This report is automatically generated with the R package **knitr** (version `1.24`) .

```
---
#title: STAT 457 Delinquency Problem
#author: Martha Eichlersmith
output:
  pdf_document:
    fig_caption: yes
header-includes:
  - \usepackage{color}
  - \usepackage{mathtools}
  - \usepackage{amsbsy} #bold in mathmode
  - \usepackage{nicefrac} # for nice fracs
  - \usepackage{booktabs}
  - \usepackage{geometry}
  - \usepackage{caption} #to remove automatic table name and number - \captionsetup[table]{labelformat=empty}, put code under ---
  - \usepackage{lastpage} #for pageref*{LastPage} - to get total # of pages
  - \usepackage{fancyhdr}
  - \pagestyle{fancy}
  - \fancyhf{}
  - \fancyhead[L]{STAT 457 Fall 2019 \\ Delinquency Problem}
  - \fancyhead[R]{Martha Eichlersmith \\ Page \thepage\ of\ \pageref*{LastPage}}
  - \setlength{\headheight}{22.5pt} #to remove \fancyhead error for head height
#left-even pages (LE) right-odd pages (RE)
geometry: "left=0.75in,right=0.75in,top=1.1in,bottom=1in"

---

\captionsetup[table]{labelformat=empty}
```{r setup, echo=FALSE, results="hide", warning=FALSE, message=FALSE}
library(ggplot2) #ggplot
library(readr) #import CSV
library(gridExtra) #organize plots
library(grid) #organize plots
library(latex2exp) #latex in ggplot titles
library(gtable) #for tablegrob functions
#library(kableExtra) #for kable functions
library(dplyr) #for piping
library(MCMCpack) #for dirichelt
knitr::opts_chunk$set(fig.width = 10, fig.height = 4)
knitr::opts_chunk$set(echo=FALSE)
decimal <- function(x, k) trimws(format(round(x, k), nsmall=k))
dec <- 3
#knitr::opts_chunk$set(echo=FALSE) #using knitr for this option but don't have to load
```

Is my little brother a delinquent?

```{r Counts}
alpha <-  c(127, 123, 93, 17) #most delinquent
gamma <-  c(345, 209, 158, 65)  #least delinquent

table <- rbind( alpha, gamma)
rownames(table) <- c("Most Delinquent", "Least Delinquent")
colnames(table) <- c("Oldest", "In-between", "Youngest", "Only Child")

knitr::kable(table, booktabs=TRUE, 'latex', digits=dec, caption="Raw Data") %>%
  kableExtra::kable_styling(latex_options="hold_position" )
```
Using the above data, we want to know if birth order affects delinquency in boys. Looking at the raw data row proportions it appears that the oldest an
```{r func_tableparam}
#FUNCTION: PUT PARAMETERS INTO TABLE
func_tableparam <- function(parameters, name){
diff <- parameters[1,]- parameters[2,]
table <- rbind( parameters, diff)
rownames(table) <- c("Most Delinquent", "Least Delinquent", "Difference (Most - Least)")
colnames(table) <- c("Oldest", "In-between", "Youngest", "Only Child")
knitr::kable(table, booktabs=TRUE, 'latex', digits=dec, caption=paste(name)) %>%
  kableExtra::kable_styling(latex_options="hold_position" )
}

func_tableparam(rbind(alpha/sum(alpha), gamma/sum(gamma)), "Row Proportions")
```


\newpage
Bayesian


