.0051	0.0046	0.0049

	0	1	2	3	4	5+
Model 0 (min 15)	0.0409	-0.0259	-0.0198	-0.0086	0.0065	0.0069
Model 3 (min 15)	0.0137	-0.0164	-0.0005	-0.0025	0.0041	0.0016
Model 8 (min 15)	0.0103	-0.0081	-0.0012	-0.0073	0.0030	0.0034
Model 0 (min 30)	0.0537	-0.0190	-0.0236	-0.0156	0.0013	0.0032
Model 3 (min 30)	0.0174	-0.0130	-0.0012	-0.0054	0.0018	0.0004
Model 8 (min 30)	0.0146	-0.0057	-0.0021	-0.0098	0.0009	0.0021
Model 0 (min 45)	0.0372	-0.0130	-0.0169	-0.0130	0.0023	0.0034
Model 3 (min 45)	0.0032	-0.0112	0.0040	-0.0017	0.0042	0.0014
Model 8 (min 45)	0.0008	-0.0054	0.0029	-0.0055	0.0036	0.0036
Model 0 (min 60)	0.0296	-0.0068	-0.0122	-0.0114	0.0005	0.0003
Model 3 (min 60)	0.0016	-0.0072	0.0044	-0.0007	0.0025	-0.0006
Model 8 (min 60)	0.0006	-0.0032	0.0032	-0.0043	0.0024	0.0013
Model 0 (min 75)	0.0226	0.0062	-0.0135	-0.0107	-0.0027	-0.0019
Model 3 (min 75)	0.0004	0.0029	-0.0005	-0.0017	0.0004	-0.0016
Model 8 (min 75)	0.0003	0.0051	-0.0016	-0.0039	0.0005	-0.0004

```r
for(i in 2:19) {
  tab_away_goals[i,] = tab_away_goals[i,] - tab_away_goals[1,]
}
kable(tab_away_goals, digits = 4)
```

|	0	1	2	3	4	5+
Observed	0.3870	0.3671	0.1792	0.0474	0.0151	0.0043
Model 0 (min 0)	0.0186	-0.0144	-0.0130	0.0087	0.0001	0.0000
Model 3 (min 0)	0.0062	0.0006	-0.0075	0.0055	-0.0030	-0.0018
Model 8 (min 0)	0.0054	0.0030	-0.0080	0.0043	-0.0032	-0.0015
Model 0 (min 15)	0.0286	-0.0131	-0.0177	0.0047	-0.0018	-0.0008
Model 3 (min 15)	0.0056	0.0028	-0.0074	0.0046	-0.0036	-0.0020
Model 8 (min 15)	0.0052	0.0052	-0.0082	0.0033	-0.0037	-0.0017
Model 0 (min 30)	0.0352	-0.0107	-0.0204	0.0011	-0.0036	-0.0016
Model 3 (min 30)	0.0023	0.0046	-0.0049	0.0043	-0.0041	-0.0023
Model 8 (min 30)	0.0023	0.0065	-0.0059	0.0032	-0.0041	-0.0020
Model 0 (min 45)	0.0302	-0.0053	-0.0172	-0.0011	-0.0047	-0.0020
Model 3 (min 45)	-0.0044	0.0088	-0.0008	0.0033	-0.0046	-0.0023
Model 8 (min 45)	-0.0033	0.0093	-0.0018	0.0024	-0.0045	-0.0021
Model 0 (min 60)	0.0244	0.0044	-0.0211	-0.0012	-0.0047	-0.0018
Model 3 (min 60)	-0.0051	0.0148	-0.0063	0.0030	-0.0044	-0.0020
Model 8 (min 60)	-0.0033	0.0140	-0.0071	0.0024	-0.0043	-0.0018
Model 0 (min 75)	0.0202	0.0101	-0.0201	-0.0043	-0.0042	-0.0017
Model 3 (min 75)	-0.0031	0.0162	-0.0081	0.0001	-0.0034	-0.0017
Model 8 (min 75)	-0.0016	0.0154	-0.0088	-0.0003	-0.0032	-0.0015

```
tibble(x = sims$pred_0$loglik_results_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_0_pred_0, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 0 at minute 0")
```


Results model 0 at minute 0
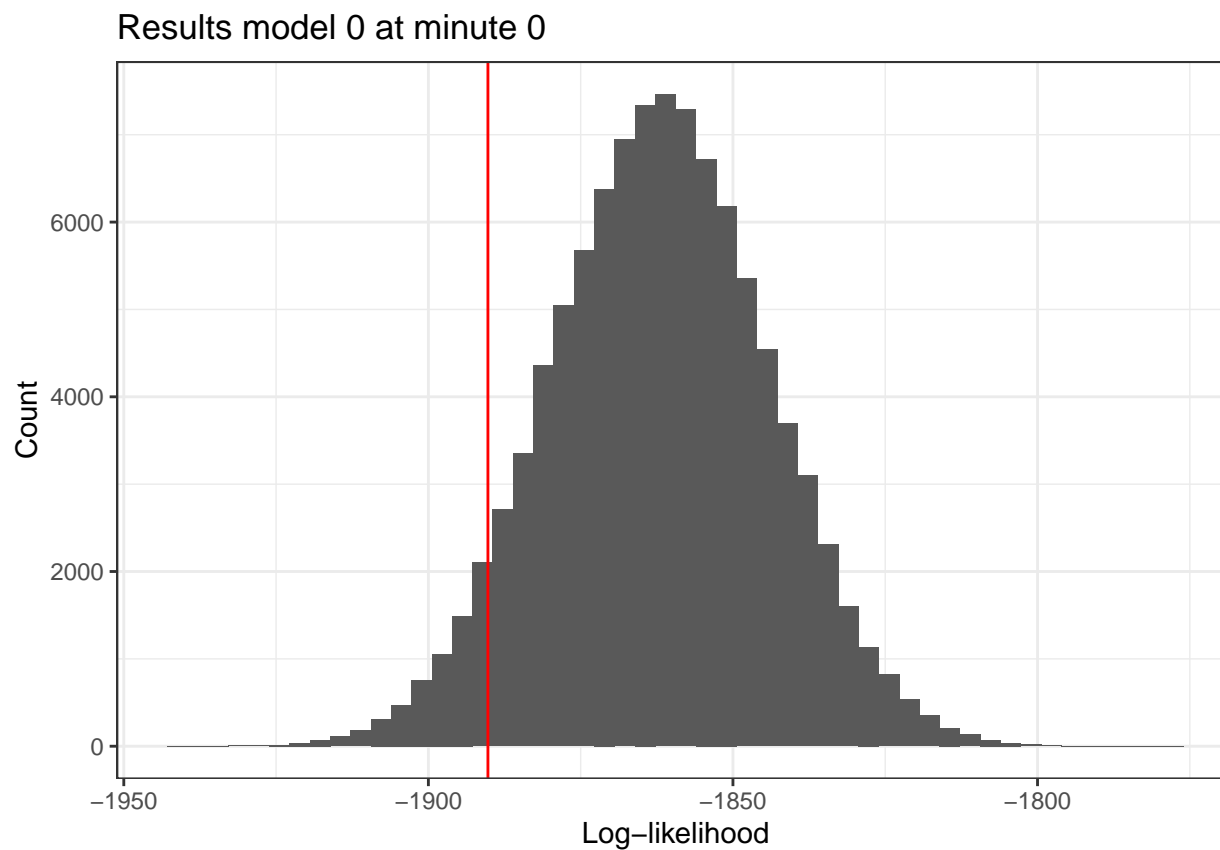
```
sum(sims$pred_0$loglik_results_mod_0 <= loglik_observed_results_mod_0_pred_0) /
  length(sims$pred_0$loglik_results_mod_0)
```
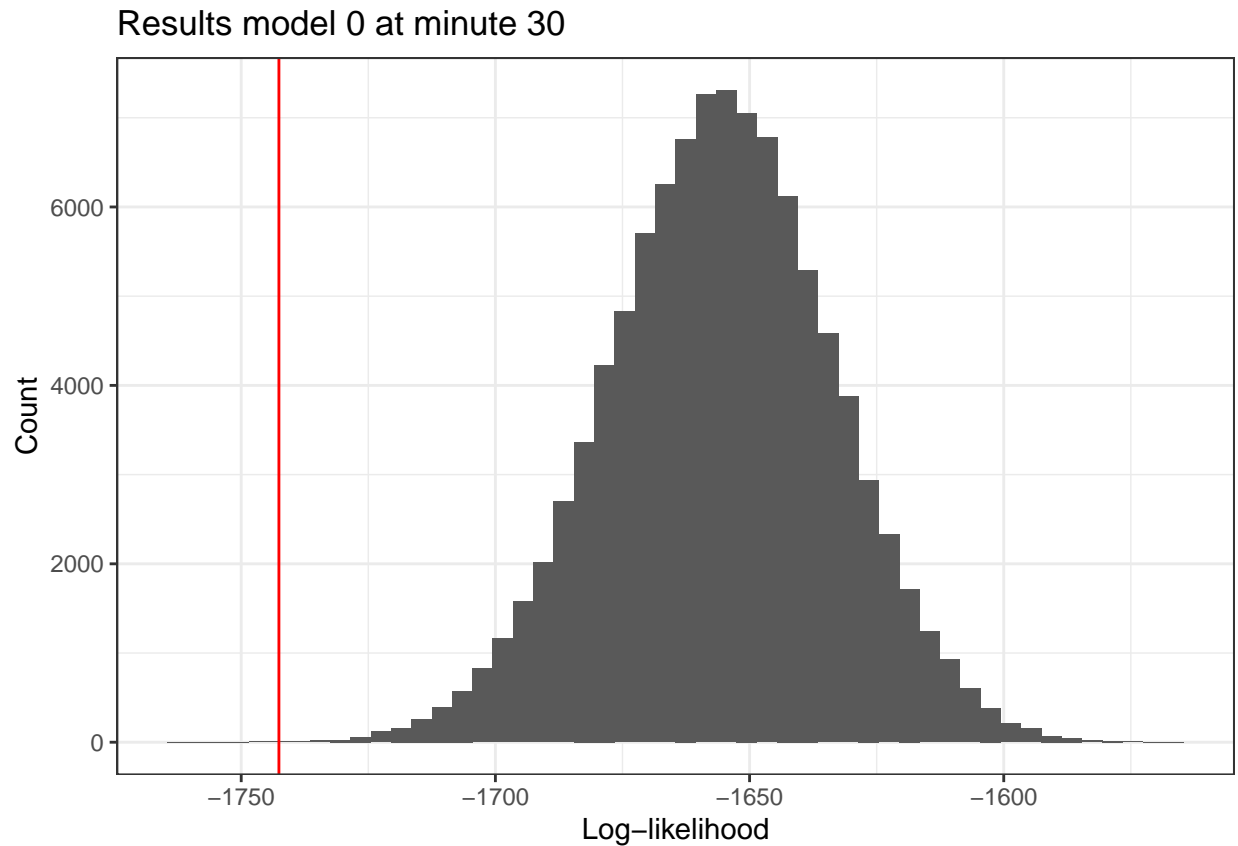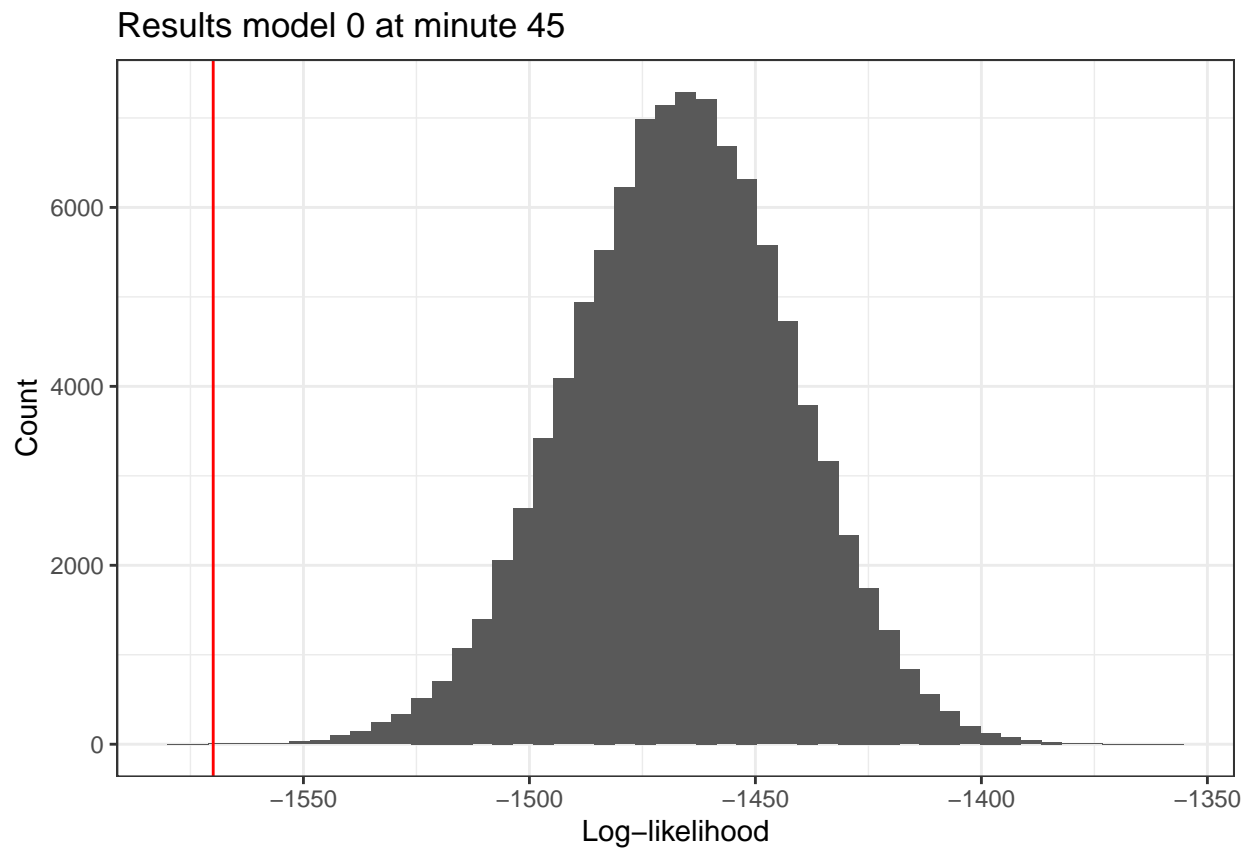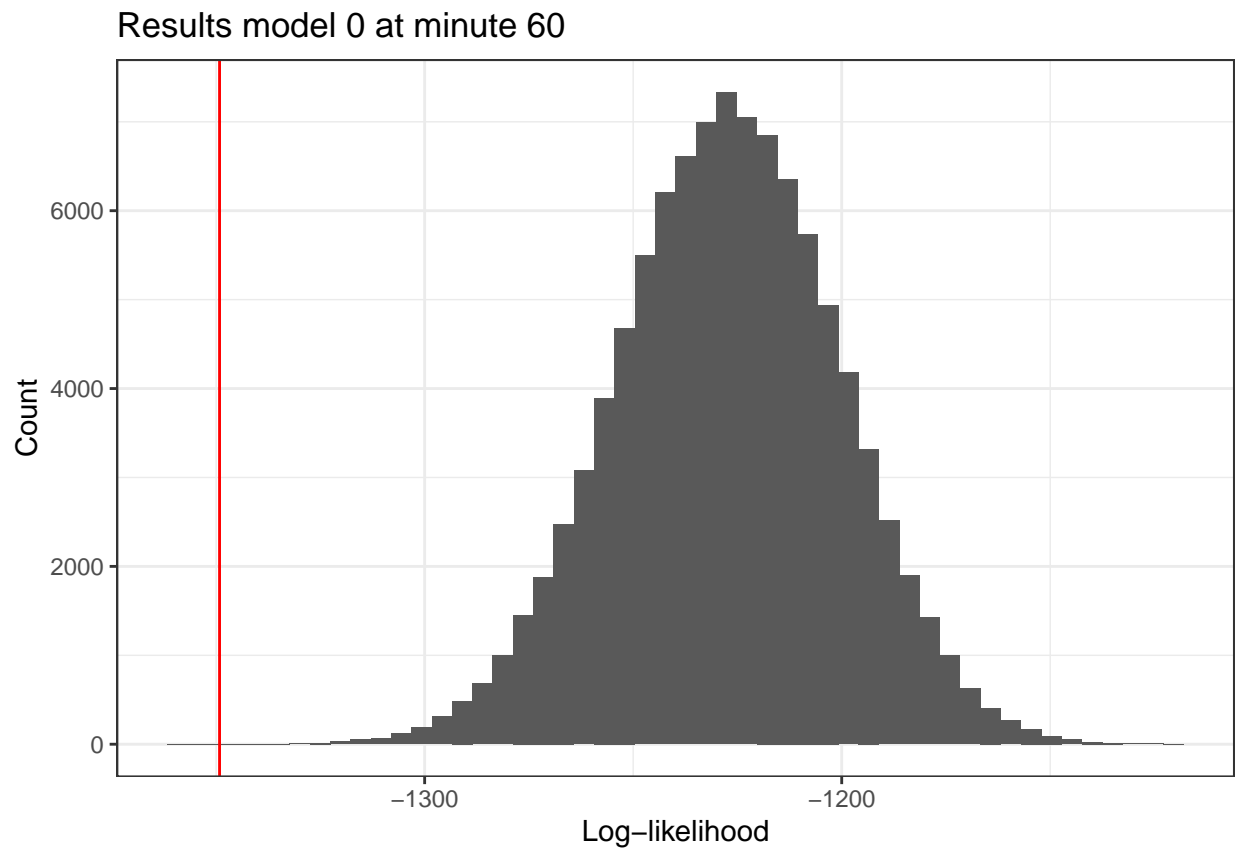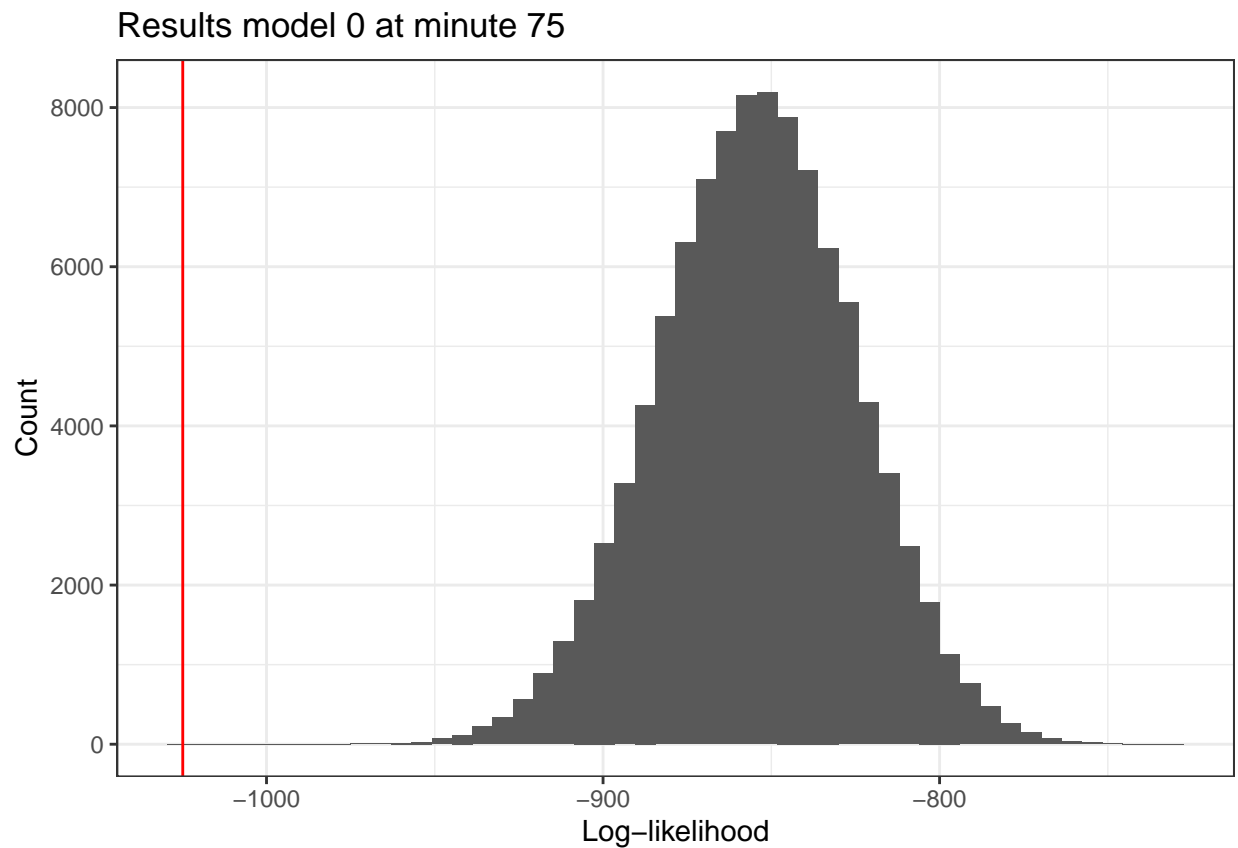
```
## [1] 0.06041
```

```
tibble(x = sims$pred_15$loglik_results_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_0_pred_15, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 0 at minute 15")
```

