Feature Extraction

degreedata.xlsx

```
library(tidyverse)
```

```
## -- Attaching packages ---------------------------------------------------------------------------
```

```
## v ggplot2 3.3.2     v purrr   0.3.4
## v tibble  3.0.3     v dplyr   1.0.3
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0
```

```
## -- Conflicts ------------------------------------------------------------------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(readxl)
p2_degree = read_excel(path = "feature/p2-fro_degreedata.xlsx", col_names = TRUE)
p3_degree = read_excel(path = "feature/p3-fro_degreedata.xlsx", col_names = TRUE)
p4_degree = read_excel(path = "feature/p4-fro_degreedata.xlsx", col_names = TRUE)
p5_degree = read_excel(path = "feature/p5-fro_degreedata.xlsx", col_names = TRUE)
p6_degree = read_excel(path = "feature/p6-fro_degreedata.xlsx", col_names = TRUE)
p7_degree = read_excel(path = "feature/p7-fro_degreedata.xlsx", col_names = TRUE)
```

Count of branchpoints

```
# Count of branchpoints
nrow(p2_degree)
```

```
## [1] 481
```

```
nrow(p3_degree)
```

```
## [1] 910
```

```
nrow(p4_degree)
```

```
## [1] 1444
```

```r
nrow(p5_degree)
```

```
## [1] 2723
```

```r
nrow(p6_degree)
```

```
## [1] 3238
```

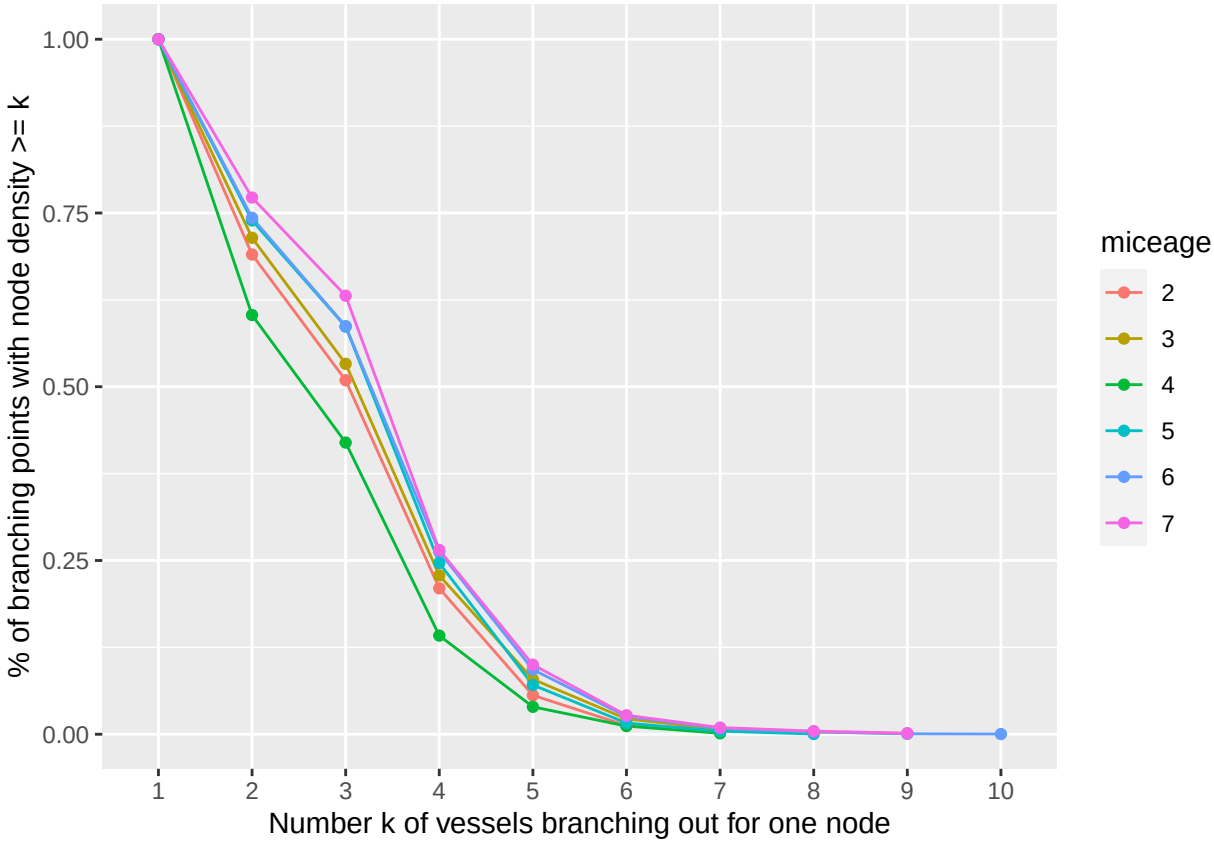
```r
nrow(p7_degree)
```

```
## [1] 3956
```

