Test STATS 769 Data Science Practice 9:05-9:55am Wednesday 21 October

1. Briefly explain how you would calculate a cross-validated estimate of prediction error in a linear regression. Is this estimate likely to be smaller or greater than the in-sample error?

2. (a) I fit a neural network (using the `nnet()` function). I then fit the model again using identical code. But the residual sum of squares from the second fit is different from that from the first fit! What is going on? Have I made a mistake?

(b) I fit a neural network using the code

```
nnet(y~.,  data = data.df,  size=10)
```

What is the significance of the argument `size=10`? If you increase the value of `size`, would you expect the residual sum of squares to increase or decrease?

3. Explain the differences in the recursive partitioning algorithm for fitting trees (a) when doing prediction of a continuous outcome, and (b) when doing classification.

4. Figure 1 shows the content of a JSON file, `"data.json"` and the following code reads this file into R.

```
> library(jsonlite)
> crimes <- fromJSON("data.json")
```

Write down what the result of the following R code would be.

```
> crimes
```

Write down what the result of the following R code would be.

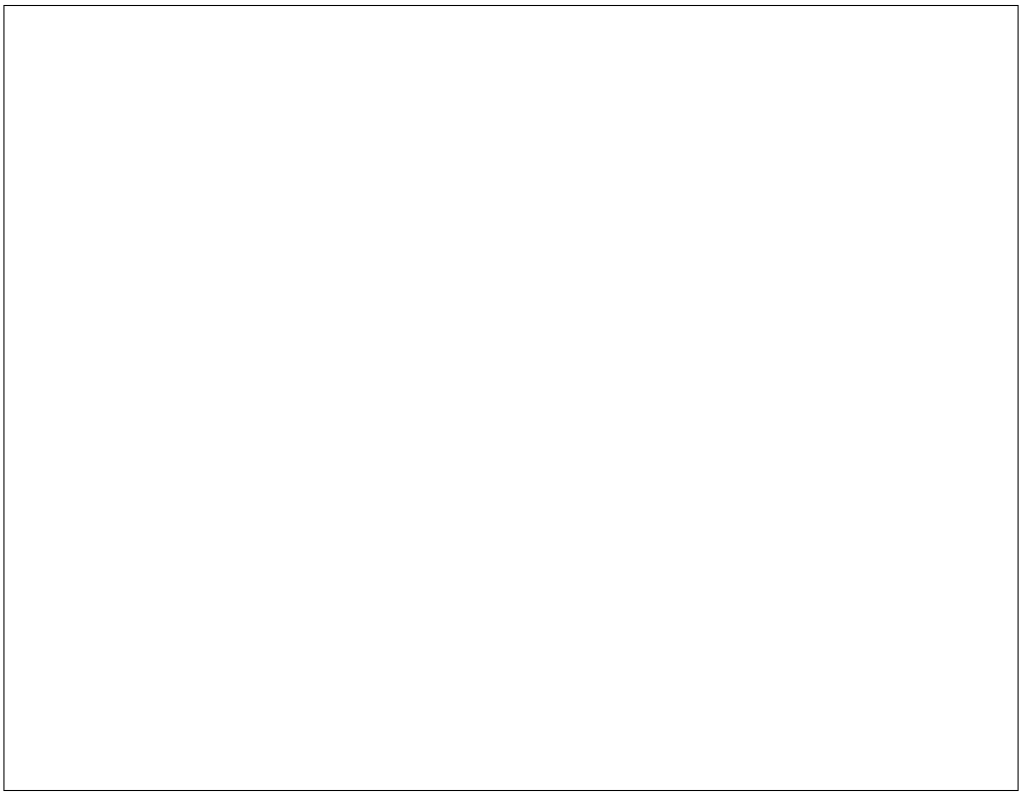
```
> dim(crimes)
```

The following code creates a mongoDB collection from the JSON file.

```
> library(mongolite)
> m <- mongo(collection="testcrimes")
> m$insert(crimes)
```

Write down what the result of the following R code would be.

```
> m$find(query='{ "id": 34274772 }',
+        fields='{ "_id": 0, "category": 1, "location_type": 1, "month": 1 }')
```



```
[
    {
        "category": "anti-social-behaviour",
        "location_type": "Force",
        "location": {
            "latitude": "51.497899",
            "street.id": 953525,
            "longitude": "-0.119685"
        },
        "id": 34274772,
        "month": "2014-07"
    },
    {
        "category": "anti-social-behaviour",
        "location_type": "Force",
        "location": {
            "latitude": "51.507309",
            "street.id": 956645,
            "longitude": "-0.128348"
        },
        "id": 34290854,
        "month": "2014-07"
    }
]
```


Figure 1: The JSON file "data.json"

5. Figure 2 shows the content of an XML file, `"data.xml"`.

   Write R code to read that file into R and extract all donation elements where the donation amount is larger than 2000.