Results model 0 at minute 15
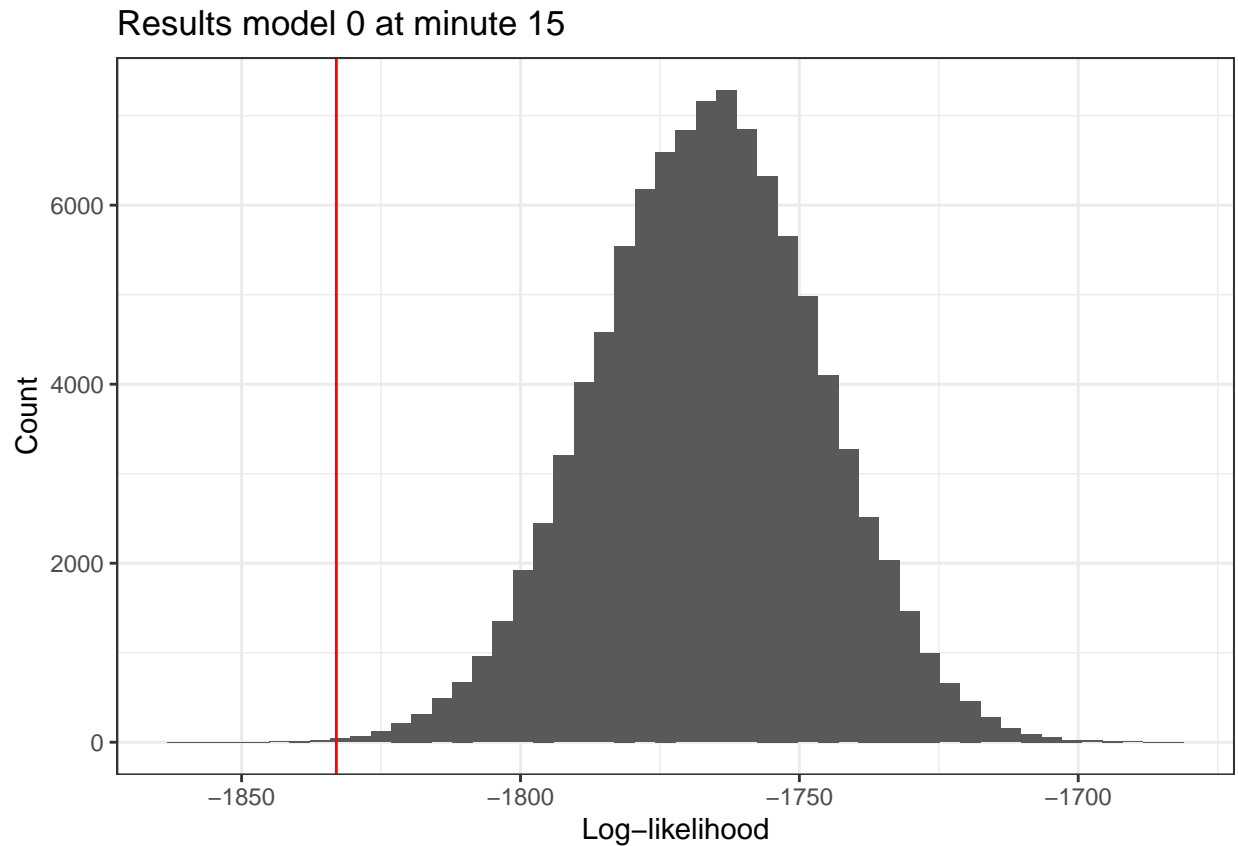

```
sum(sims$pred_15$loglik_results_mod_0 <= loglik_observed_results_mod_0_pred_15) /
  length(sims$pred_15$loglik_results_mod_0)
```

```
## [1] 0.00064
```

```
tibble(x = sims$pred_30$loglik_results_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_0_pred_30, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 0 at minute 30")
```

Results model 0 at minute 30


```
sum(sims$pred_30$loglik_results_mod_0 <= loglik_observed_results_mod_0_pred_30) /
  length(sims$pred_30$loglik_results_mod_0)
```

```
## [1] 0.00011
```

```
tibble(x = sims$pred_45$loglik_results_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_0_pred_45, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 0 at minute 45")
```
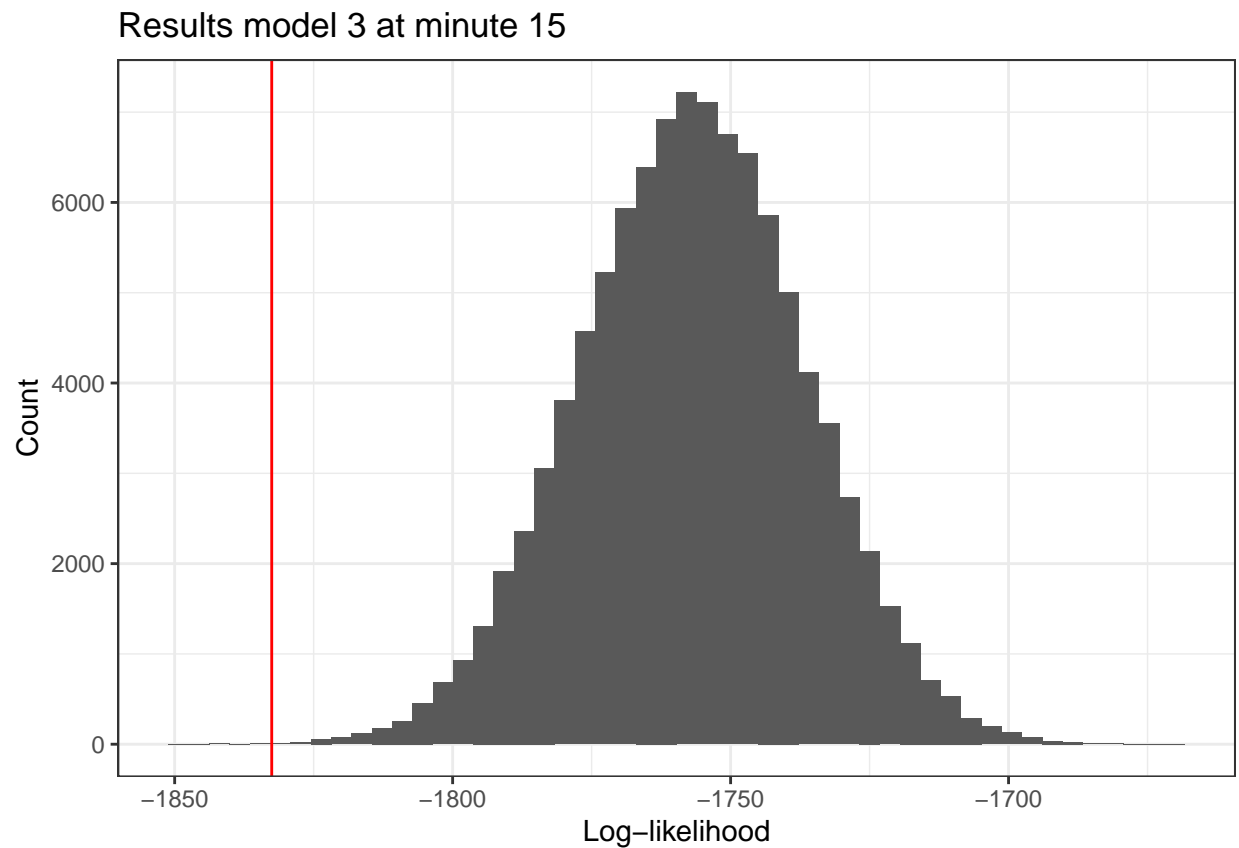

Results model 0 at minute 45

```
sum(sims$pred_45$loglik_results_mod_0 <= loglik_observed_results_mod_0_pred_45) /
  length(sims$pred_45$loglik_results_mod_0)
```

```
## [1] 5e-05
```

```r
tibble(x = sims$pred_60$loglik_results_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_0_pred_60, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 0 at minute 60")
```

Results model 0 at minute 60


```r
sum(sims$pred_60$loglik_results_mod_0 <= loglik_observed_results_mod_0_pred_60) /
  length(sims$pred_60$loglik_results_mod_0)
```
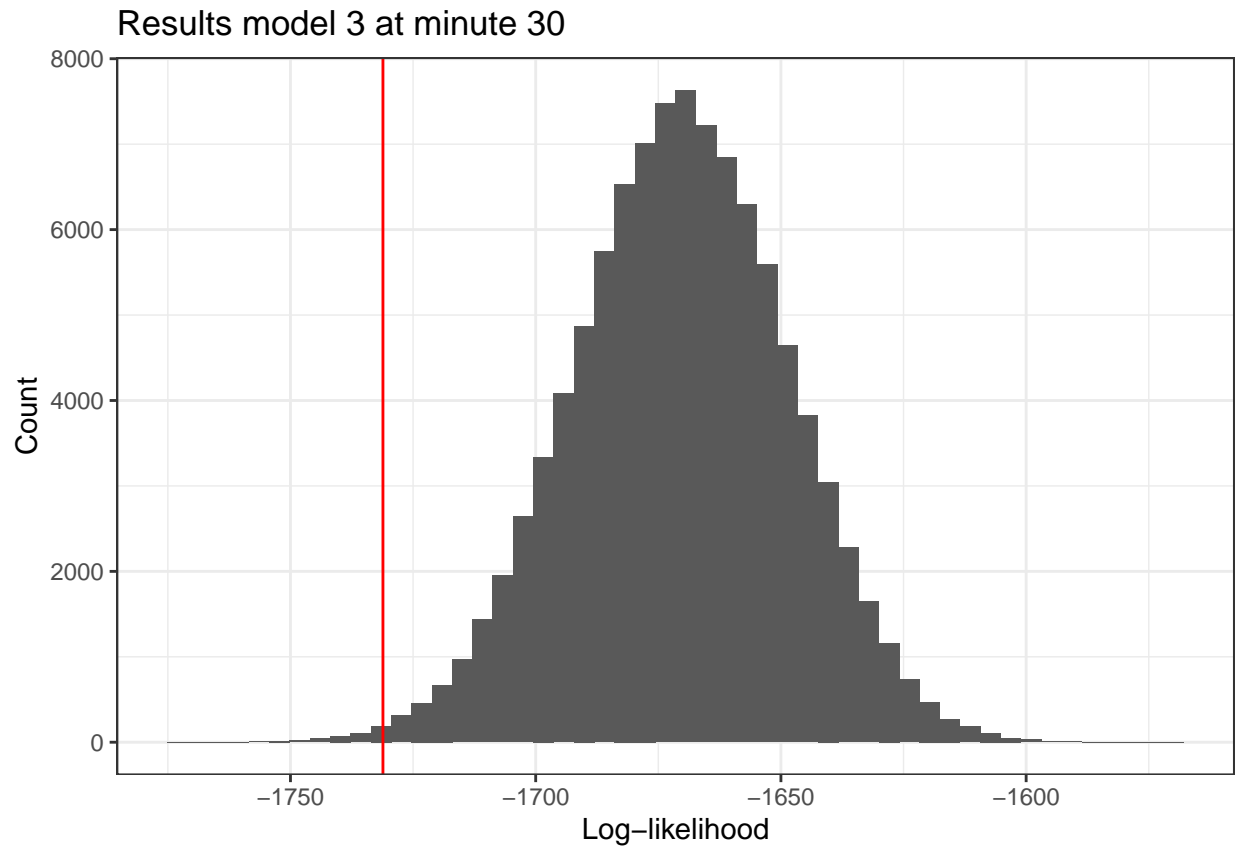
```
## [1] 2e-05
```

```
tibble(x = sims$pred_75$loglik_results_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_0_pred_75, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 0 at minute 75")
```