Spatial density of nodes (Branching number per node)

```r
# Branching number per node
# Spatial density of nodes
deg_spatial_density = data.frame(miceage = c(), degree = c(), density = c())

degree = p2_degree$degree
deg_density = table(degree)[max(degree):1] %>%
  prop.table() %>%
  cumsum() %>%
  rev()
deg_spatial_density = rbind(deg_spatial_density,
                            data.frame(miceage = rep(2,max(degree)), degree = 1:max(degree), density = d

degree = p3_degree$degree
deg_density = table(degree)[max(degree):1] %>%
  prop.table() %>%
  cumsum() %>%
  rev()
deg_spatial_density = rbind(deg_spatial_density,
                            data.frame(miceage = rep(3,max(degree)), degree = 1:max(degree), density = d

degree = p4_degree$degree
deg_density = table(degree)[max(degree):1] %>%
  prop.table() %>%
  cumsum() %>%
  rev()
deg_spatial_density = rbind(deg_spatial_density,
                            data.frame(miceage = rep(4,max(degree)), degree = 1:max(degree), density = d

degree = p5_degree$degree
deg_density = table(degree)[max(degree):1] %>%
  prop.table() %>%
  cumsum() %>%
  rev()
deg_spatial_density = rbind(deg_spatial_density,
                            data.frame(miceage = rep(5,max(degree)), degree = 1:max(degree), density = d
```

```
degree = p6_degree$degree
deg_density = table(degree)[max(degree):1] %>%
  prop.table() %>%
  cumsum() %>%
  rev()
deg_spatial_density = rbind(deg_spatial_density,
                            data.frame(miceage = rep(6,max(degree)), degree = 1:max(degree), density = d

degree = p7_degree$degree
deg_density = table(degree)[max(degree):1] %>%
  prop.table() %>%
  cumsum() %>%
  rev()
deg_spatial_density = rbind(deg_spatial_density,
                            data.frame(miceage = rep(7,max(degree)), degree = 1:max(degree), density = d

deg_spatial_density$miceage = as.factor(deg_spatial_density$miceage)
deg_spatial_density$degree = as.factor(deg_spatial_density$degree)
ggplot(deg_spatial_density, aes(x = degree, y = density, color = miceage, group = miceage)) +
  geom_line() +
  geom_point() +
  labs(x = "Number k of vessels branching out for one node",
       y = "% of branching points with node density >= k")
```



Reference: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6076630

alldata.xlsx

```
p2_all = read_excel(path = "feature/p2-fro_alldata.xlsx", col_names = TRUE)
p3_all = read_excel(path = "feature/p3-fro_alldata.xlsx", col_names = TRUE)
p4_all = read_excel(path = "feature/p4-fro_alldata.xlsx", col_names = TRUE)
p5_all = read_excel(path = "feature/p5-fro_alldata.xlsx", col_names = TRUE)
p6_all = read_excel(path = "feature/p6-fro_alldata.xlsx", col_names = TRUE)
p7_all = read_excel(path = "feature/p7-fro_alldata.xlsx", col_names = TRUE)
```

Vessel segment - the number of vessel edges

```
nrow(p2_all)
```

```
## [1] 598
```

```
nrow(p3_all)
```

```
## [1] 1178
```

```
nrow(p4_all)
```

```
## [1] 1601
```

```
nrow(p5_all)
```

```
## [1] 3627
```

```
nrow(p6_all)
```

```
## [1] 4411
```

```
nrow(p7_all)
```

```
## [1] 5561
```

It certainly increases as it gets older.

