Normal model for basketball scores

Basketball scores

This notebook demonstrates simple normal models for describing basketball scores.

```r
library(tibble)
library(ggplot2)
library(cmdstanr)
```

```
## This is cmdstanr version 0.4.0
```

```
## - Online documentation and vignettes at mc-stan.org/cmdstanr
```

```
## - Use set_cmdstan_path() to set the path to CmdStan
```

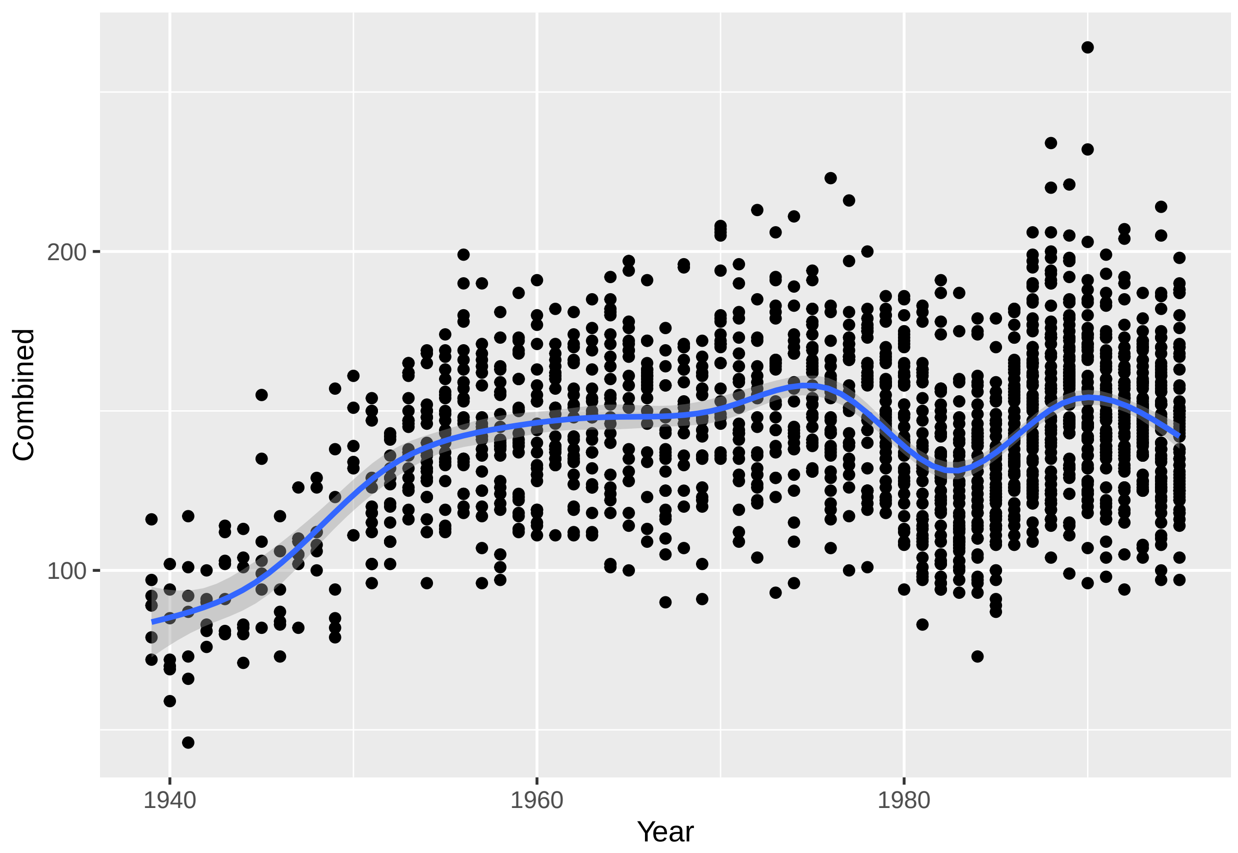
```
## - Use install_cmdstan() to install CmdStan
```

Selecting out modern scores

First, we will prune some of the early years from the data set. As the plot below indicates, scores increased year to year for the first 10 or 15 years of the tournament. After this time, scores were more stable, although there was a drop in typical scores in the early 1980s, likely attributable to the introduction of the three-point shot.

```r
bball <- tibble(read.csv('../../data/basketball.csv'))
ggplot(bball) +
  geom_point(aes(Year, Combined)) +
  geom_smooth(aes(Year, Combined))
```