Results model 0 at minute 75


```
sum(sims$pred_75$loglik_results_mod_0 <= loglik_observed_results_mod_0_pred_75) /
  length(sims$pred_75$loglik_results_mod_0)
```
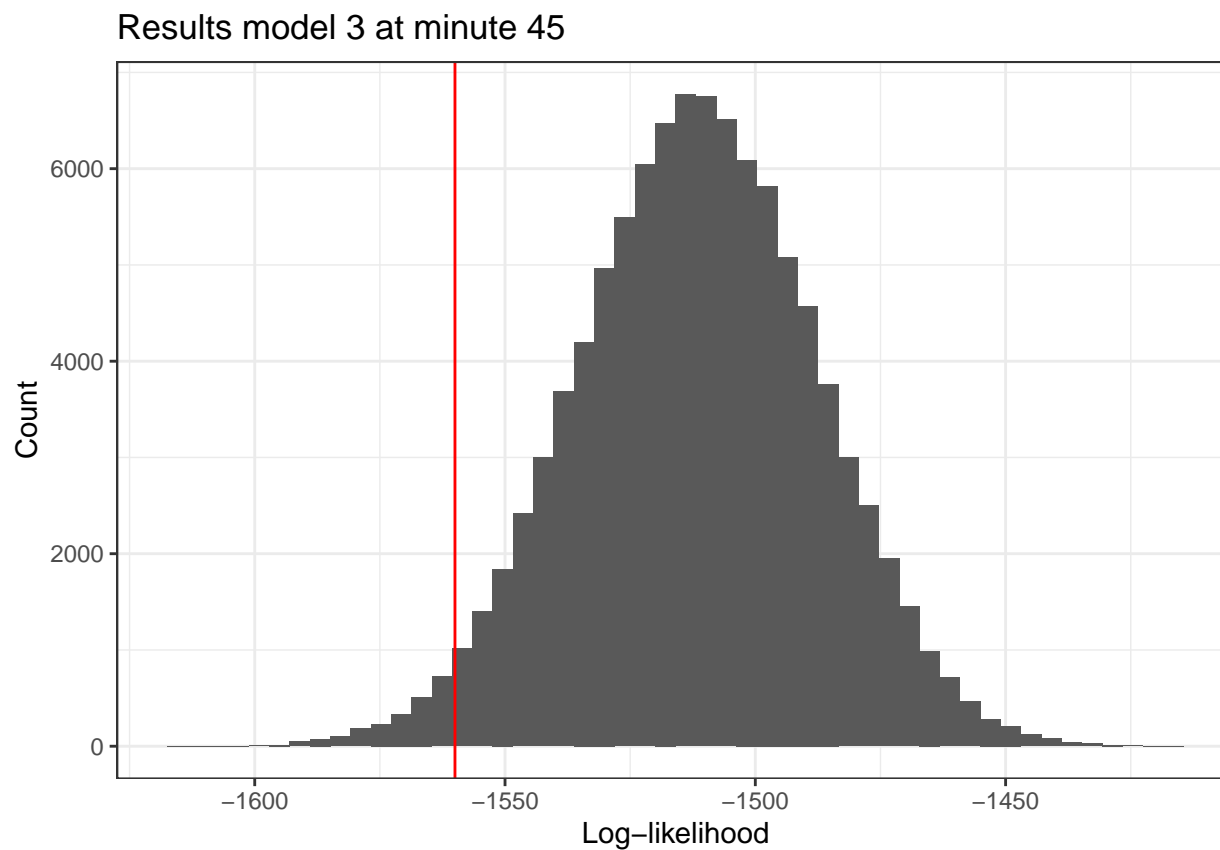
```
## [1] 0
```

```
tibble(x = sims$pred_0$loglik_results_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_3_pred_0, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 3 at minute 0")
```


Results model 3 at minute 0
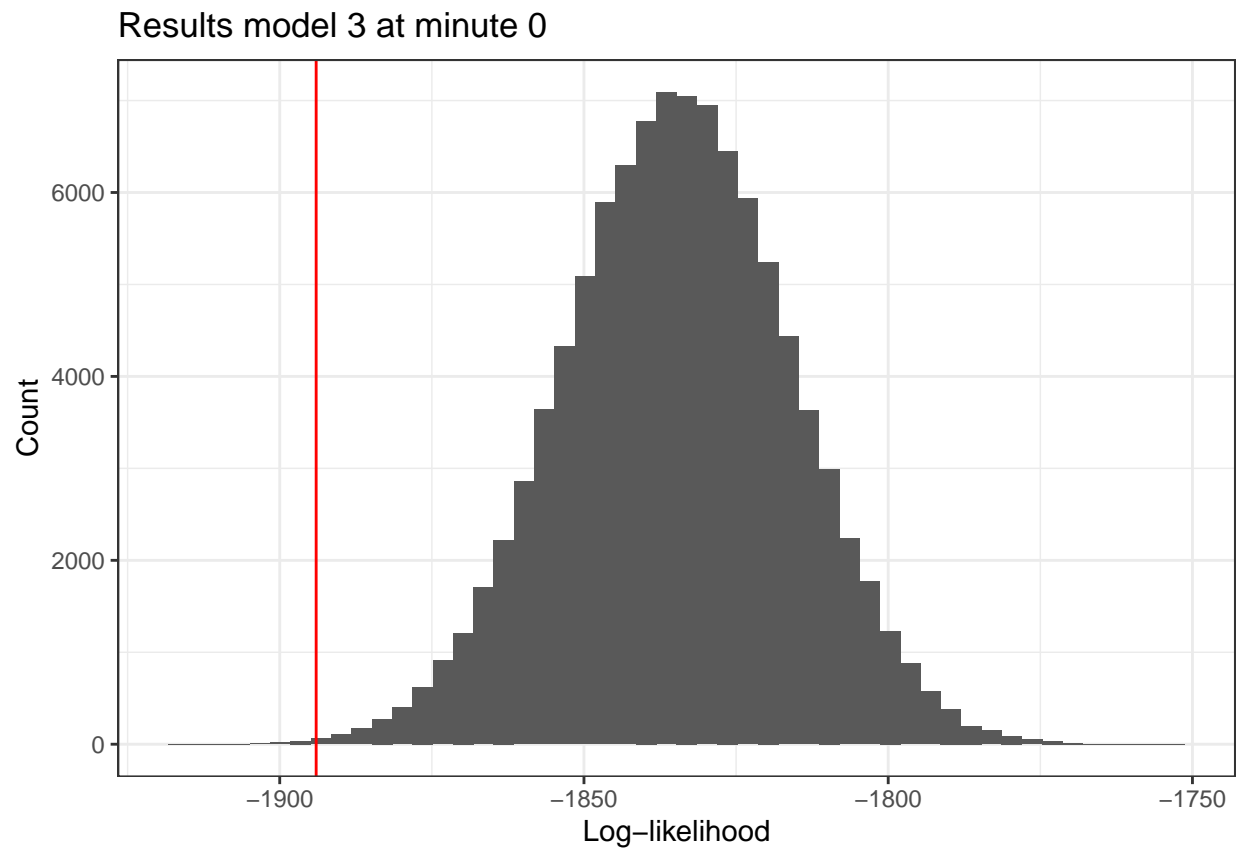
```
sum(sims$pred_0$loglik_results_mod_3 <= loglik_observed_results_mod_3_pred_0) /
  length(sims$pred_0$loglik_results_mod_3)
```
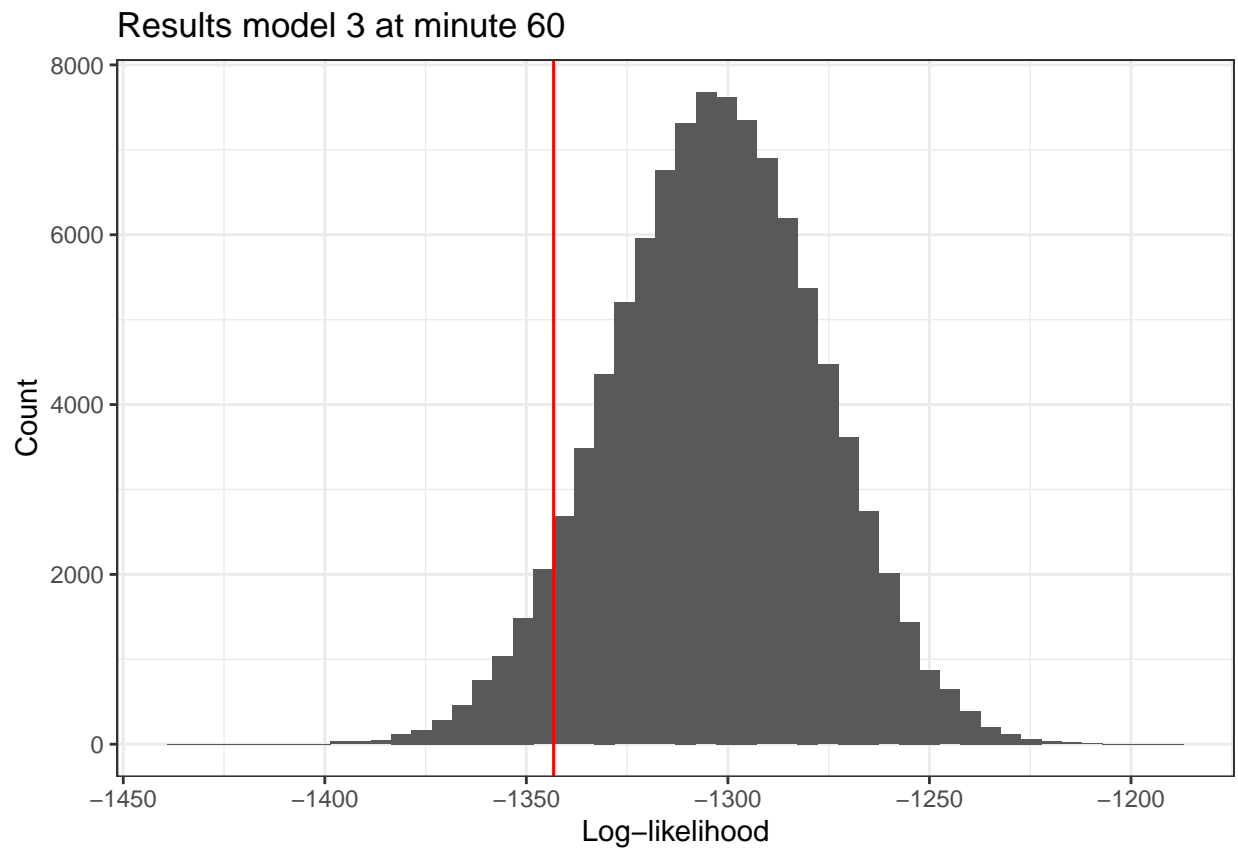
```
## [1] 0.00078
```

```
tibble(x = sims$pred_15$loglik_results_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_3_pred_15, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 3 at minute 15")
```

Results model 3 at minute 15


```
sum(sims$pred_15$loglik_results_mod_3 <= loglik_observed_results_mod_3_pred_15) /
  length(sims$pred_15$loglik_results_mod_3)
```

```
## [1] 0.00016
```

```
tibble(x = sims$pred_30$loglik_results_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_3_pred_30, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 3 at minute 30")
```
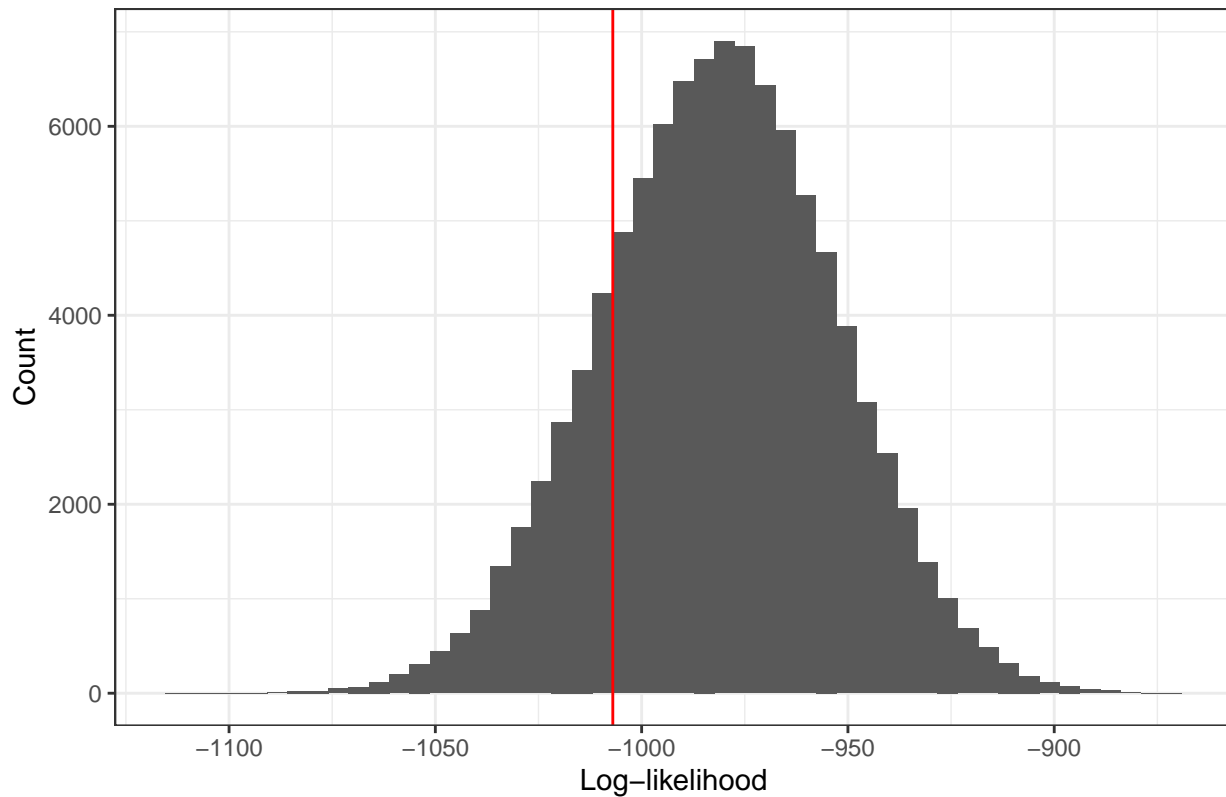


```
sum(sims$pred_30$loglik_results_mod_3 <= loglik_observed_results_mod_3_pred_30) /
  length(sims$pred_30$loglik_results_mod_3)
```

```
## [1] 0.00368
```

```
tibble(x = sims$pred_45$loglik_results_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_3_pred_45, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 3 at minute 45")
```


Results model 3 at minute 45

```
sum(sims$pred_45$loglik_results_mod_3 <= loglik_observed_results_mod_3_pred_45) /
  length(sims$pred_45$loglik_results_mod_3)
```
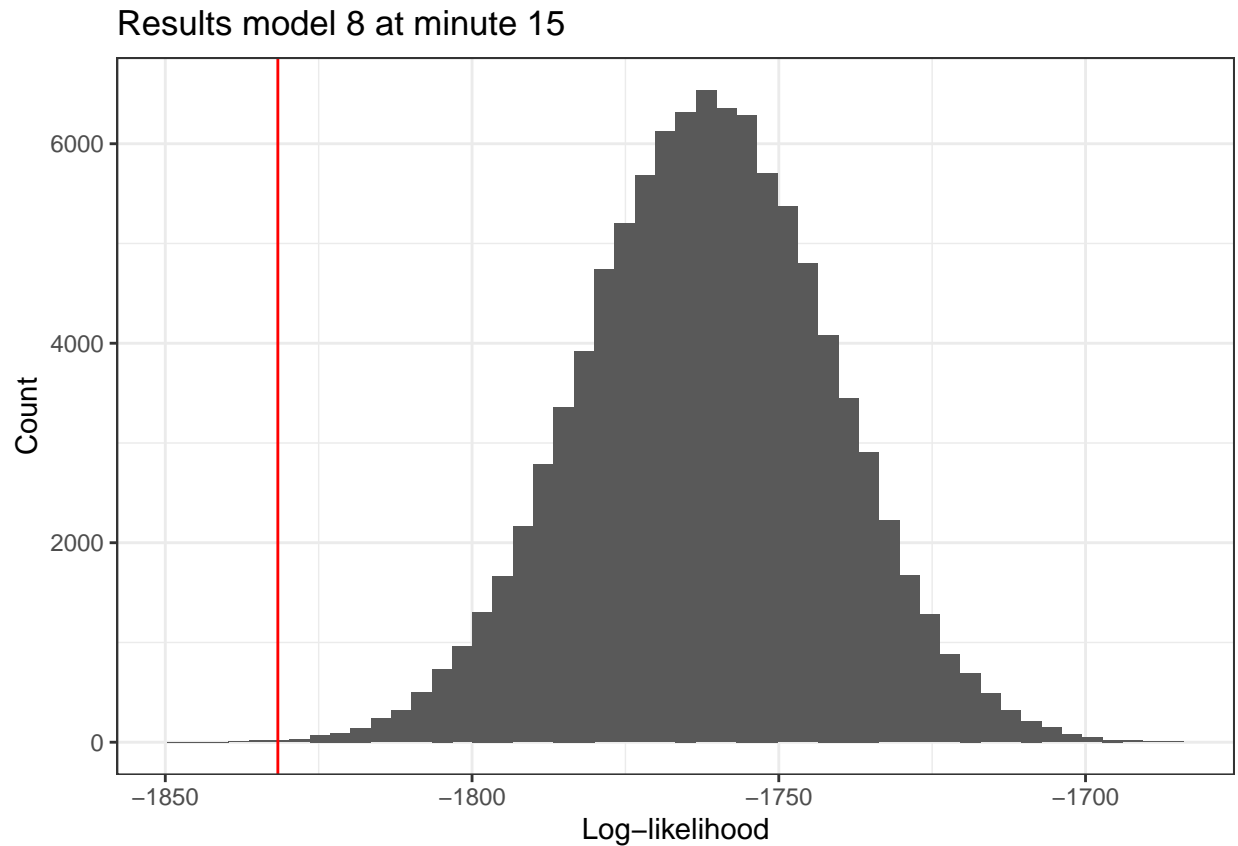
```
## [1] 0.02366
```

```
tibble(x = sims$pred_60$loglik_results_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_3_pred_60, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 3 at minute 60")
```