   The output that your code should produce is shown below:

```
[[1]]
<donation id="d1" amount="15000.00" donor="D4"/>

[[2]]
<donation id="d2" amount="10000.00" donor="D1"/>

[[3]]
<donation id="d3" amount="5383.73" donor="D5"/>

[[4]]
<donation id="d5" amount="2940.00" donor="D3"/>

attr(,"class")
[1] "XMLNodeSet"
```

```
<?xml version="1.0"?>
<ElectoralDonations>
  <party id="P2" name="National">
    <candidate id="C1" name="Amy" surname="ADAMS" electorate="E2">
      <donation id="d1" amount="15000.00" donor="D4"/>
      <donation id="d2" amount="10000.00" donor="D1"/>
    </candidate>
  </party>
  <party id="P1" name="Labour">
    <candidate id="C2" name="Glenda" surname="ALEXANDER" electorate="E3">
      <donation id="d3" amount="5383.73" donor="D5"/>
      <donation id="d4" amount="2000.00" donor="D6"/>
    </candidate>
    <candidate id="C3" name="Cliff" surname="ALLEN" electorate="E1">
      <donation id="d5" amount="2940.00" donor="D3"/>
      <donation id="d6" amount="2000.00" donor="D2"/>
    </candidate>
  </party>
  <donor id="D1" name="Douglas Catley (D H Catley Trust)"/>
  <donor id="D2" name="(Hamilton East Labour Electorate Committee)"/>
  <donor id="D3" name="J &amp;amp; K Broughan"/>
  <donor id="D4" name="New Zealand National Party"/>
  <donor id="D5" name="Nordmeyer Trust"/>
  <donor id="D6" name="NZ Meatworkers Union"/>
  <electorate id="E1" name="Hamilton East"/>
  <electorate id="E2" name="Selwyn"/>
  <electorate id="E3" name="Waitaki"/>
</ElectoralDonations>
```

Figure 2: The XML file `"data.xml"`

6. Figure 3 shows the first few lines of a CSV file, `"data.csv"`. The complete file has 6,000,000 rows.

   Estimate the amount of memory that this data set would occupy if it was read into R using the following R code (and explain your reasoning).

```
> data <- read.csv("data.csv", stringsAsFactors=FALSE)
```

   Describe an alternative way to work with the data set in R that would require less memory.