Vessel length & Tortuosity & Width

```
mean(p2_all$length)
```

```
## [1] 11.86584
```

```r
mean(p3_all$length)
```

```
## [1] 11.79226
```

```r
mean(p4_all$length)
```

```
## [1] 12.09268
```

```r
mean(p5_all$length)
```

```
## [1] 11.68207
```

```r
mean(p6_all$length)
```

```
## [1] 11.56996
```

```r
mean(p7_all$length)
```

```
## [1] 11.62666
```

```r
var(p2_all$length)
```

```
## [1] 26.2967
```

```r
var(p3_all$length)
```

```
## [1] 24.70441
```

```r
var(p4_all$length)
```

```
## [1] 29.44215
```

```r
var(p5_all$length)
```

```
## [1] 27.38568
```

```r
var(p6_all$length)
```

```
## [1] 28.80742
```

```r
var(p7_all$length)
```

```
## [1] 34.81712
```

```r
mean(p2_all$tortuosity)
```

```
## [1] 1.101782
```

```r
mean(p3_all$tortuosity)
```

```
## [1] 1.099792
```

```r
mean(p4_all$tortuosity)
```

```
## [1] 1.142496
```

```r
mean(p5_all$tortuosity)
```

```
## [1] 1.096093
```

```r
mean(p6_all$tortuosity)
```

```
## [1] 1.092839
```

```r
mean(p7_all$tortuosity)
```

```
## [1] 1.085495
```

```r
mean(p2_all$width)
```

```
## [1] 2.862876
```

```r
mean(p3_all$width)
```

```
## [1] 2.736418
```

```r
mean(p4_all$width)
```

```
## [1] 2.404747
```

```r
mean(p5_all$width)
```

```
## [1] 2.60863
```

```r
mean(p6_all$width)
```

```
## [1] 2.665949
```

```
mean(p7_all$width)
```

```
## [1] 2.4893
```

Couldn't find any interesting facts (differences) for length and tortuosity.
Maybe Vessel width (diameter) gets smaller as it gets older? (perform t-test?)

```
vessel_summary = data.frame(p2 = c(),p3 = c(),p4 = c(),p5 = c(),p6 = c(),p7 = c())
f1 = c(nrow(p2_degree),nrow(p3_degree),nrow(p4_degree),nrow(p5_degree),nrow(p6_degree),nrow(p7_degree))
f2 = c(nrow(p2_all),nrow(p3_all),nrow(p4_all),nrow(p5_all),nrow(p6_all),nrow(p7_all))
f3 = c(mean(p2_all$length),mean(p3_all$length),mean(p4_all$length),
       mean(p5_all$length),mean(p6_all$length),mean(p7_all$length))
f4 = c(mean(p2_all$tortuosity),mean(p3_all$tortuosity),mean(p4_all$tortuosity),
       mean(p5_all$tortuosity),mean(p6_all$tortuosity),mean(p7_all$tortuosity))
f5 = c(mean(p2_all$width),mean(p3_all$width),mean(p4_all$width),
       mean(p5_all$width),mean(p6_all$width),mean(p7_all$width))


m = rbind(f1,f2,f3,f4,f5)
colnames(m) = c("p2","p3","p4","p5","p6","p7")
rownames(m) = c("Number of Branchpoints", "Number of Vessel Edges","Mean of Vessel Length",
                "Mean of Vessel Tortuosity","Mean of Vessel Width")

options(digits=4)
knitr::kable(as.data.frame(m), align="c")
```

	p2	p3	p4	p5	p6	p7
Number of Branchpoints	481.000	910.000	1444.000	2723.000	3238.000	3956.000
Number of Vessel Edges	598.000	1178.000	1601.000	3627.000	4411.000	5561.000
Mean of Vessel Length	11.866	11.792	12.093	11.682	11.570	11.627
Mean of Vessel Tortuosity	1.102	1.100	1.143	1.096	1.093	1.085
Mean of Vessel Width	2.863	2.736	2.405	2.609	2.666	2.489