Results model 3 at minute 60


```
sum(sims$pred_60$loglik_results_mod_3 <= loglik_observed_results_mod_3_pred_60) /
  length(sims$pred_60$loglik_results_mod_3)
```

```
## [1] 0.06465
```

```
tibble(x = sims$pred_75$loglik_results_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_3_pred_75, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 3 at minute 75")
```

Results model 3 at minute 75


```
sum(sims$pred_75$loglik_results_mod_3 <= loglik_observed_results_mod_3_pred_75) /
  length(sims$pred_75$loglik_results_mod_3)
```
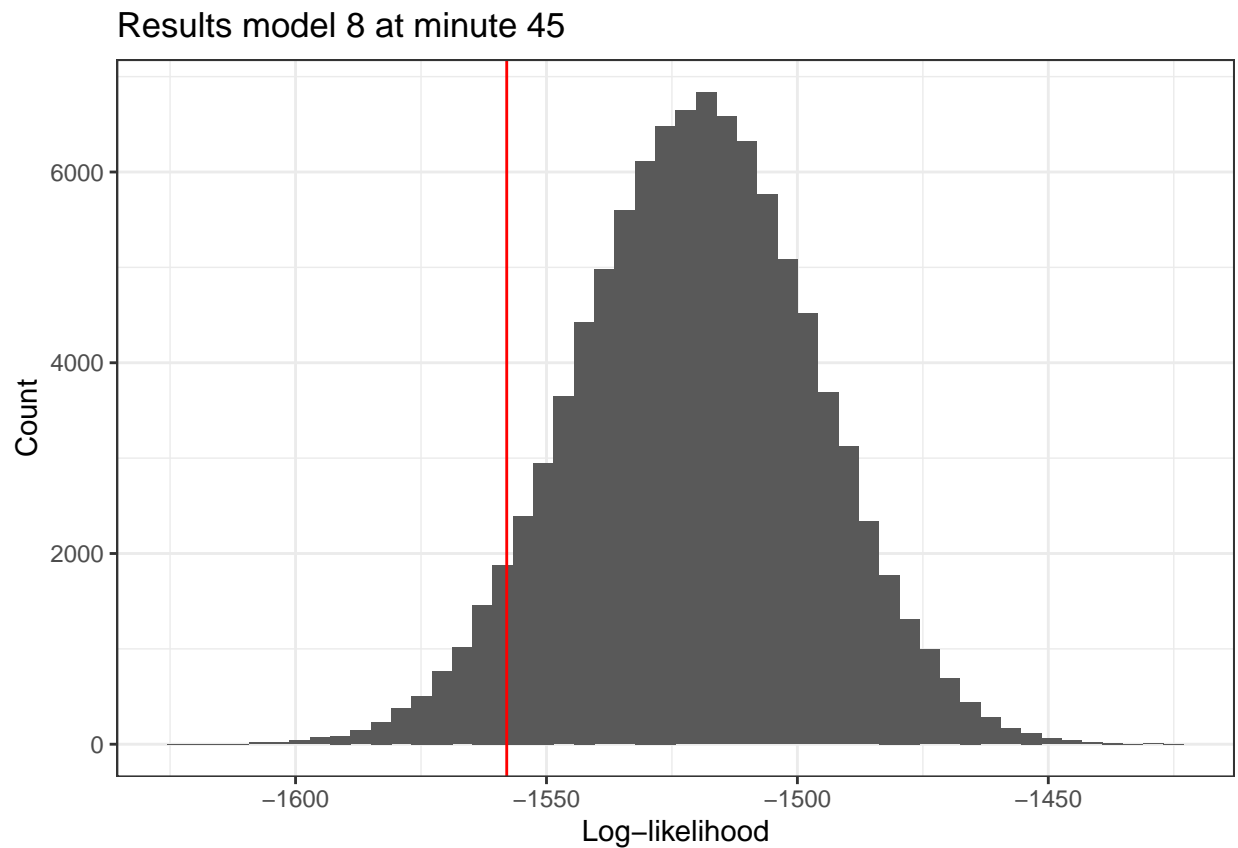
```
## [1] 0.18622
```

```
tibble(x = sims$pred_0$loglik_results_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_8_pred_0, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 8 at minute 0")
```


Results model 8 at minute 0
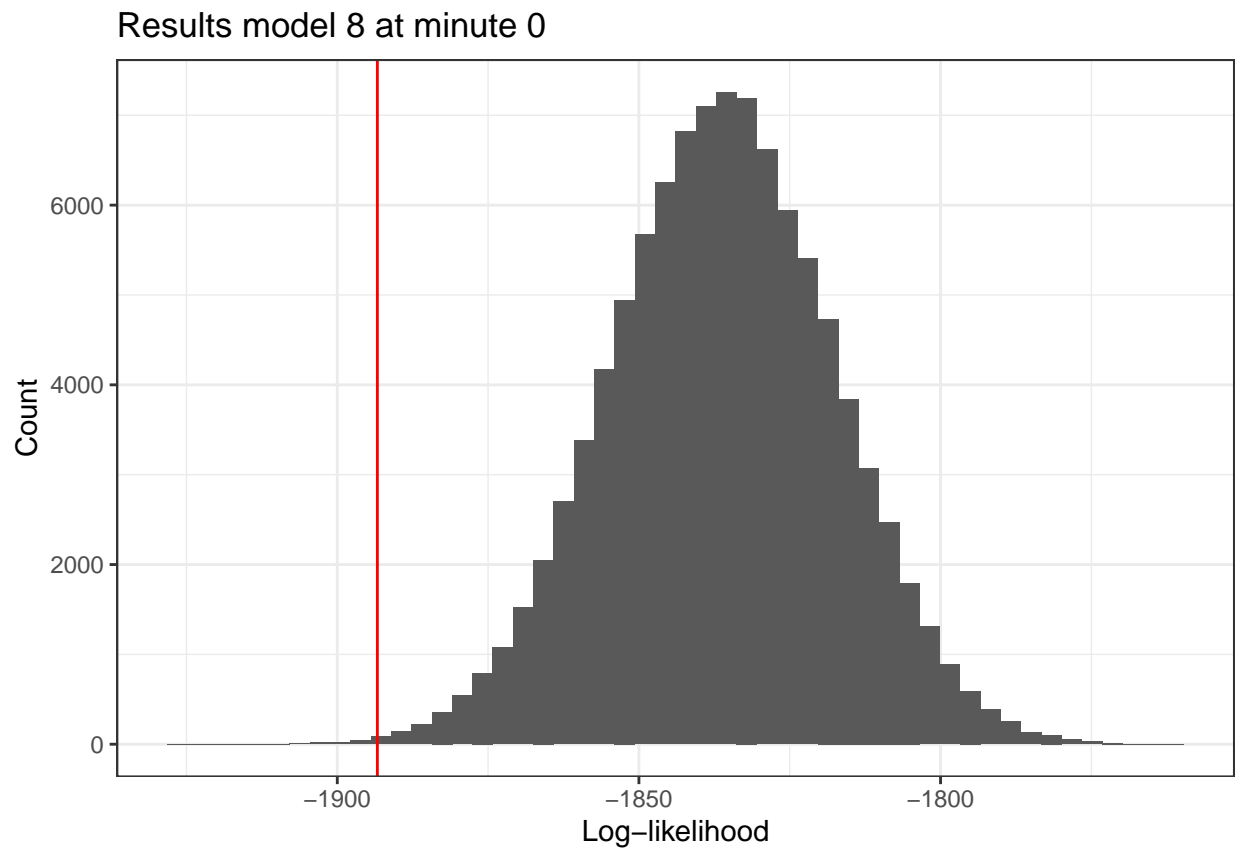
```
sum(sims$pred_0$loglik_results_mod_8 <= loglik_observed_results_mod_8_pred_0) /
  length(sims$pred_0$loglik_results_mod_8)
```
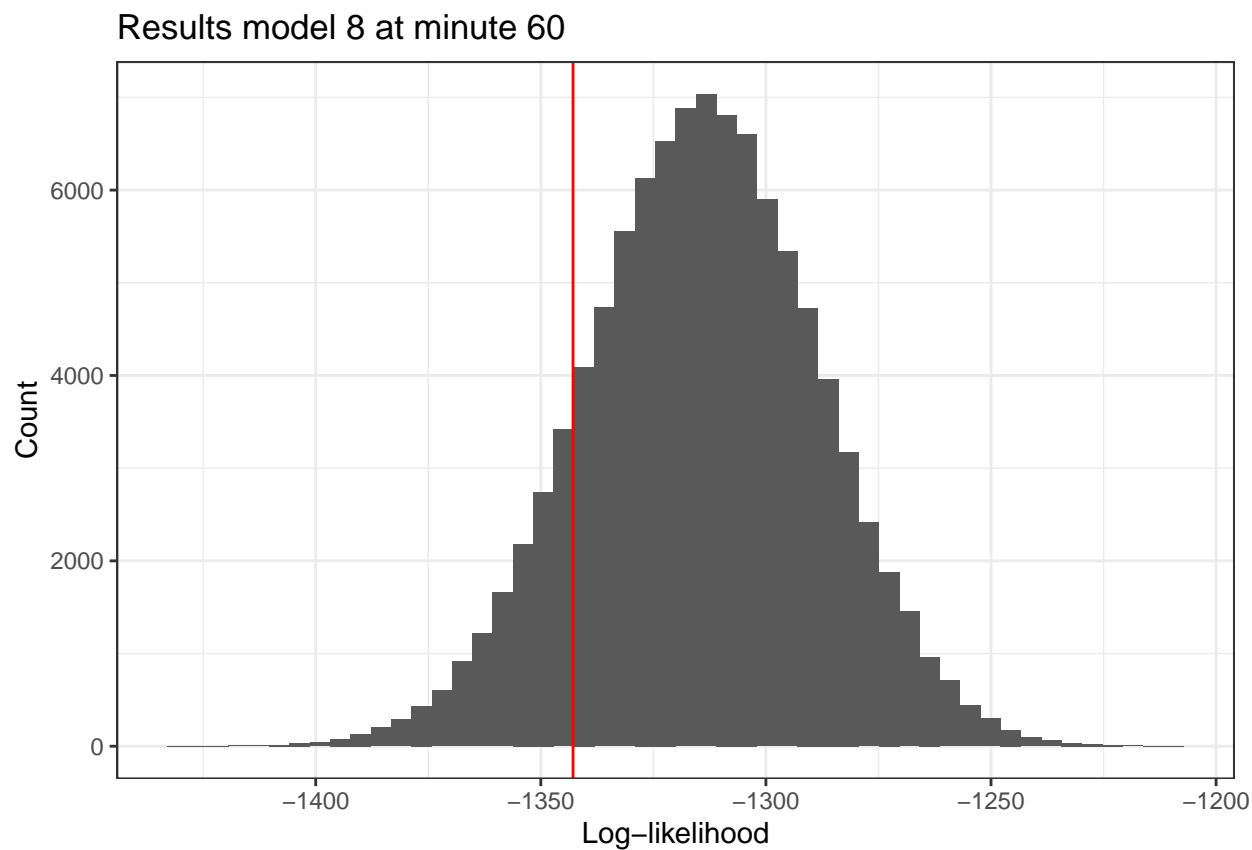
```
## [1] 0.00119
```

```
tibble(x = sims$pred_15$loglik_results_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_8_pred_15, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 8 at minute 15")
```



```
sum(sims$pred_15$loglik_results_mod_8 <= loglik_observed_results_mod_8_pred_15) /
  length(sims$pred_15$loglik_results_mod_8)
```

```
## [1] 0.00036
```

```
tibble(x = sims$pred_30$loglik_results_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_8_pred_30, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 8 at minute 30")
```

Results model 8 at minute 30
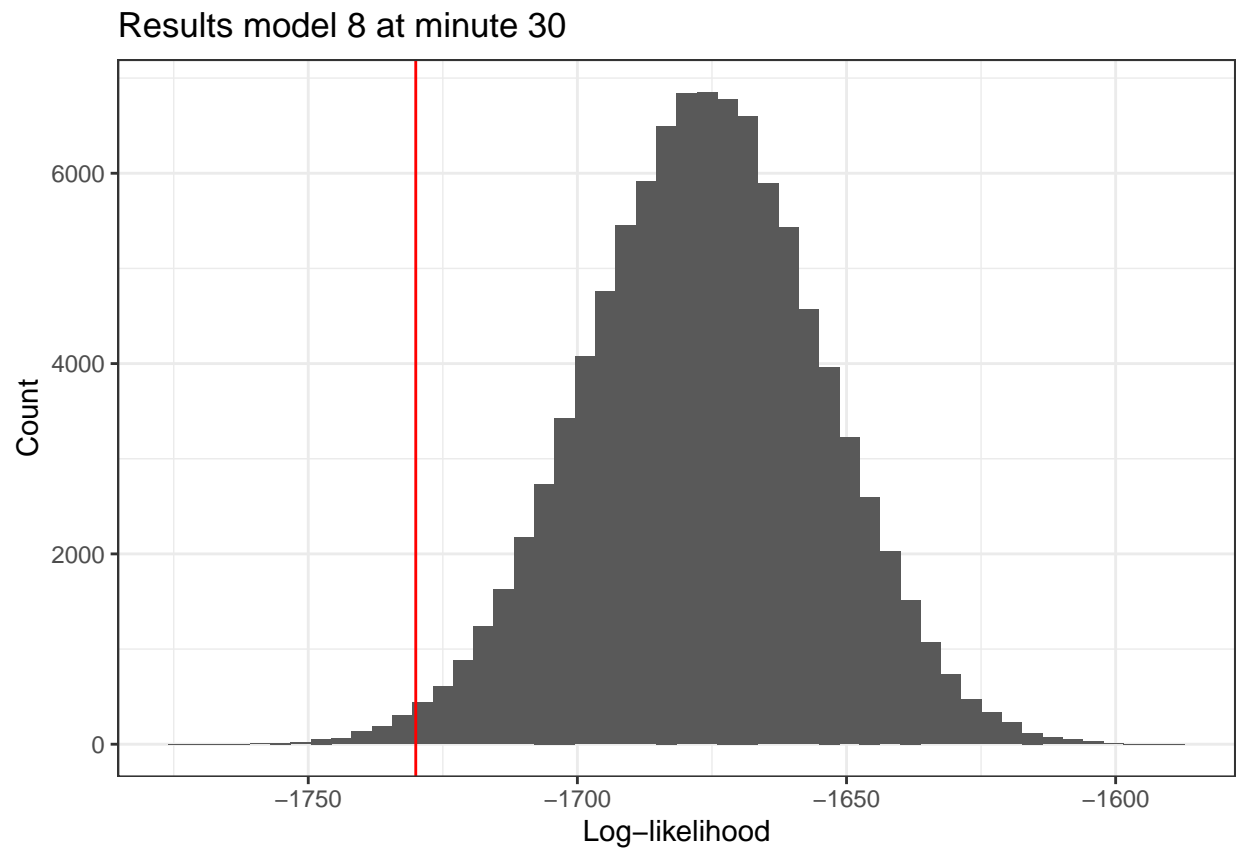

```
sum(sims$pred_30$loglik_results_mod_8 <= loglik_observed_results_mod_8_pred_30) /
  length(sims$pred_30$loglik_results_mod_8)
```

```
## [1] 0.00847
```

```
tibble(x = sims$pred_45$loglik_results_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_8_pred_45, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 8 at minute 45")
```
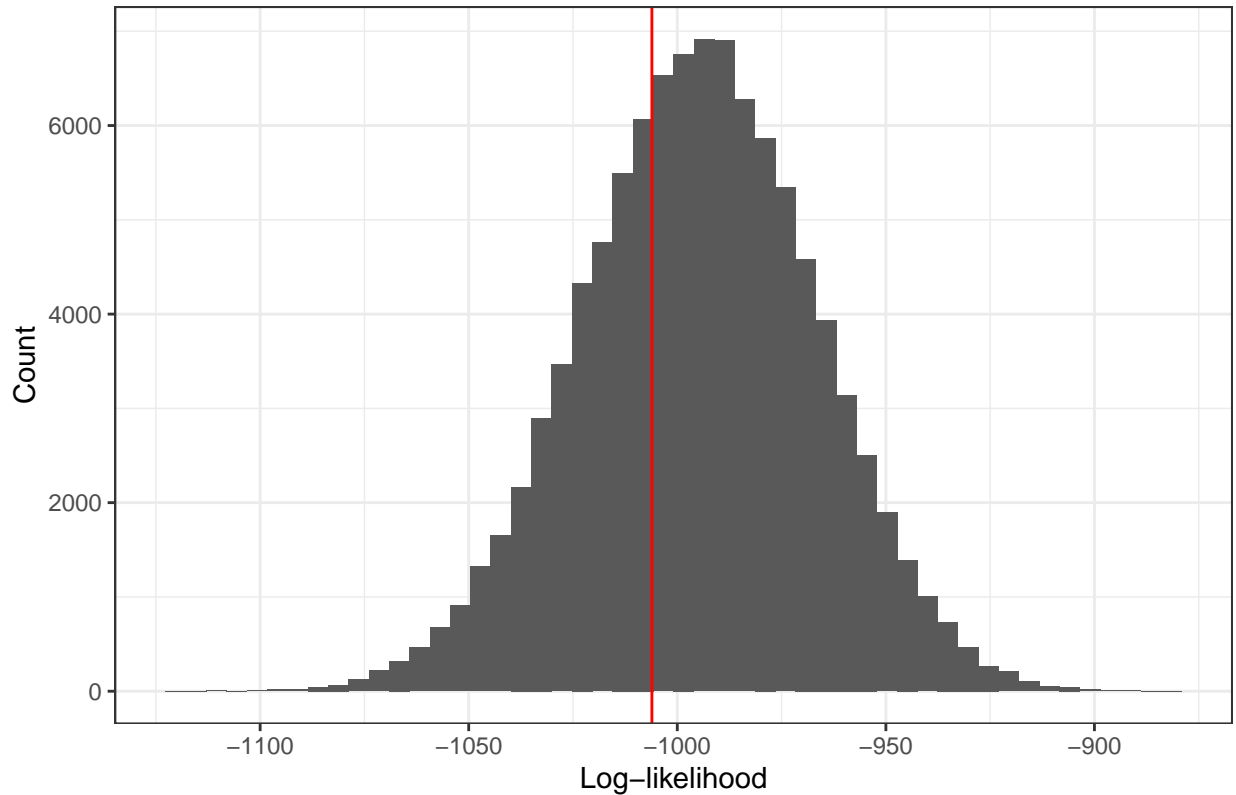


```
sum(sims$pred_45$loglik_results_mod_8 <= loglik_observed_results_mod_8_pred_45) /
  length(sims$pred_45$loglik_results_mod_8)
```

```
## [1] 0.05918
```

```
tibble(x = sims$pred_60$loglik_results_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_8_pred_60, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 8 at minute 60")
```