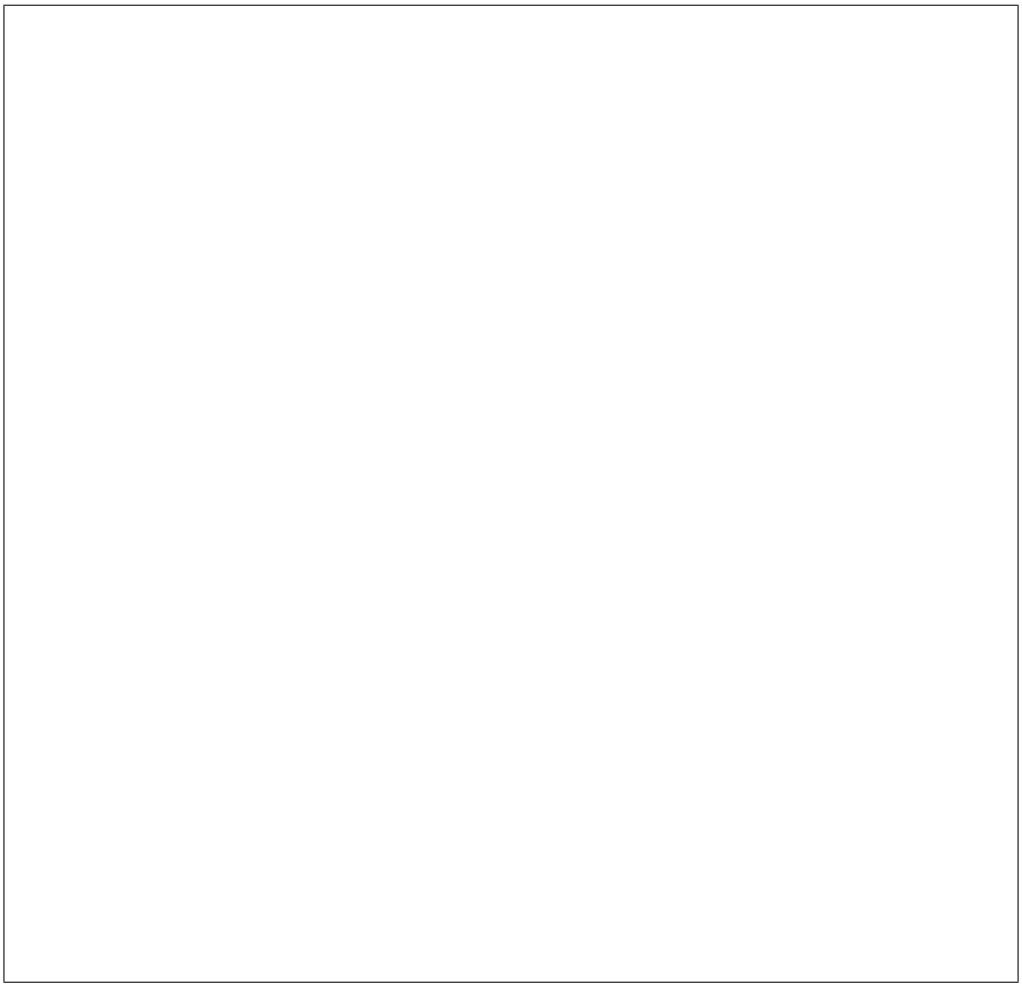
```
2000,1,28,5,1647,1647,1906,1859,HP,154,N808AW,259,252,233,7,0,ATL,PHX,1587,15,11,0
2000,1,29,6,1648,1647,1939,1859,HP,154,N653AW,291,252,239,40,1,ATL,PHX,1587,5,47,0
2000,1,30,7,NA,1647,NA,1859,HP,154,N801AW,NA,252,NA,NA,NA,ATL,PHX,1587,0,0,1
2000,1,31,1,1645,1647,1852,1859,HP,154,N806AW,247,252,226,-7,-2,ATL,PHX,1587,7,14,0
2000,1,1,6,842,846,1057,1101,HP,609,N158AW,255,255,244,-4,-4,ATL,PHX,1587,3,8,0
2000,1,2,7,849,846,1148,1101,HP,609,N656AW,299,255,267,47,3,ATL,PHX,1587,8,24,0
2000,1,3,1,844,846,1121,1101,HP,609,N803AW,277,255,244,20,-2,ATL,PHX,1587,6,27,0
2000,1,1,6,1702,1657,1912,1908,HP,611,N652AW,250,251,232,4,5,ATL,PHX,1587,5,13,0
2000,1,2,7,1658,1657,1901,1908,HP,611,N807AW,243,251,233,-7,1,ATL,PHX,1587,3,7,0
2000,1,3,1,1656,1657,1922,1908,HP,611,N807AW,266,251,241,14,-1,ATL,PHX,1587,5,20,0
2000,1,4,2,1955,1932,2230,2153,HP,613,N509DC,275,261,232,37,23,ATL,PHX,1587,5,38,0
2000,1,5,3,1934,1932,2133,2153,HP,613,N509DC,239,261,224,-20,2,ATL,PHX,1587,5,10,0
2000,1,6,4,1929,1932,2125,2153,HP,613,N303AW,236,261,220,-28,-3,ATL,PHX,1587,5,11,0
2000,1,7,5,1932,1932,2146,2153,HP,613,N173AW,254,261,237,-7,0,ATL,PHX,1587,4,13,0
2000,1,9,7,2008,1932,2221,2153,HP,613,N168AW,253,261,237,28,36,ATL,PHX,1587,4,12,0
2000,1,10,1,1926,1932,2147,2153,HP,613,N160AW,261,261,235,-6,-6,ATL,PHX,1587,7,19,0
2000,1,11,2,1932,1932,2126,2153,HP,613,N160AW,234,261,217,-27,0,ATL,PHX,1587,6,11,0
2000,1,12,3,1936,1932,2142,2153,HP,613,N322AW,246,261,227,-11,4,ATL,PHX,1587,7,12,0
2000,1,13,4,1942,1932,2153,2153,HP,613,N160AW,251,261,220,0,10,ATL,PHX,1587,5,26,0
2000,1,14,5,1932,1932,2131,2153,HP,613,N314AW,239,261,218,-22,0,ATL,PHX,1587,6,15,0
```

Figure 3: The first few lines of the CSV file `"data.csv"`

.

