Mind the hubris in mathematical modeling

R code

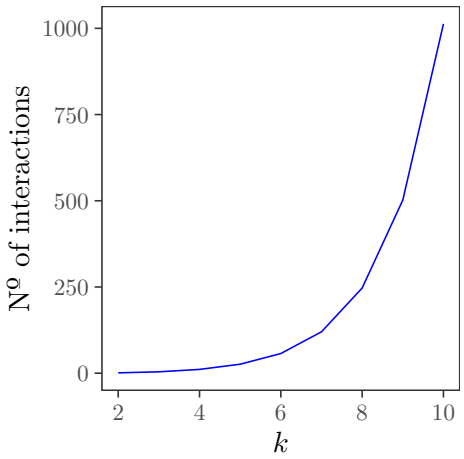
Arnald Puy

Contents

```r
# PRELIMINARY ------------------------------------------------------------------

# Function to read in all required packages in one go:
loadPackages <- function(x) {
  for(i in x) {
    if(!require(i, character.only = TRUE)) {
      install.packages(i, dependencies = TRUE)
      library(i, character.only = TRUE)
    }
  }
}

theme_AP <- function() {
  theme_bw() +
    theme(panel.grid.major = element_blank(),
          panel.grid.minor = element_blank(),
          legend.background = element_rect(fill = "transparent",
                                           color = NA),
          legend.margin=margin(0, 0, 0, 0),
          legend.box.margin=margin(-7,-7,-7,-7),
          legend.key = element_rect(fill = "transparent",
                                    color = NA),
          strip.background = element_rect(fill = "white"))
}

# Load the packages
loadPackages(c("data.table", "tidyverse", "cowplot", "scales", "patchwork"))

# Set checkpoint
dir.create(".checkpoint")
library("checkpoint")

checkpoint("2022-05-20",
           R.version ="4.2.0",
           checkpointLocation = getwd())
```

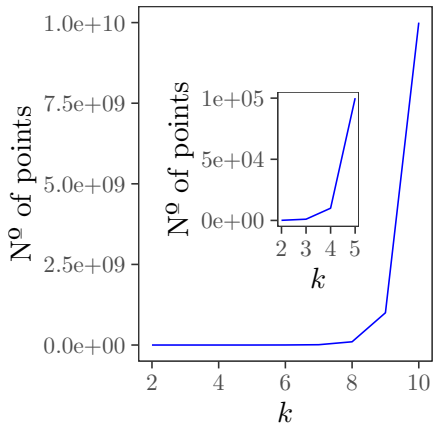
1 Explosion of the uncertainty space

```
# EXPLOSION OF THE UNCERTAINTY SPACE ------------------------------------------

# Define dimensions -------------------------------
k <- 2:10

# Compute number of interactions-------------------
x <- sapply(k, function(k) 2^k - k - 1)

a <- data.table(cbind(x, k)) %>%
  ggplot(., aes(k, x)) +
  geom_line(color = "blue") +
  labs(x = "$k$", y = "Nº of interactions") +
  theme_AP()

a
```

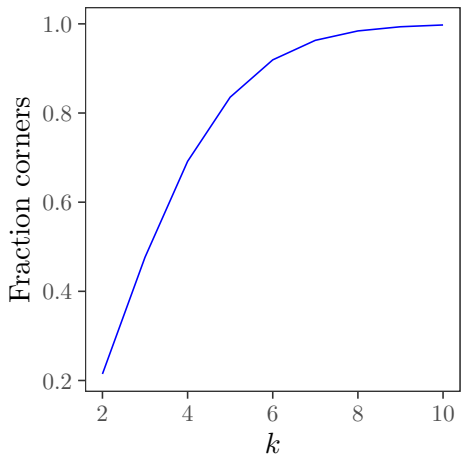



```
# Curse of dimensionality -----------------------------------------------------
N <- 10 # Sample density

out <- N^k

b <- cbind(k, out) %>%
  data.table() %>%
  ggplot(., aes(k, out)) +
  geom_line(color = "blue") +
  labs(x = "$k$", y = "Nº of points") +
  theme_AP()

inset.plot <- b +
  scale_x_continuous(limits = c(2, 5),
                     breaks = pretty_breaks(n = 3)) +
  scale_y_continuous(limits = c(1e+02, 1e+05),
                     breaks = pretty_breaks(n = 3)) +
```