Results model 8 at minute 60

```
sum(sims$pred_60$loglik_results_mod_8 <= loglik_observed_results_mod_8_pred_60) /
  length(sims$pred_60$loglik_results_mod_8)
```
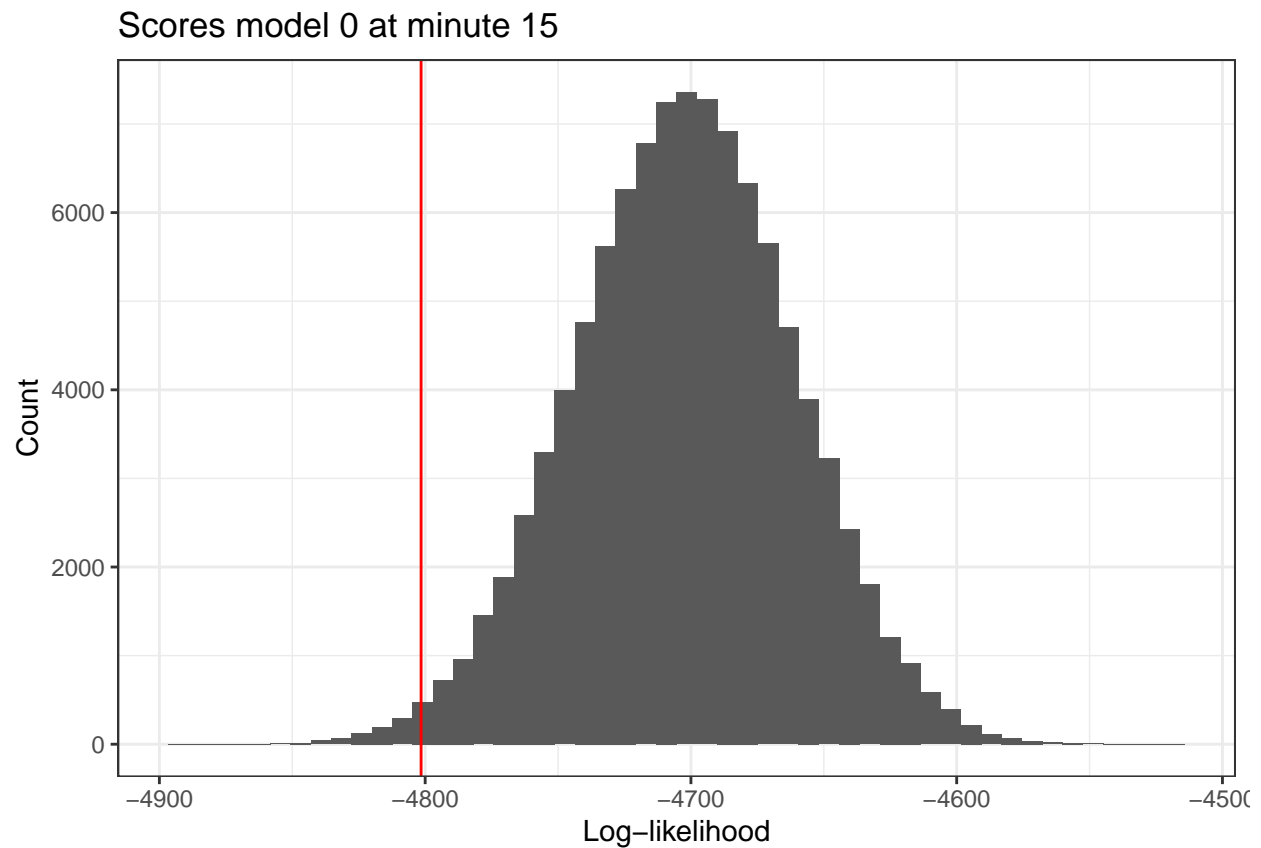
```
## [1] 0.13774
```

```
tibble(x = sims$pred_75$loglik_results_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_results_mod_8_pred_75, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Results model 8 at minute 75")
```

Results model 8 at minute 75


```
sum(sims$pred_75$loglik_results_mod_8 <= loglik_observed_results_mod_8_pred_75) /
  length(sims$pred_75$loglik_results_mod_8)
```
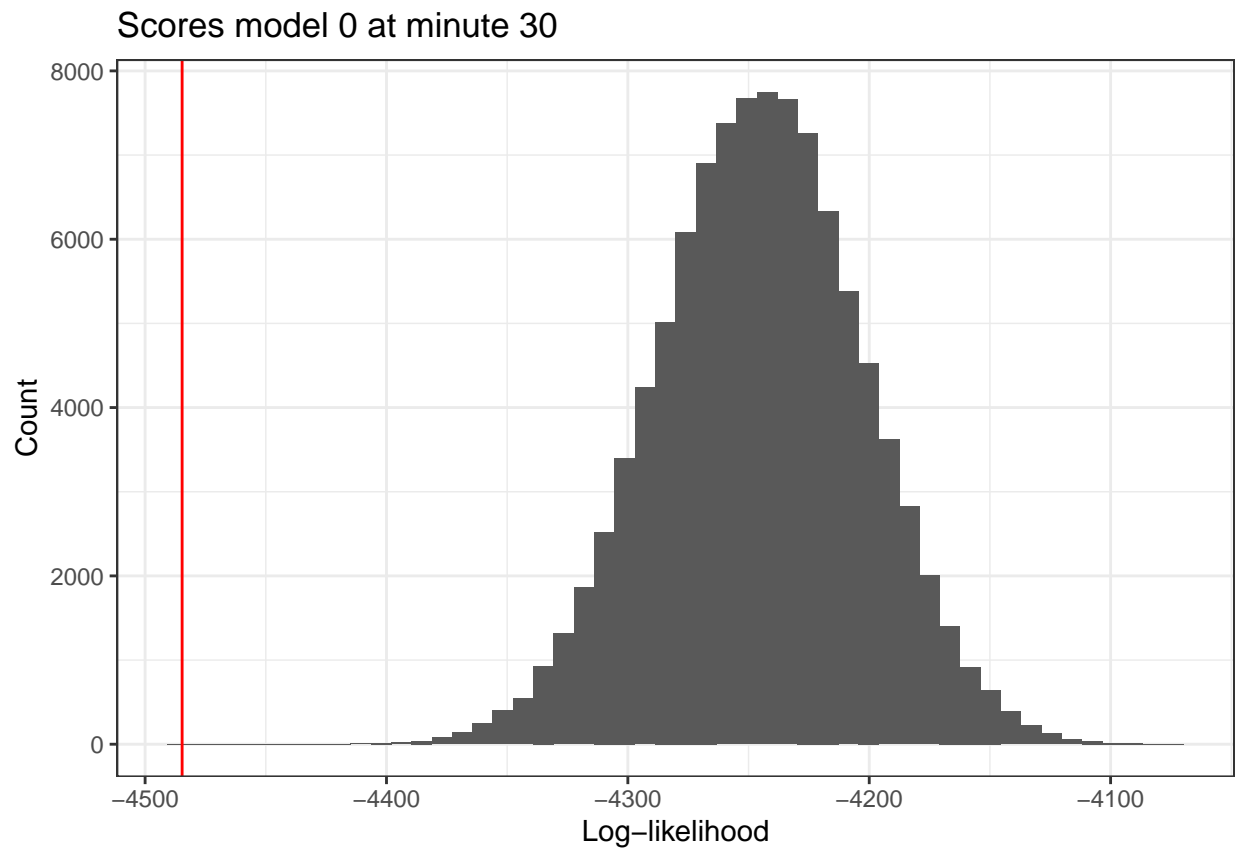
```
## [1] 0.34585
```

```
tibble(x = sims$pred_0$loglik_scores_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_0_pred_0, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 0 at minute 0")
```

Scores model 0 at minute 0
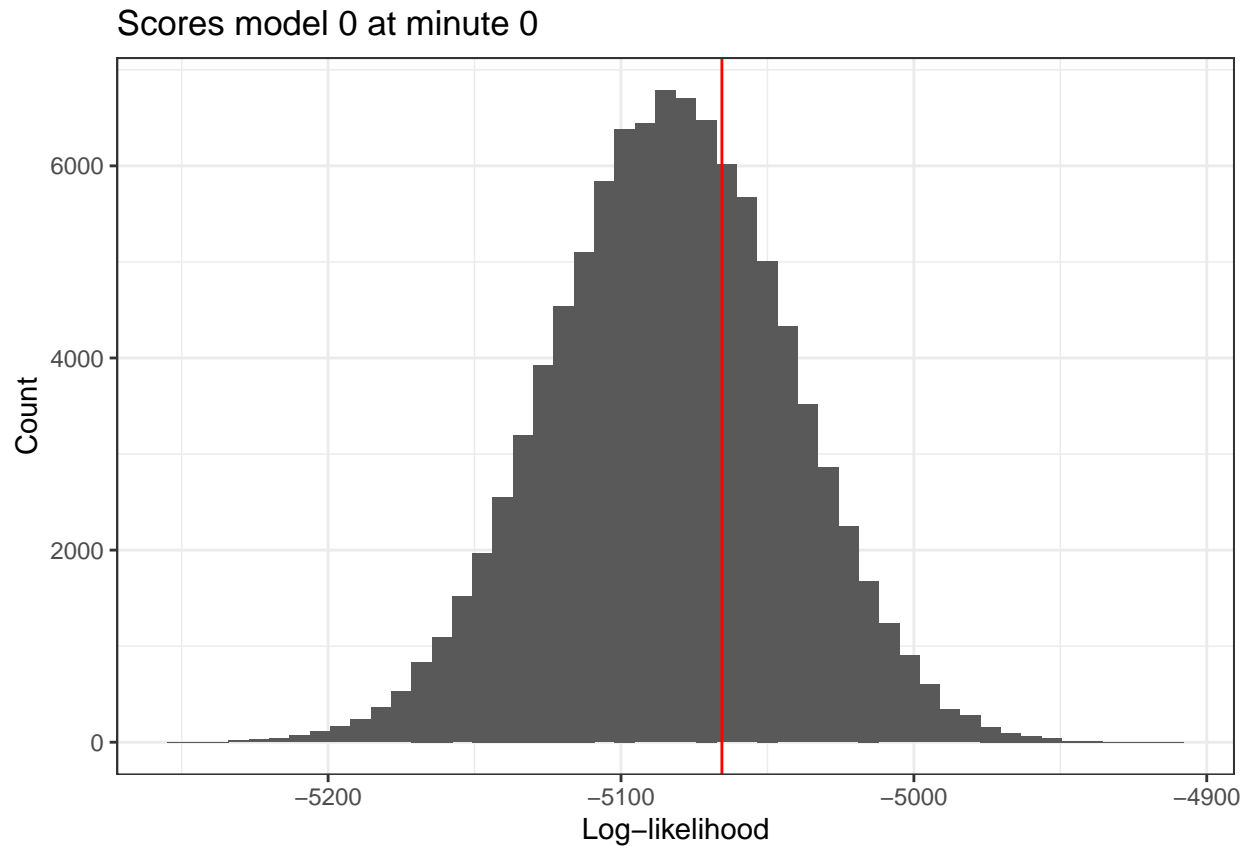

```
sum(sims$pred_0$loglik_scores_mod_0 >= loglik_observed_scores_mod_0_pred_0) /
  length(sims$pred_0$loglik_scores_mod_0)
```

```
## [1] 0.33347
```

```
tibble(x = sims$pred_15$loglik_scores_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_0_pred_15, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 0 at minute 15")
```

