UNIVERSITY
OF OSLO

Conformal Prediction Workshop

Statistics section, UiO

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(Academic) life story

2014-2019:
MSc Industrial Mathematics, NTNU

2020-2024:
PhD Statistics, UiO

2024--:
Data Scientist, Eiendomsverdi

Life story (conformal prediction edition)

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- Now: Involved in some CP research projects

Today’s tutorial

- Part 1: Basic CP
  - An implementation from scratch
  - Different non-conformity scores
  - Mondrian calibration

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- Part 1: Basic CP
  - An implementation from scratch
  - Different non-conformity scores
  - Mondrian calibration
- Part 2: CP for non-exchangeable data
  - Electricity data (from Foygel Barber et al. 2023)
- Part 3: Spatial CP
  - Oslo housing data (Hjort et al. 2025)

Base R vs. Tidyverse

Base R

```
mean(mtcars[mtcars$cyl == 6, "mpg"])
```

Tidyverse

```
mtcars %>%
  filter(cyl == 6) %>%
  summarise(avg_mpg = mean(mpg))
```

Base R vs. Tidyverse: Mutate Example

Base R

```r
mtcars$kW <- mtcars$hp * 0.7457
head(mtcars[, c("hp", "kW")])
```

Tidyverse

```r
mtcars %>%
  mutate(kW = hp * 0.7457) %>%
  select(hp, kW) %>%
  head()
```

GitHub

https://github.com/adhjort/ConformalPredictionTutorial

Beyond exchangeability?

What if non-conformity scores $s_1, ..., s_N, s_{N+1}$ are not exchangeable?

- Drifts over time?
- Covariate shift between training, calibration and/or test set?
- Spatial trends?

Two adaptive solutions beyond exchangeability

1. Weighted conformal prediction

$$q_{1-\alpha,N+1} = \text{WeightedQuantile}(s_1, \ldots, s_N;\ w_1, \ldots, w_N)$$

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2. Adaptive conformal prediction (Gibbs & Candès, 2021)

$$\alpha_{t+1} = \alpha_t - \eta\,(\text{err}_t - \alpha), \quad \text{err}_t = \mathbf{1}\{y_t \notin C_t\}$$

- Dynamically adjusts α_t to keep long-run miscoverage near the target α

ELEC2 data

5.2 Electricity data set

We now compare the three methods on a real data set. The ELEC2 data set[5] [Harries, 1999] tracks electricity usage and pricing in the states of New South Wales and Victoria in Australia, every 30 minutes over a 2.5 year period in 1996–1999. (This data set was previously analyzed by Vovk et al. [2021] in the context of conformal prediction, finding distribution drift that violated exchangeability.)

[5]Data was obtained from `https://www.kaggle.com/yashsharan/the-elec2-dataset`.

Screenshot from Foygel Barber et al. 2023.

References I

- Foygel Barber, Rina, Emmanuel Candès, Aaditya Ramdas and Ryan J. Tibshirani (2023). “Conformal prediction beyond exchangeability”. In: *The Annals of Statistics* 51.2, pp. 816–845.
- Hjort, Anders, Gudmund Horn Hermansen, Johan Pensar and Jonathan P. Williams (2025). “Uncertainty quantification in automated valuation models with spatially weighted conformal prediction”. In: *International Journal of Data Science and Analytics*.
- Vovk, Vladimir, Alex Gammerman and Glenn Shafer (2005). *Algorithmic Learning in a Random World*. Springer-Verlag.