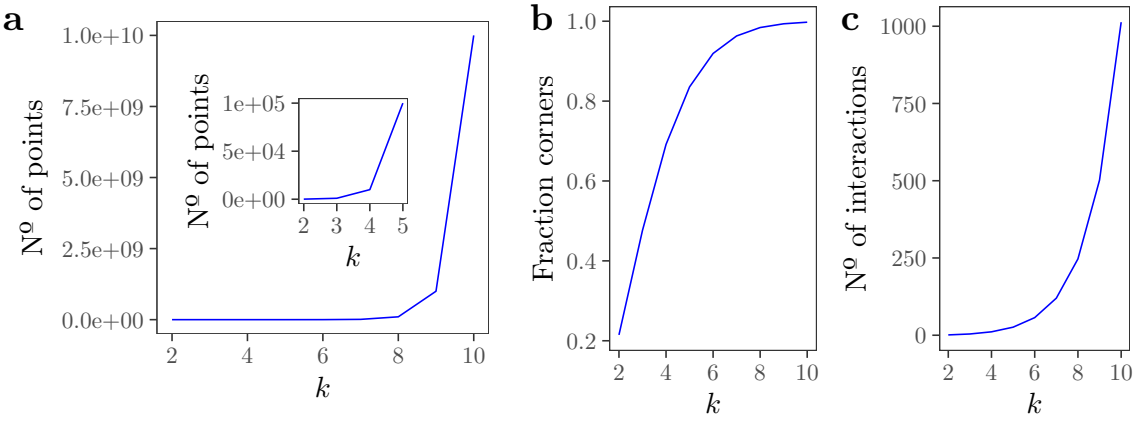
```
  labs(x = "", y = "") +
  labs(x = "$k$", y = "Nº of points")

b <- b +
  inset_element(inset.plot, 0.05, 0.15, 0.8, 0.8)

b
```




```
# Ratio of the hypersphere to the hypercube -----------------------------------

sphere_to_cube <- function(x) pi ^ ((x) / 2) * (0.5) ^ (x) / gamma(1 + x / 2)

out <- sapply(k, function(x) sphere_to_cube(x))

c <- data.table(cbind(k, out)) %>%
  .[, corner:= 1 - out] %>%
  ggplot(., aes(k, corner)) +
  geom_line(color = "blue") +
  labs(x = "$k$", y = "Fraction corners") +
  theme_AP()

c
```



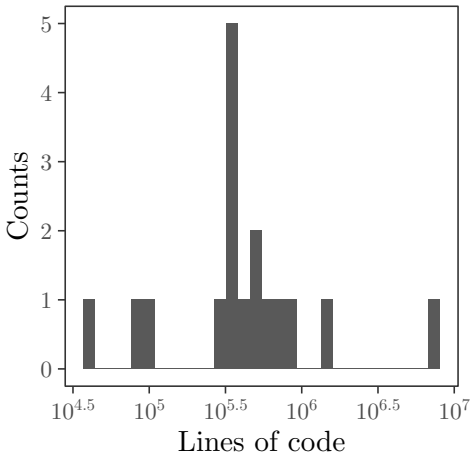
```
# MERGE PLOTS ------------------------------------------------------------------

plot_grid(b, c, a, ncol = 3, labels = "auto",
          rel_widths = c(0.47, 0.28, 0.28), align = "tb")
```



2 Black boxing processes

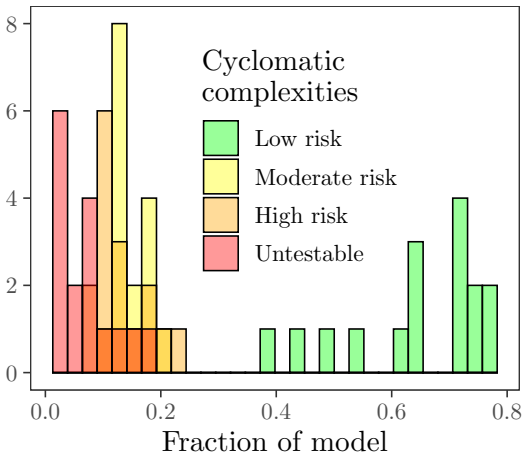
```
# LINES OF CODE ----------------------------------------------------------------

code <- fread("lines_code.csv")
colNames <- colnames(code)[-1]
code[, (colNames):= lapply(.SD, function(x) x * 1000), .SDcols = (colNames)]

# Plot -------------------------------------------------------------------------
code.plot <- code %>%
  ggplot(., aes(KLOC)) +
  geom_histogram() +
  scale_x_log10(breaks = trans_breaks("log10", function(x) 10^x),
                labels = trans_format("log10", scales::math_format(10^.x))) +
  coord_cartesian(clip = "off") +
  labs(x = "Lines of code", y = "Counts") +
  theme_AP()

code.plot
```

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




```
# CYCLOMATIC COMPLEXITIES ----------------------------------------------------

cyclomatic <- fread("cyclomatic_complexity.csv")
colNames <- colnames(cyclomatic)[-1]
new_colNames <- c("Low risk", "Moderate risk", "High risk", "Untestable")
cyclomatic[, total:= rowSums(.SD), .SDcols = colNames]
fraction <- cyclomatic[, lapply(.SD, function(x) x / total), .SDcols = colNames]
colnames(fraction) <- new_colNames

# Plot ---------------------------------
cyclomatic.plot <- melt(fraction, measure.vars = new_colNames,
     variable.name = "Cyclomatic \n complexities") %>%
  ggplot(., aes(value, fill = `Cyclomatic \n complexities`)) +
  scale_fill_manual(values = c("green", "yellow", "orange", "red")) +
  labs(x = "Fraction of model", y = "") +
  geom_histogram(alpha = 0.4, position = "identity", color = "black") +
  theme_AP() +
  theme(legend.position = c(0.55, 0.6))

cyclomatic.plot
```

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



```
# MERGE PLOTS ------------------------------------------------------------------

plot_grid(code.plot, cyclomatic.plot, ncol = 2, labels = "auto",
          rel_widths = c(0.45, 0.55))
```

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