Scores model 0 at minute 15


```
sum(sims$pred_15$loglik_scores_mod_0 <= loglik_observed_scores_mod_0_pred_15) /
  length(sims$pred_15$loglik_scores_mod_0)
```
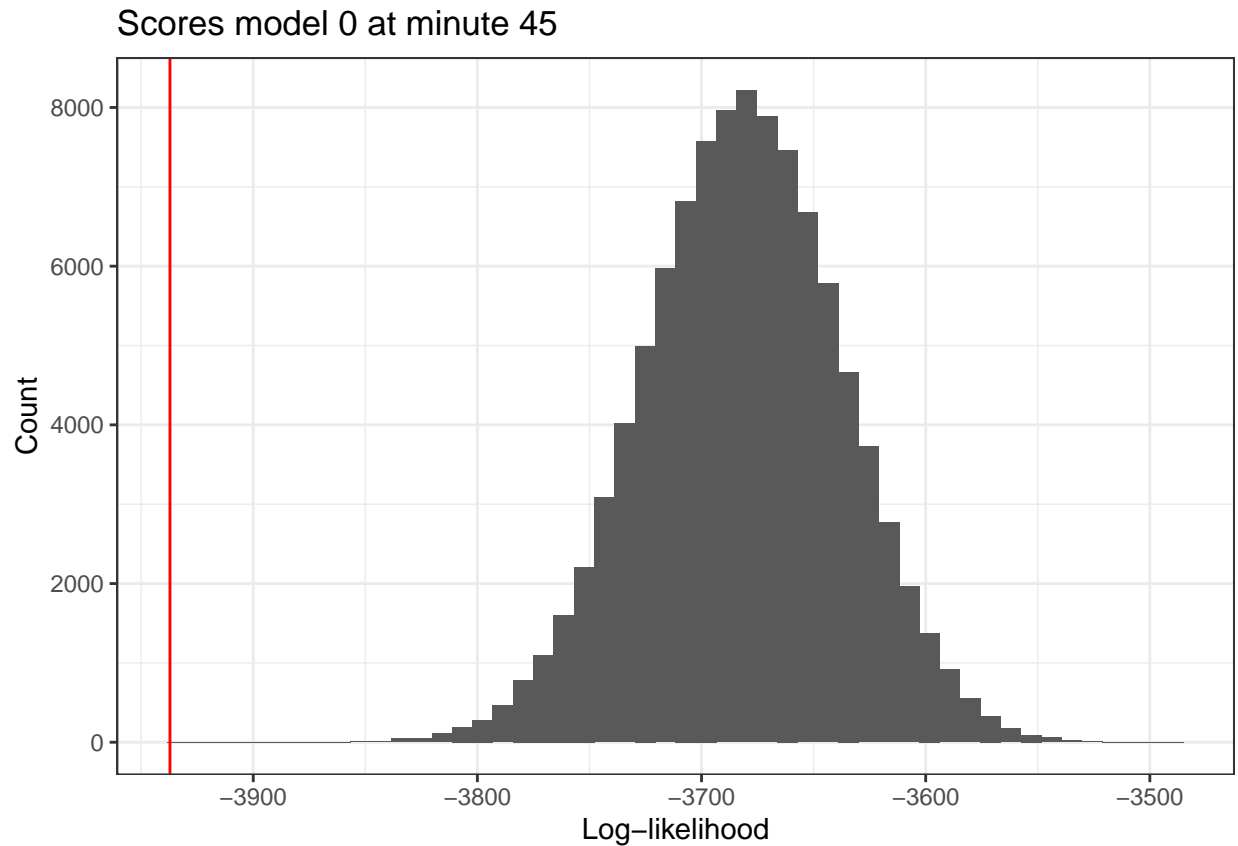
```
## [1] 0.00952
```

```
tibble(x = sims$pred_30$loglik_scores_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_0_pred_30, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 0 at minute 30")
```
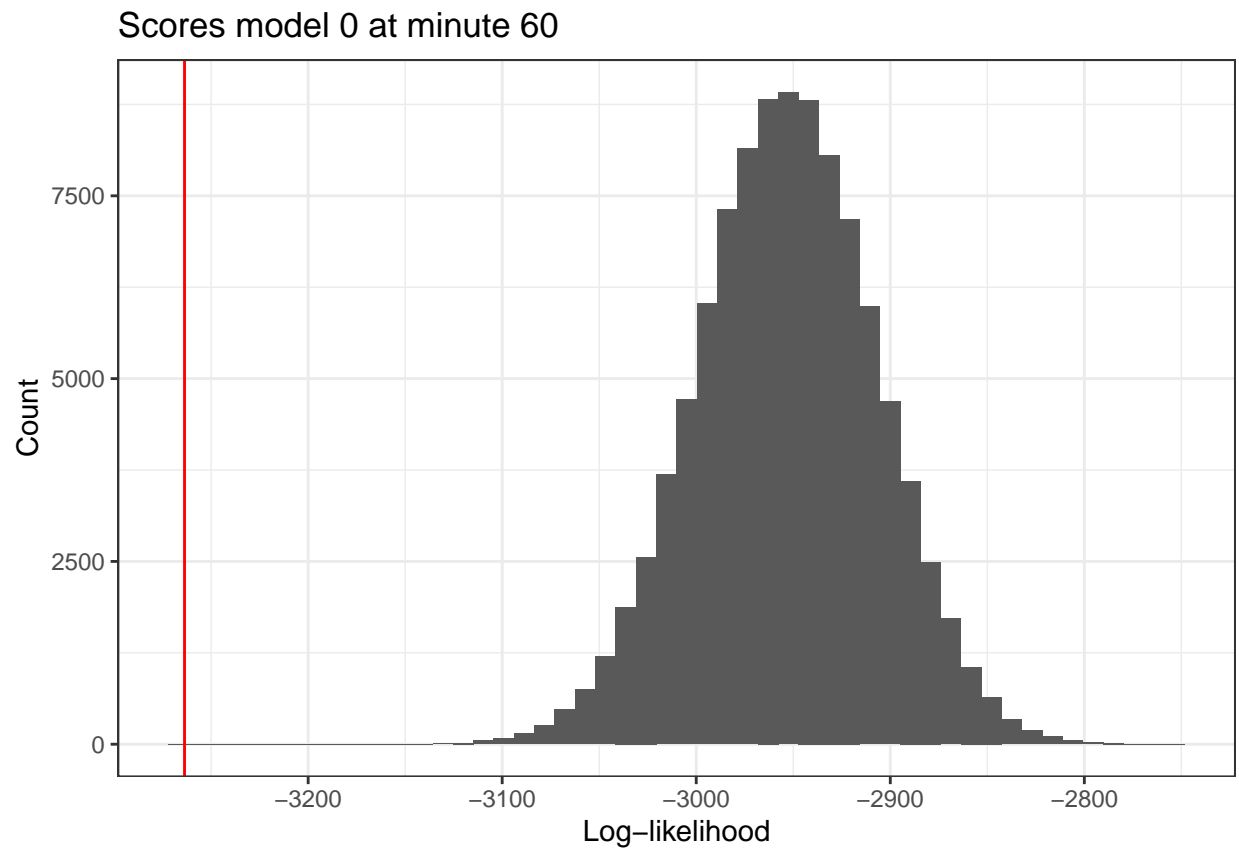
Scores model 0 at minute 30


```
sum(sims$pred_30$loglik_scores_mod_0 <= loglik_observed_scores_mod_0_pred_30) /
  length(sims$pred_30$loglik_scores_mod_0)
```
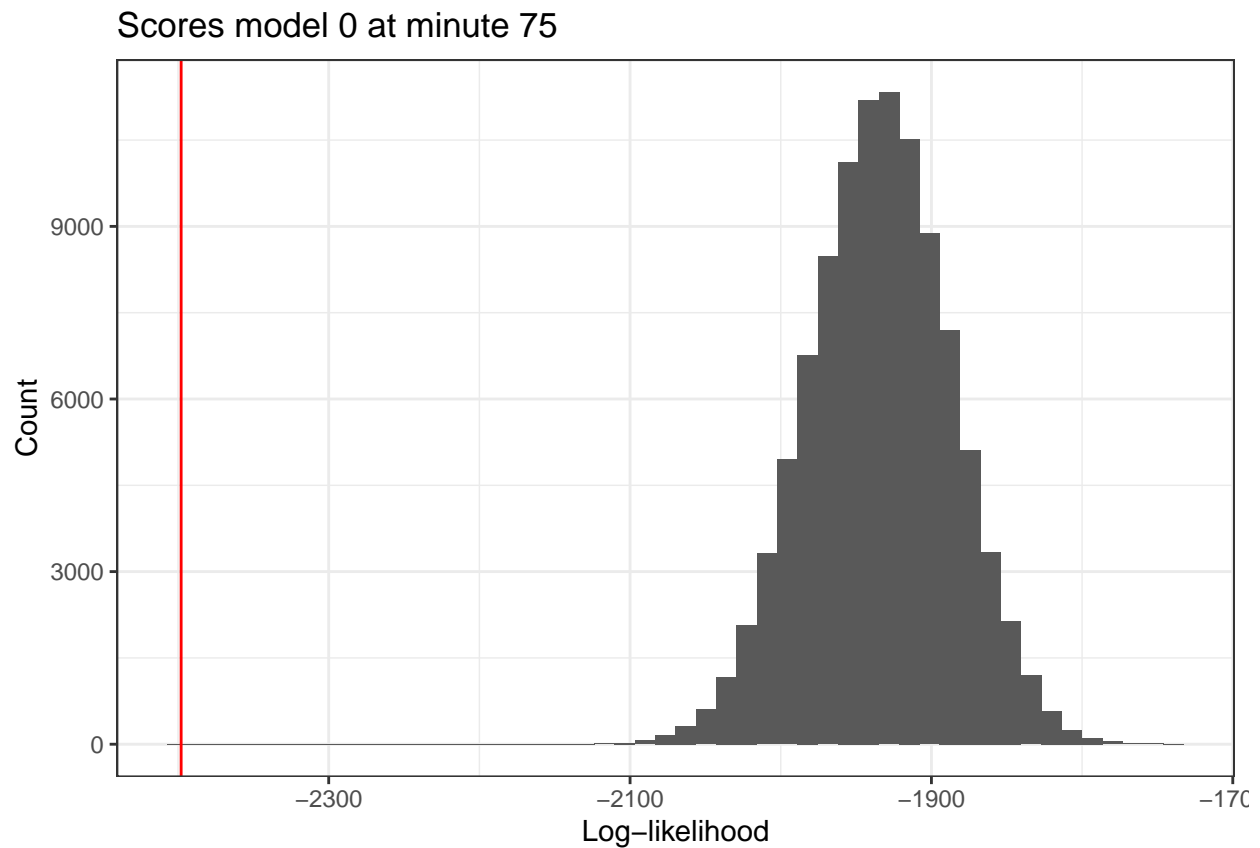
```
## [1] 0
```

```
tibble(x = sims$pred_45$loglik_scores_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_0_pred_45, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 0 at minute 45")
```

Scores model 0 at minute 45


```
sum(sims$pred_45$loglik_scores_mod_0 <= loglik_observed_scores_mod_0_pred_45) /
  length(sims$pred_45$loglik_scores_mod_0)
```
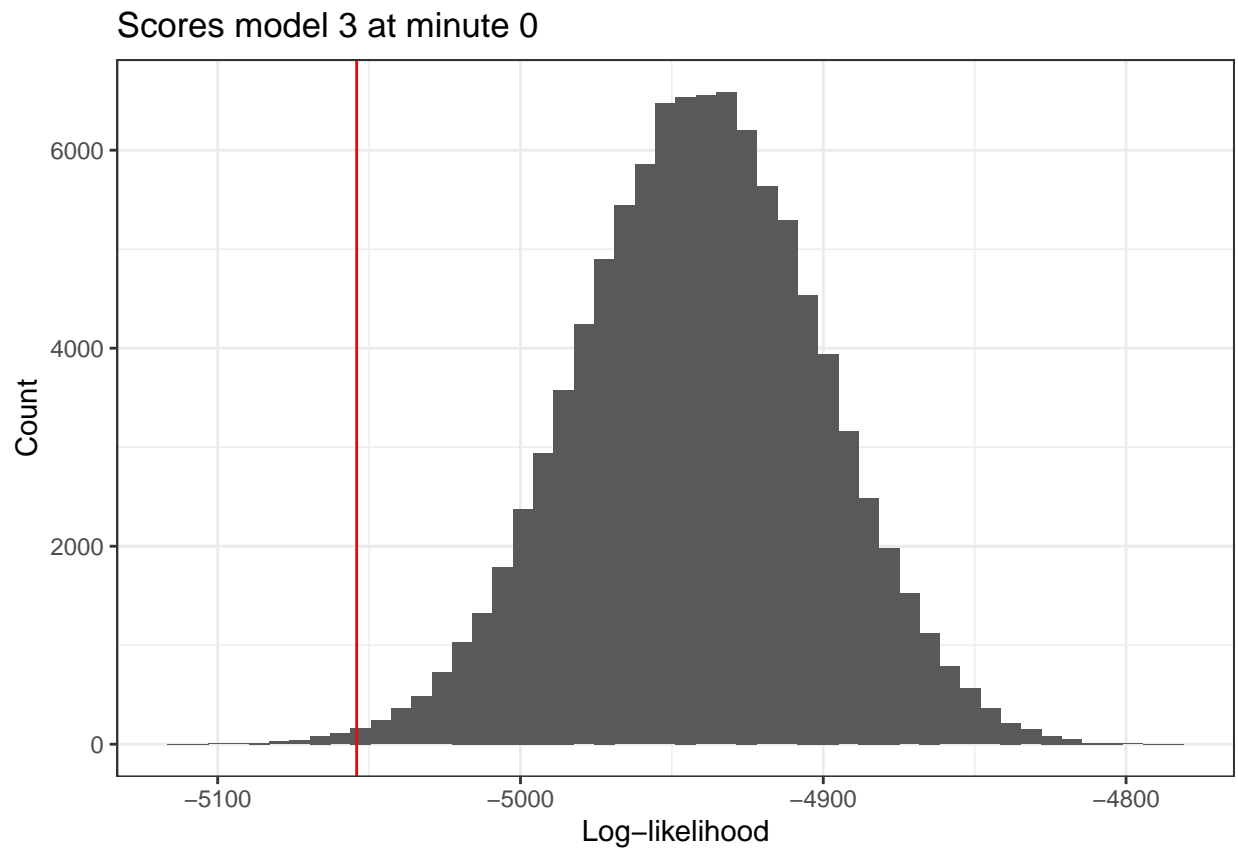
```
## [1] 0
```

```
tibble(x = sims$pred_60$loglik_scores_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_0_pred_60, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 0 at minute 60")
```

Scores model 0 at minute 60


```
sum(sims$pred_60$loglik_scores_mod_0 <= loglik_observed_scores_mod_0_pred_60) /
  length(sims$pred_60$loglik_scores_mod_0)
```

```
## [1] 0
```

```
tibble(x = sims$pred_75$loglik_scores_mod_0) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_0_pred_75, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 0 at minute 75")
```

Scores model 0 at minute 75


```
sum(sims$pred_75$loglik_scores_mod_0 <= loglik_observed_scores_mod_0_pred_75) /
  length(sims$pred_75$loglik_scores_mod_0)
```

```
## [1] 0
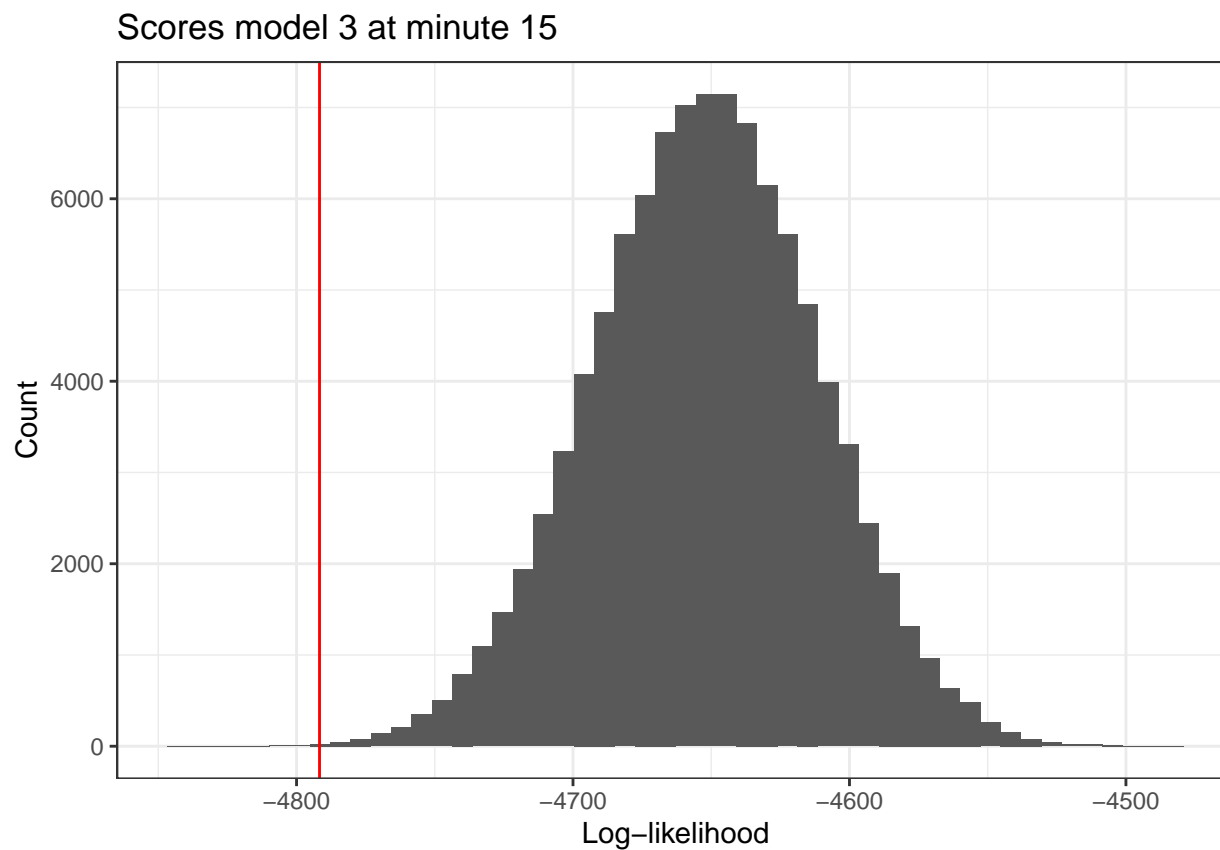```

```
tibble(x = sims$pred_0$loglik_scores_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_3_pred_0, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 3 at minute 0")
```


Scores model 3 at minute 0