7. Figure 4 shows some of the output from `top` on a Linux computer.

   How many CPU cores does this machine have? How much RAM does this machine have? How busy are the CPU cores? How much RAM is currently being used?



```
top - 10:19:02 up 38 days,  1:59,  3 users,  load average: 0.00, 0.01, 0.05
Tasks: 163 total,   1 running, 162 sleeping,   0 stopped,   0 zombie
Cpu0  :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu1  :  0.3%us,  0.3%sy,  0.0%ni, 99.3%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Mem:   3973448k total,  2512664k used,  1460784k free,   408404k buffers
Swap:  4115452k total,   125816k used,  3989636k free,   945436k cached
```

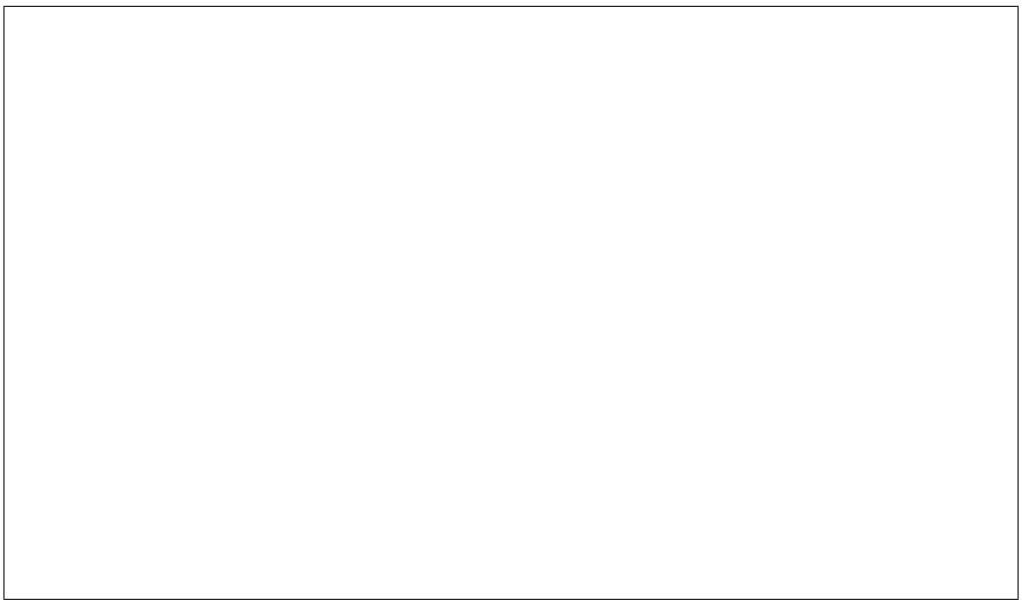
Figure 4: The first few lines of output from `top` on a Linux machine.

8. Given the following bash commands and output ...

```
$ ls
2000.csv         data.json               data.xml~
Alan.docx        data-science-test.aux   full.txt
code-better.R    data-science-test.log   ideas.txt
code-better.R~   data-science-test.out   ideas.txt~
code-efficiency  data-science-test.pdf   medium.txt
code.R           data-science-test.Rnw   sample.json~
code.R~          data-science-test.Rnw~  sample.txt
data.csv         data-science-test.tex   Test779_2015.pdf
data.csv~        data.xml                unused-question.Rnw

$ mkdir Temp

$ cp data-science-test.* Temp

$ cp unused-question.Rnw Temp

$ rm Temp/*.Rnw
```

