Dempster-Shafer Theory - Decision making under uncertainty

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1 Introduction

Dempster-Shafer Theory (DST) is a way to account for uncertainty when making a decision. For example, imagine the answer to a question has two mutually exclusive outcomes: yes or no. Then, DST, would describe this as the *frame of discernment*, or θ, where,

$$\theta = \{yes, no\}$$

But, when we try to estimate these answers, there are multiple possibilities, especially if you're unsure. For example, sometimes when you measure something, you're not sure if the answer is yes or no. All possible states are represented as a power set, 2^θ, such that

$$2^\theta = \{\{\emptyset\}, \{yes\}, \{no\}, \{\theta\}\}$$

and notice that $\theta = \{yes, no\}$, which is the set where you're sure whether the answer is yes or no.

1.1 References

- Rathman JF, Yang C, Zhou H. **Dempster-Shafer theory for combining in silico evidence and estimating uncertainty in chemical risk assessment**. Comput Toxicol. 2018;6:16-31. doi: 10.1016/j.comtox.2018.03.001

2 Load libraries

```
library(tidyverse) # data wrangling, visualization
library(EvCombR) # package for dempster shafer
```

3 Session info

```
sessionInfo()
```

```
## R version 4.3.1 (2023-06-16 ucrt)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 10 x64 (build 19045)
##
## Matrix products: default
##
##
## locale:
## [1] LC_COLLATE=English_United States.utf8
## [2] LC_CTYPE=English_United States.utf8
## [3] LC_MONETARY=English_United States.utf8
## [4] LC_NUMERIC=C
## [5] LC_TIME=English_United States.utf8
##
## time zone: America/New_York
## tzcode source: internal
```

```
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] EvCombR_0.1-4   lubridate_1.9.2 forcats_1.0.0   stringr_1.5.0
##  [5] dplyr_1.1.2     purrr_1.0.2     readr_2.1.4     tidyr_1.3.0
##  [9] tibble_3.2.1    ggplot2_3.4.3   tidyverse_2.0.0
##
## loaded via a namespace (and not attached):
##  [1] gtable_0.3.4      compiler_4.3.1    tidyselect_1.2.0  scales_1.2.1
##  [5] yaml_2.3.7        fastmap_1.1.1     R6_2.5.1          generics_0.1.3
##  [9] knitr_1.43        munsell_0.5.0     pillar_1.9.0      tzdb_0.4.0
## [13] rlang_1.1.1       utf8_1.2.3        stringi_1.7.12    xfun_0.40
## [17] timechange_0.2.0  cli_3.6.1         withr_2.5.0       magrittr_2.0.3
## [21] digest_0.6.33     grid_4.3.1        rstudioapi_0.15.0 hms_1.1.3
## [25] lifecycle_1.0.3   vctrs_0.6.3       evaluate_0.21     glue_1.6.2
## [29] fansi_1.0.4       colorspace_2.1-0  rmarkdown_2.24    tools_4.3.1
## [33] pkgconfig_2.0.3   htmltools_0.5.6
```