```
sum(sims$pred_0$loglik_scores_mod_3 <= loglik_observed_scores_mod_3_pred_0) /
  length(sims$pred_0$loglik_scores_mod_3)
```
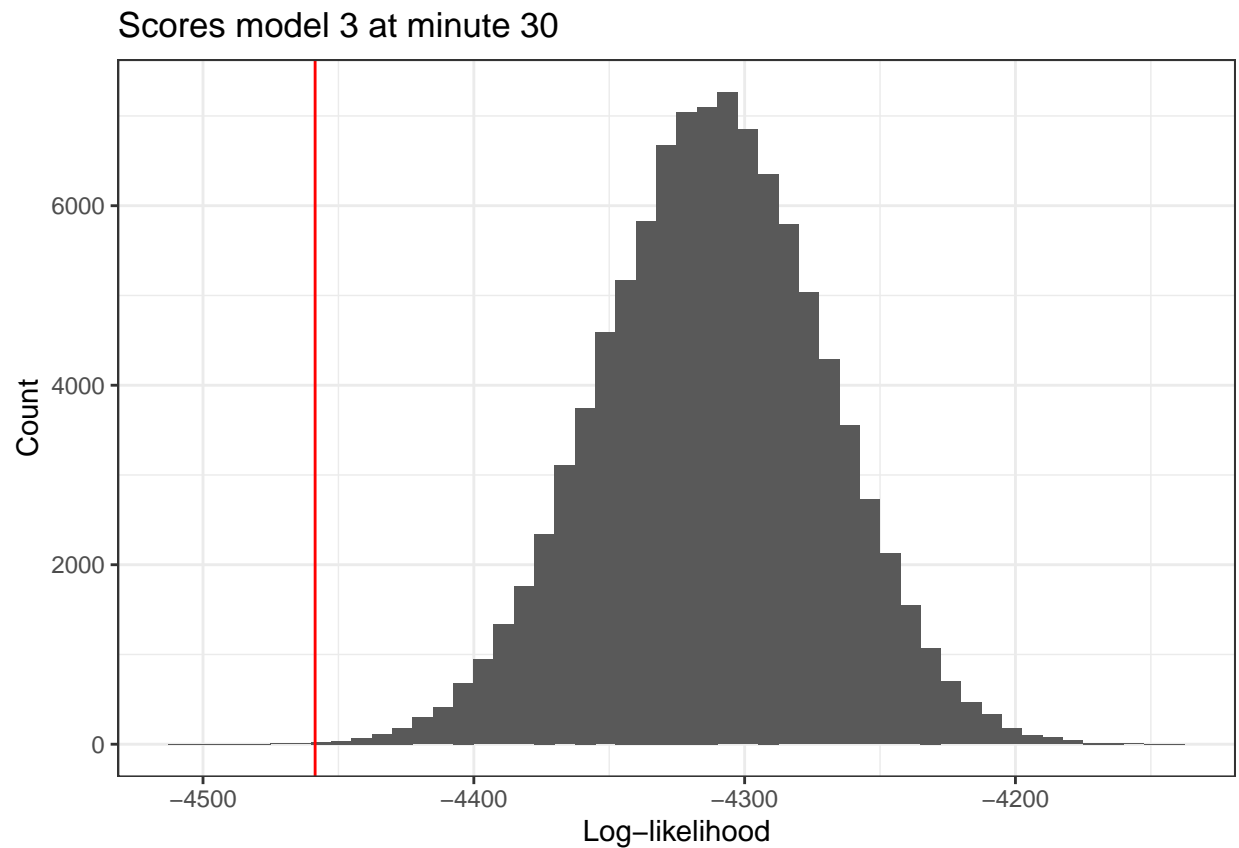
```
## [1] 0.00326
```

```
tibble(x = sims$pred_15$loglik_scores_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_3_pred_15, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 3 at minute 15")
```

Scores model 3 at minute 15


```
sum(sims$pred_15$loglik_scores_mod_3 <= loglik_observed_scores_mod_3_pred_15) /
  length(sims$pred_15$loglik_scores_mod_3)
```
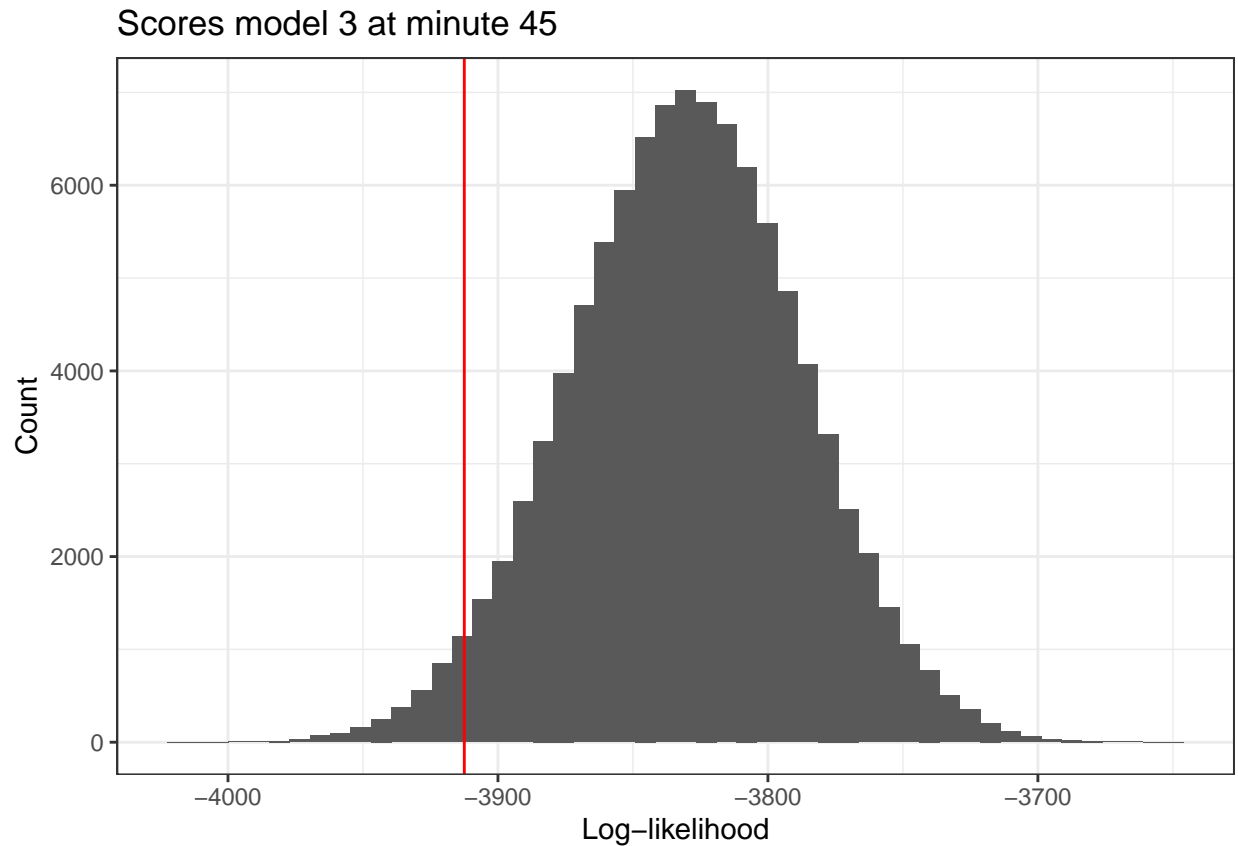
```
## [1] 0.00031
```

```
tibble(x = sims$pred_30$loglik_scores_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_3_pred_30, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 3 at minute 30")
```

Scores model 3 at minute 30


```
sum(sims$pred_30$loglik_scores_mod_3 <= loglik_observed_scores_mod_3_pred_30) /
  length(sims$pred_30$loglik_scores_mod_3)
```
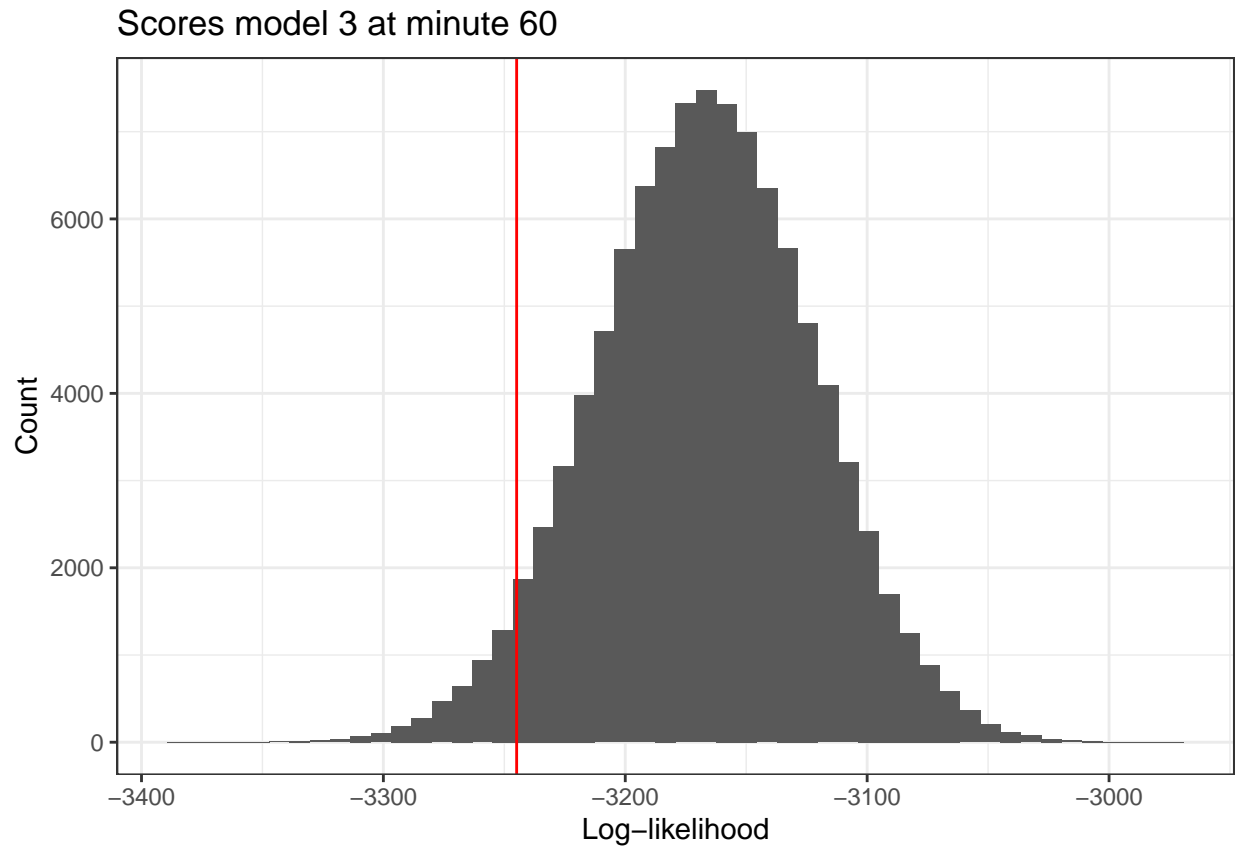
```
## [1] 0.00024
```

```
tibble(x = sims$pred_45$loglik_scores_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_3_pred_45, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 3 at minute 45")
```

Scores model 3 at minute 45


```
sum(sims$pred_45$loglik_scores_mod_3 <= loglik_observed_scores_mod_3_pred_45) /
  length(sims$pred_45$loglik_scores_mod_3)
```
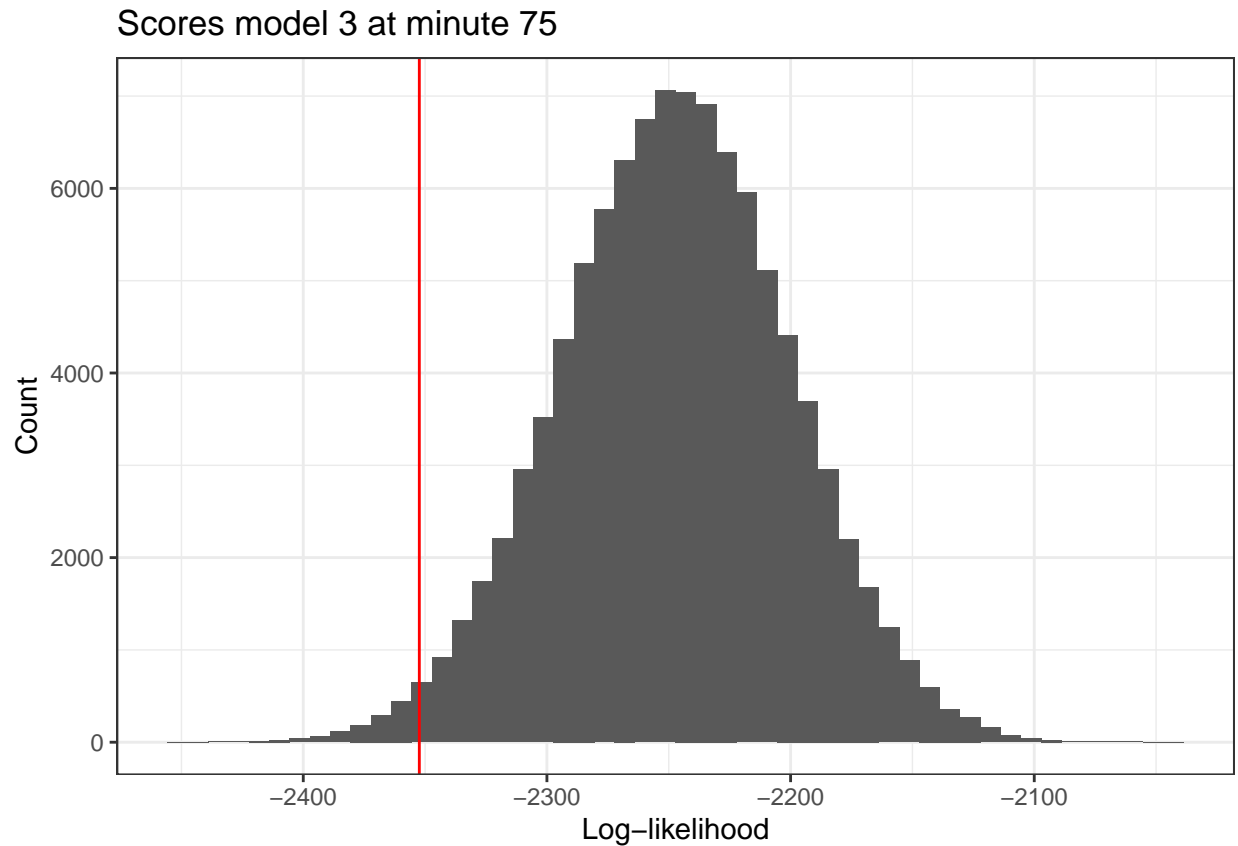
```
## [1] 0.03056
```

```
tibble(x = sims$pred_60$loglik_scores_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_3_pred_60, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 3 at minute 60")
```

Scores model 3 at minute 60


```
sum(sims$pred_60$loglik_scores_mod_3 <= loglik_observed_scores_mod_3_pred_60) /
  length(sims$pred_60$loglik_scores_mod_3)
```

```
## [1] 0.04336
```

```
tibble(x = sims$pred_75$loglik_scores_mod_3) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_3_pred_75, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 3 at minute 75")
```

Scores model 3 at minute 75


```
sum(sims$pred_75$loglik_scores_mod_3 <= loglik_observed_scores_mod_3_pred_75) /
  length(sims$pred_75$loglik_scores_mod_3)
```
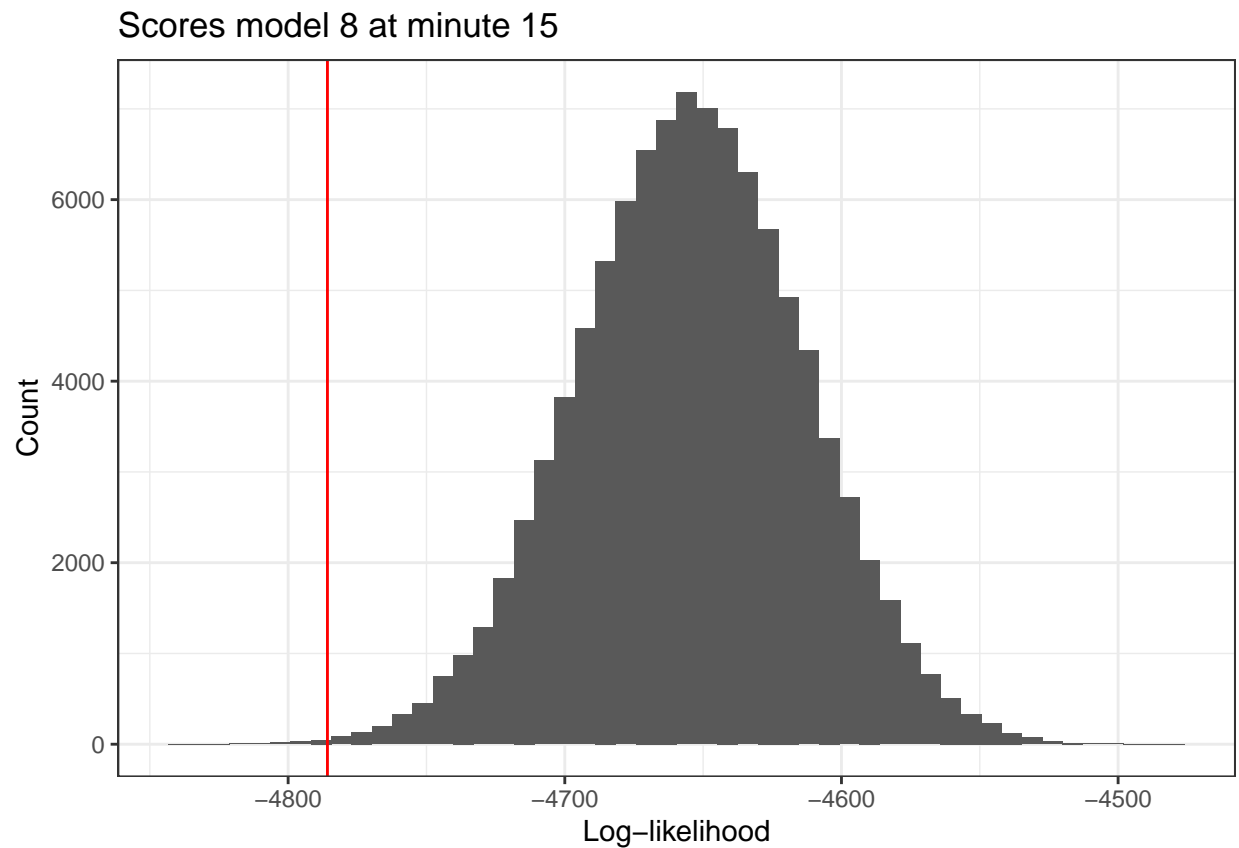
```
## [1] 0.01416
```