... write down the result of the following bash command:

```
$ ls Temp
```

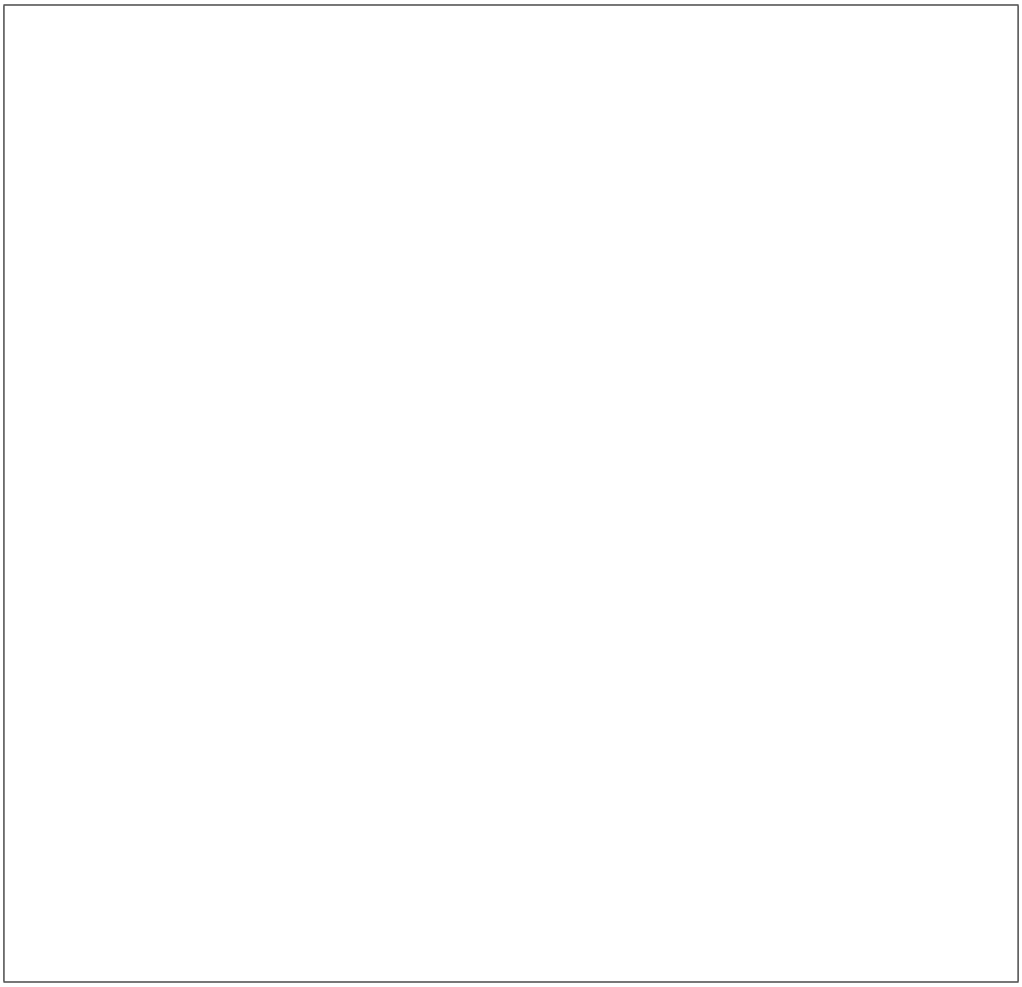


The contents of the file `data.xml` are shown in Figure 2.
Write down the result of the following bash command (and explain what the output means):

```
$ grep party data.xml | wc
```

9. Explain what the following R code is doing and what the output means.

```
> Rprof("test.out")

> replicate(5, mean(rnorm(1000000)))
[1] -0.0017922088 -0.0011004727 -0.0008793575  0.0017379549  0.0007257155

> Rprof(NULL)

> summaryRprof("test.out")
$by.self
        self.time self.pct total.time total.pct
"rnorm"      0.46      100       0.46       100

$by.total
            total.time total.pct self.time self.pct
"rnorm"           0.46       100      0.46      100
"FUN"             0.46       100      0.00        0
"lapply"          0.46       100      0.00        0
"mean"            0.46       100      0.00        0
"replicate"       0.46       100      0.00        0
"sapply"          0.46       100      0.00        0
```



10. The following code runs a simple bootstrap permutation test using 10000 replications and measures how long it takes to run the test.

```
> diffs <- function(N) {
+     diffMean <- 1:N
+     for(i in diffMean){
+         GrpSample <- sample(Grp)
+         diffMean[i] <- diff(tapply(BP, GrpSample, mean))
+     }
+     diffMean
+ }
> set.seed(1000)
> BP <- rnorm(10, 100, 20)
> Grp <- rep(1:2, 5)
> system.time(diffs(10000))

   user  system elapsed
  1.204   0.000   1.207
```

Write R code to perform the 10000 replications in parallel on 4 cores. You can assume that the machine you are running on has at least 4 cores. Estimate how much time your code will take to run and explain your reasoning.