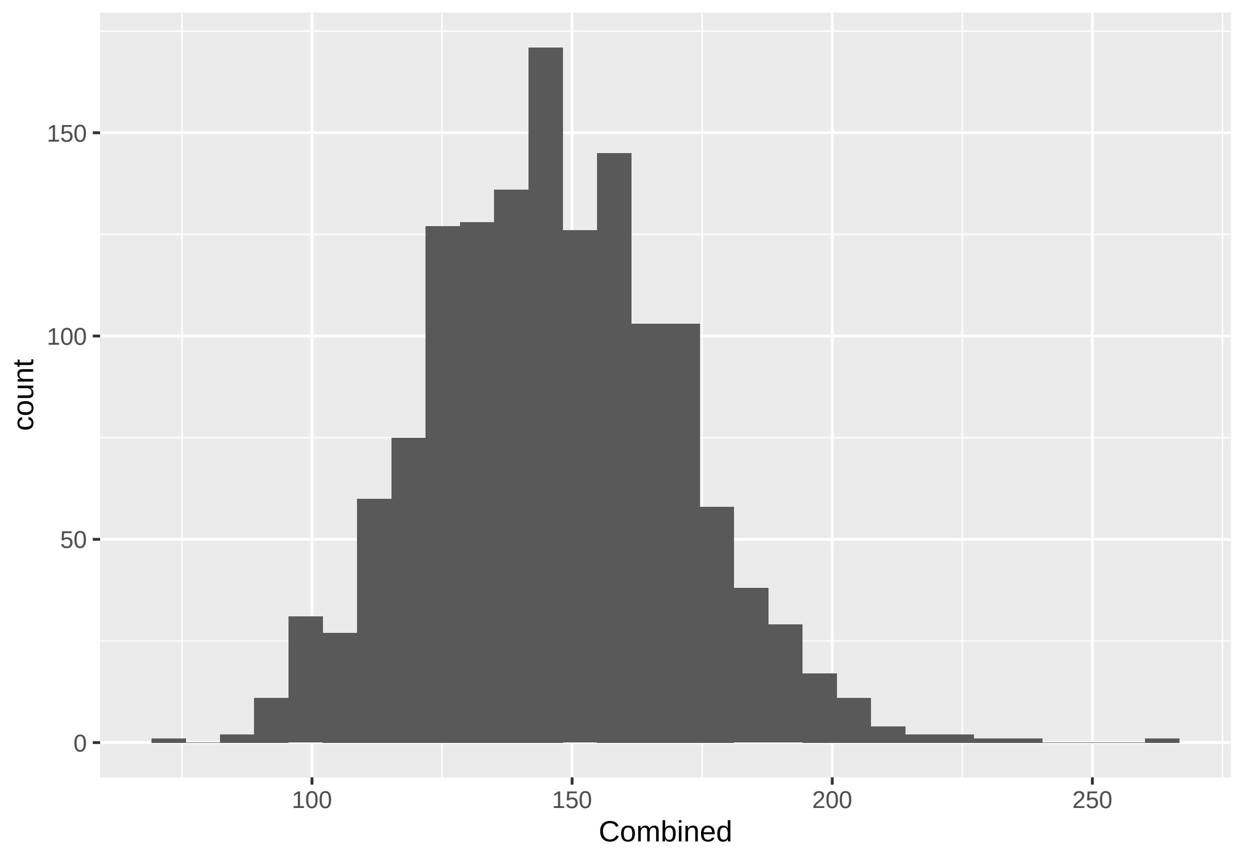
```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Below, a histogram of the scores remaining after we prune years before 1960 suggests a normal distribution of scores. This is to be expected, because a basketball score is a sum of small approximately independent contributions and thus should follow the central limit theorem.

```r
modern_era <- bball[bball$Year > 1960, ]
ggplot(modern_era) + geom_histogram(aes(Combined))
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



Estimating the average score

To fit a model with MCMC, we define it in Stan.

```
data {
int N;
vector[N] score;
}
parameters {
real mu;
real<lower=0> sigma;
}
model {
mu ~ normal(150, 25);
sigma ~ exponential(1);
score ~ normal(mu, sigma);
}
```

```r
set_cmdstan_path('/opt/cmdstan/')
```

```
## CmdStan path set to: /opt/cmdstan
```

```r
mod <- cmdstan_model('basketball.stan')
datalist <- list(N = nrow(modern_era), score = modern_era$Combined)
result <- mod$sample(data = datalist, chains = 4, parallel_chains = 4)
```

```
## Running MCMC with 4 parallel chains...
##
```

```
## Chain 1 Iteration:    1 / 2000 [  0%]  (Warmup)
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## Chain 4 Iteration: 1900 / 2000 [ 95%]  (Sampling)
## Chain 4 Iteration: 2000 / 2000 [100%]  (Sampling)
## Chain 1 finished in 0.1 seconds.
## Chain 2 finished in 0.1 seconds.
## Chain 3 finished in 0.1 seconds.
## Chain 4 finished in 0.1 seconds.
##
## All 4 chains finished successfully.
## Mean chain execution time: 0.1 seconds.
## Total execution time: 0.6 seconds.
```

```
bball.summary <- result$summary()
bball.summary
```

```
## # A tibble: 3 x 10
##   variable    mean  median    sd   mad      q5     q95  rhat ess_bulk ess_tail
##   <chr>      <dbl>   <dbl> <dbl> <dbl>   <dbl>   <dbl> <dbl>    <dbl>    <dbl>
## 1 lp__     -5222.  -5222.  1.01  0.726 -5224.  -5221.   1.00    1916.    2369.
## 2 mu         147.    147.  0.639 0.626   146.    148.   1.00    3519.    2573.
## 3 sigma       24.1    24.1 0.448 0.453    23.3    24.8  1.00    3612.    2766.
```