```
tibble(x = sims$pred_0$loglik_scores_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_8_pred_0, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 8 at minute 0")
```

Scores model 8 at minute 0


```
sum(sims$pred_0$loglik_scores_mod_8 <= loglik_observed_scores_mod_8_pred_0) /
  length(sims$pred_0$loglik_scores_mod_8)
```
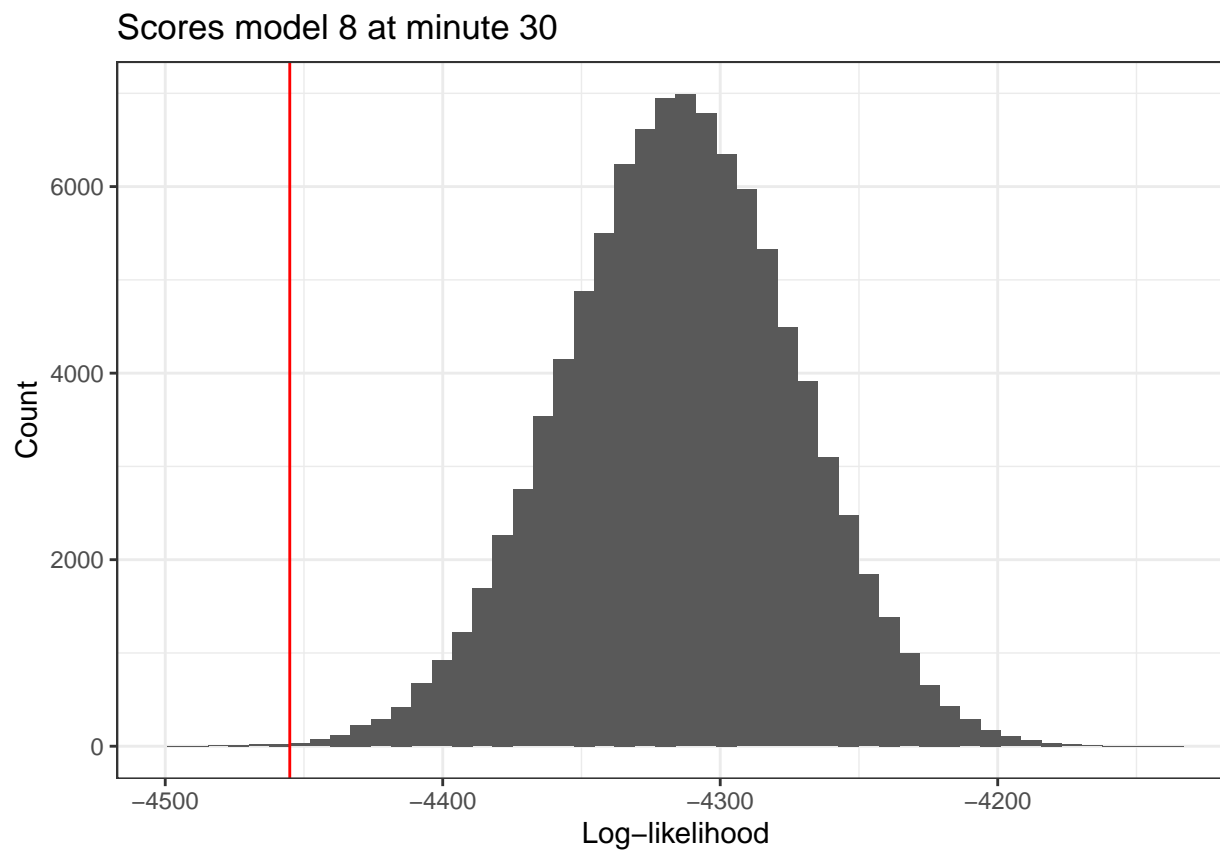
```
## [1] 0.00367
```

```
tibble(x = sims$pred_15$loglik_scores_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_8_pred_15, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 8 at minute 15")
```

Scores model 8 at minute 15


```
sum(sims$pred_15$loglik_scores_mod_8 <= loglik_observed_scores_mod_8_pred_15) /
  length(sims$pred_15$loglik_scores_mod_8)
```
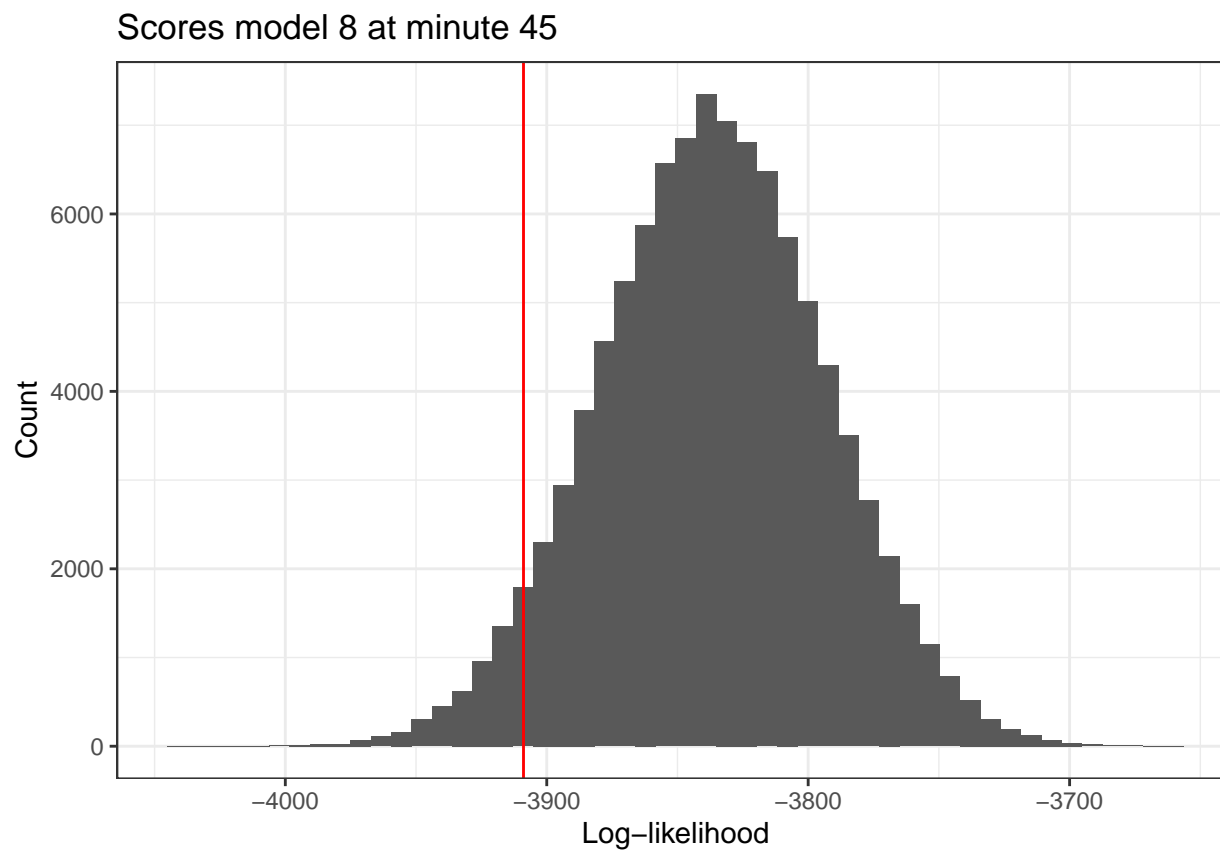
```
## [1] 0.00095
```

```
tibble(x = sims$pred_30$loglik_scores_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_8_pred_30, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 8 at minute 30")
```

Scores model 8 at minute 30


```
sum(sims$pred_30$loglik_scores_mod_8 <= loglik_observed_scores_mod_8_pred_30) /
  length(sims$pred_30$loglik_scores_mod_8)
```
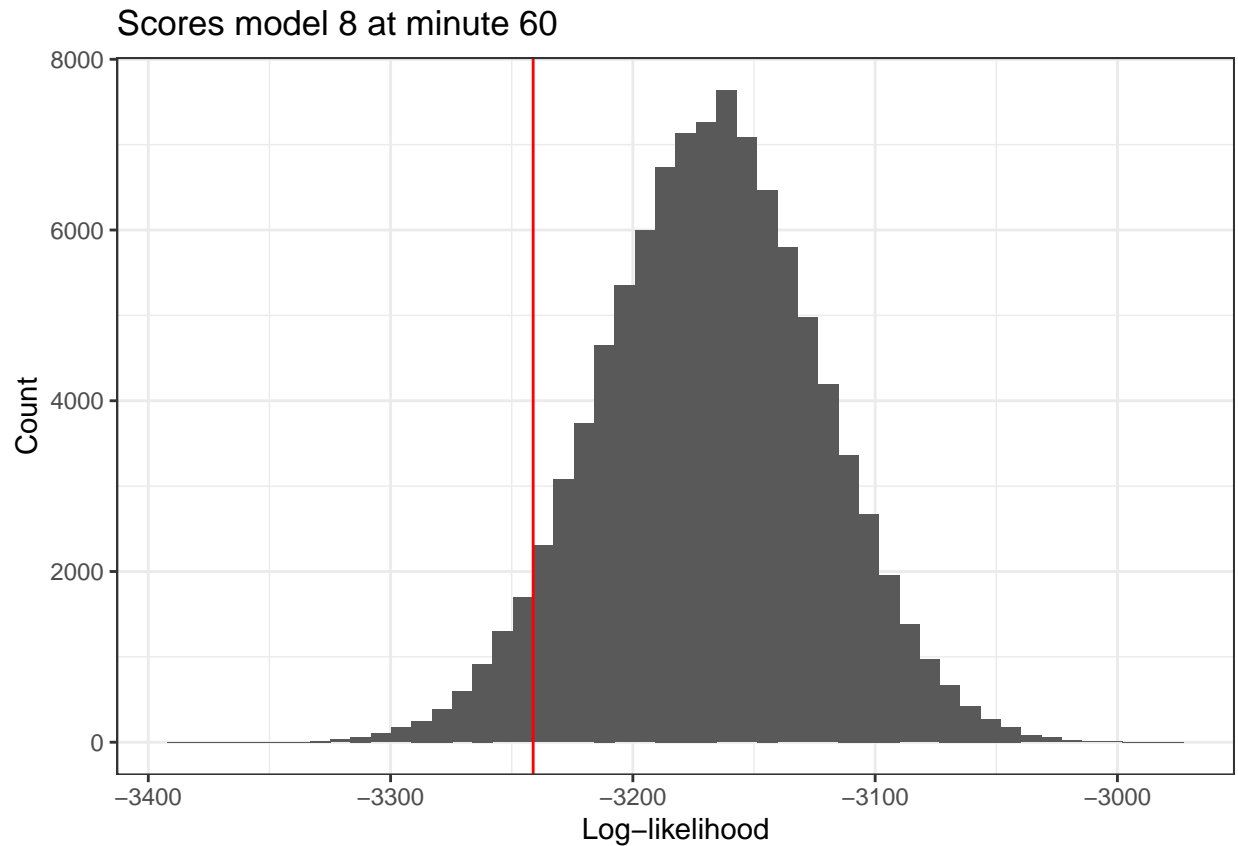
```
## [1] 6e-04
```

```
tibble(x = sims$pred_45$loglik_scores_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_8_pred_45, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 8 at minute 45")
```


Scores model 8 at minute 45

```
sum(sims$pred_45$loglik_scores_mod_8 <= loglik_observed_scores_mod_8_pred_45) /
  length(sims$pred_45$loglik_scores_mod_8)
```

```
## [1] 0.04946
```

```
tibble(x = sims$pred_60$loglik_scores_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_8_pred_60, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 8 at minute 60")
```

Scores model 8 at minute 60


```
sum(sims$pred_60$loglik_scores_mod_8 <= loglik_observed_scores_mod_8_pred_60) /
  length(sims$pred_60$loglik_scores_mod_8)
```

```
## [1] 0.05501
```

```
tibble(x = sims$pred_75$loglik_scores_mod_8) %>%
  ggplot(aes(x = x)) +
  geom_histogram(bins = 50) +
  theme_bw() +
  geom_vline(xintercept = loglik_observed_scores_mod_8_pred_75, col = "red") +
  xlab("Log-likelihood") +
  ylab("Count") +
  ggtitle("Scores model 8 at minute 75")
```

Scores model 8 at minute 75
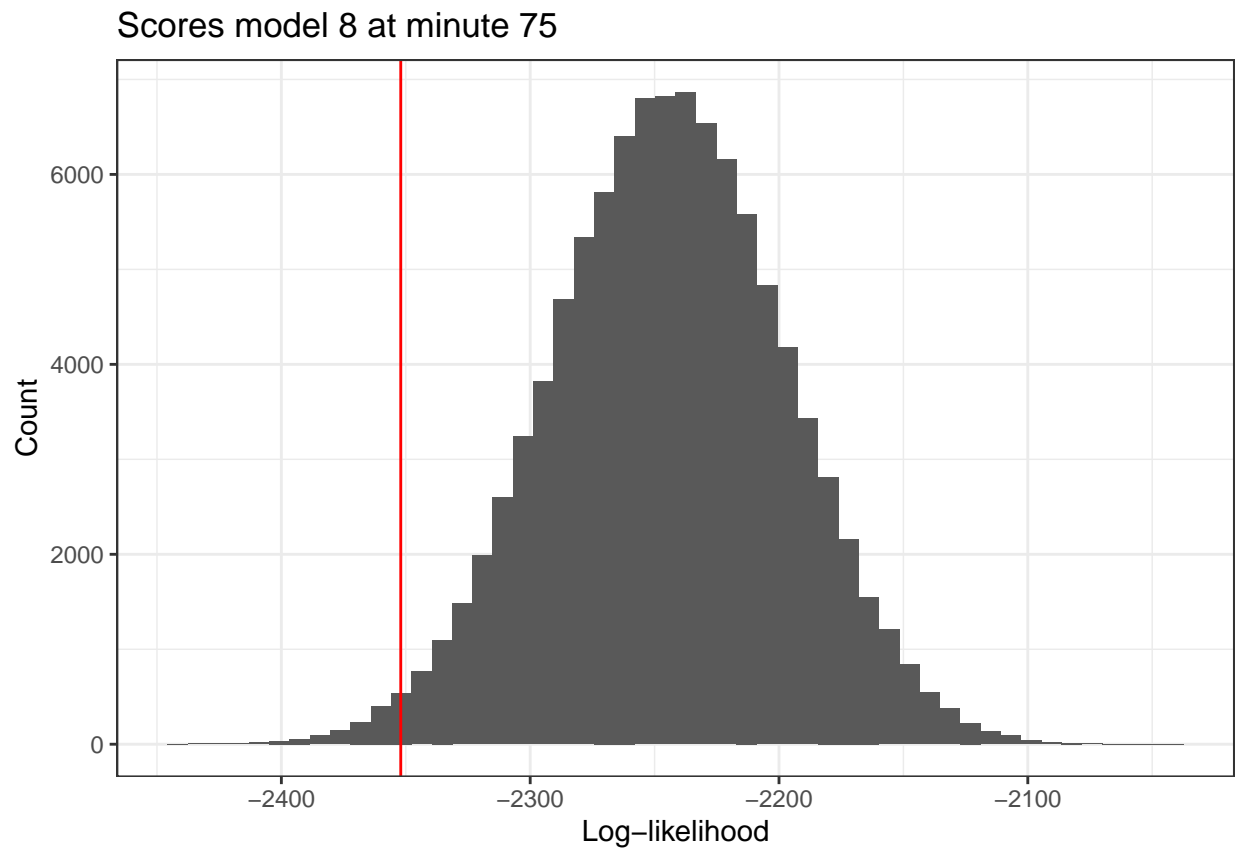

```
sum(sims$pred_75$loglik_scores_mod_8 <= loglik_observed_scores_mod_8_pred_75) /
  length(sims$pred_75$loglik_scores_mod_8)
```

```
## [1] 0.01235
```