```{r func_values}
#FUNCTION: RETURN IT, MEAN, CI, AND PVALUE
func_values <- function(vec){
  it <- length(vec)
  CI.val <- decimal(quantile(vec, c(0.025, 0.975)), dec)
  CI.95 <- paste("(", paste(CI.val, collapse=", "), ")")
  mean <- decimal(mean(vec), dec)
  pval <- decimal(min(length(vec[vec > 0])/it, 1 - length(vec[vec > 0])/it), dec)
  vec <- c(it, mean, CI.95, pval)
  vec
}
```
```{r func_delinq}
#FUNCTION: SIMIULATE VALUES
func_delinq <- function(it, alpha, gamma){
set.seed(050104)
```
```

```
prop.alpha <- rdirichlet(it, alpha)
prop.gamma <- rdirichlet(it, gamma)
diff <- cbind( #most - least
   prop.alpha[,1] - prop.gamma[,1] #diff for Oldest
  ,prop.alpha[,2] - prop.gamma[,2] #diff for in-between
  ,prop.alpha[,3] - prop.gamma[,3] #diff for youngest
  ,prop.alpha[,4] - prop.gamma[,4] #diff for only-child
   )
apply(diff, 2, func_values)
}
```

```{r func_table}
#FUNCTION: put into a table
func_table <- function(i, name, it.1, it.2, it.3){
table <- cbind(it.1[,i], it.2[,i] , it.3[,i])
rownames(table) <- c("Iterations", "Mean", "95% CI", "pval")
title <- paste("Difference in Proportion for", name, ": Most Delinquent - Least Delinquent")

knitr::kable(table, booktabs=TRUE, 'latex', digits=dec, caption=paste(title)) %>%
  kableExtra::kable_styling(latex_options="hold_position" )
}
```

```{r func_chisq}
#FUNCTION: CHI SQUARE - COMBINING P-VALUES
func_pval.chisq <- function(pvals){
  x <- -2*sum(log(as.numeric(pvals)))
  combined.pval <-  1- pchisq(x, 2*length(pvals))
}
```

```{r func_combinedpval}
#FUNCTION: COMBINE THE P-VALUES INTO TABLE
func_combinedpval <- function(it.1, it.2, it.3){
pvals.matrix <- cbind(  as.numeric(it.1[4,])
                      , as.numeric(it.2[4,])
                      , as.numeric(it.3[4,])
)

combined <- apply(pvals.matrix, 2, func_pval.chisq)
combined.pvals <- rbind(it.vec, decimal(combined, 10))
rownames(combined.pvals) <- c("Iterations", "Combined p-value")

title <- paste("Combined p-values:","$X = -2\\sum_{i=1}^4(p_i) \\sim \\chi^2_{df=8}$")
knitr::kable(combined.pvals, booktabs=TRUE, 'latex', caption=paste(title)) %>%
  kableExtra::kable_styling(latex_options="hold_position" )
}
```

```{r bayesRESULTS}

it.vec <- c(1e04, 1e05, 1e06)
it1 <- func_delinq(it.vec[1], alpha, gamma)
it2 <- func_delinq(it.vec[2], alpha, gamma)
it3 <- func_delinq(it.vec[3], alpha, gamma)

func_table(1, "Oldest", it1, it2, it3)
func_table(2, "In-Between", it1, it2, it3)
func_table(3, "Youngest", it1, it2, it3)
func_table(4, "Only", it1, it2, it3)
func_combinedpval(it1, it2, it3)
```

Using simulations, the results support the hypothesis that delinquency levels are higher in middle and younger sons but lower in oldest and only sons.

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Frequentest Tests

Proportion Test for Specific Birth Order

```{r func_proptest}
func_proptest <- function(c, alt, name){
table2x2 <- matrix(c(alpha[c], sum(alpha), gamma[c], sum(gamma)), nrow=2, byrow=TRUE)
test <- prop.test(table2x2, alternative=alt)
X.squared <- decimal(test$statistic, dec)
p.value <- decimal(test$p.value, dec)
alternative <- test$alternative
results <- cbind(X.squared, p.value, alternative)
rownames(results) <-c("")
title <- paste("Difference in Proportion for", name, ": Most Delinquent - Least Delinquent")
knitr::kable(results, booktabs=TRUE, 'latex', caption=paste(title)) %>%
  kableExtra::kable_styling(latex_options="hold_position" )
}
```

```{r freqRESULTS1}
func_proptest(1, 'less',"Only")
func_proptest(2, 'greater',"Only")
func_proptest(3, 'greater',"Only")
func_proptest(4, 'less',"Only")
```

Chi-Sq test for Independence

```{r freqRESULTS2}
parameters <- rbind(alpha, gamma)
chisq.test(parameters)
```

Using traditional frequentest test, the results are the same: delinquency levels are higher in middle and younger sons but lower in oldest and only sons

Conclusion

```
Using the data provided, there is strong evidence that younger sons are more likely to be a delinquent.  So even though my brother is not is a delinquen


```{r}
#PRINTING THE CODE
#knitr::stitch("HW06.Rmd") to go to latex
knitr::stitch(   script="DelinquencyProblem.Rmd"  , system.file("misc", "knitr-template.Rhtml", package="knitr")) #code to HTML
```
```

```
## Error: <text>:8:5: unexpected input
## 7: header-includes:
## 8:   - \
##        ^
```

The R session information (including the OS info, R version and all packages used):

```
    sessionInfo()
```

```
## R version 3.6.1 (2019-07-05)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 10 x64 (build 17763)
##
## Matrix products: default
##
## locale:
## [1] LC_COLLATE=English_United States.1252  LC_CTYPE=English_United States.1252
## [3] LC_MONETARY=English_United States.1252 LC_NUMERIC=C
## [5] LC_TIME=English_United States.1252
##
## attached base packages:
## [1] grid      stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] invgamma_1.1        MCMCpack_1.4-4      MASS_7.3-51.4       coda_0.19-3
##  [5] gtable_0.3.0        numDeriv_2016.8-1.1 matlib_0.9.2        readr_1.3.1
##  [9] dplyr_0.8.3         latex2exp_0.4.0     gridExtra_2.3       ggplot2_3.2.1
## [13] knitr_1.24
##
## loaded via a namespace (and not attached):
##  [1] httr_1.4.1              jsonlite_1.6            viridisLite_0.3.0
##  [4] carData_3.0-2           shiny_1.3.2             assertthat_0.2.1
##  [7] highr_0.8               cellranger_1.1.0        yaml_2.2.0
## [10] pillar_1.4.2            backports_1.1.4         lattice_0.20-38
## [13] quantreg_5.51           glue_1.3.1              digest_0.6.20
## [16] manipulateWidget_0.10.0 promises_1.0.1          rvest_0.3.4
## [19] colorspace_1.4-1        htmltools_0.3.6         httpuv_1.5.1
## [22] Matrix_1.2-17           pkgconfig_2.0.2         SparseM_1.77
## [25] haven_2.1.1             purrr_0.3.2             xtable_1.8-4
## [28] scales_1.0.0            webshot_0.5.1           openxlsx_4.1.0.1
## [31] later_0.8.0             rio_0.5.16              MatrixModels_0.4-1
## [34] tibble_2.1.3            car_3.0-3               withr_2.1.2
## [37] lazyeval_0.2.2          magrittr_1.5            crayon_1.3.4
## [40] readxl_1.3.1            mime_0.7                mcmc_0.9-6
## [43] evaluate_0.14           forcats_0.4.0           xml2_1.2.2
## [46] foreign_0.8-71          tools_3.6.1             data.table_1.12.4
## [49] hms_0.5.0               stringr_1.4.0           munsell_0.5.0
## [52] zip_2.0.4               kableExtra_1.1.0        compiler_3.6.1
## [55] rlang_0.4.0             rstudioapi_0.10         htmlwidgets_1.5.1
## [58] crosstalk_1.0.0         miniUI_0.1.1.1          labeling_0.3
## [61] rmarkdown_1.14          abind_1.4-5             curl_4.2
## [64] R6_2.4.0                zeallot_0.1.0           stringi_1.4.3
## [67] Rcpp_1.0.2              vctrs_0.2.0             rgl_0.100.30
## [70] tidyselect_0.2.5        xfun_0.8
```

```
    Sys.time()
```

```
## [1] "2019-12-09 17:46:27 CST"
```