funHDDC, a new package for Clustering of multivariate functional data

https://cran.r-project.org/web/packages/funHDDC/index.html

Speaker : **Amandine Schmutz**[1,2,3,4]

Directors : Julien Jacques[2], Charles Bouveyron[5], Laurence Chèze[3] & Pauline Martin[1, 4]

1 Lim France, Leather in motion

2 Université Lumière Lyon 2

3 Université Claude Bernard Lyon 1

4 VetLab, EnvA, CWD

5 Université Côte d'Azur

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Context

- **8,3 billion** of **smart devices** [Gartner study (2017)]

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Collection of high frequency data

Functional data

Smart devices collect **continuous measurements**

❖Functional data

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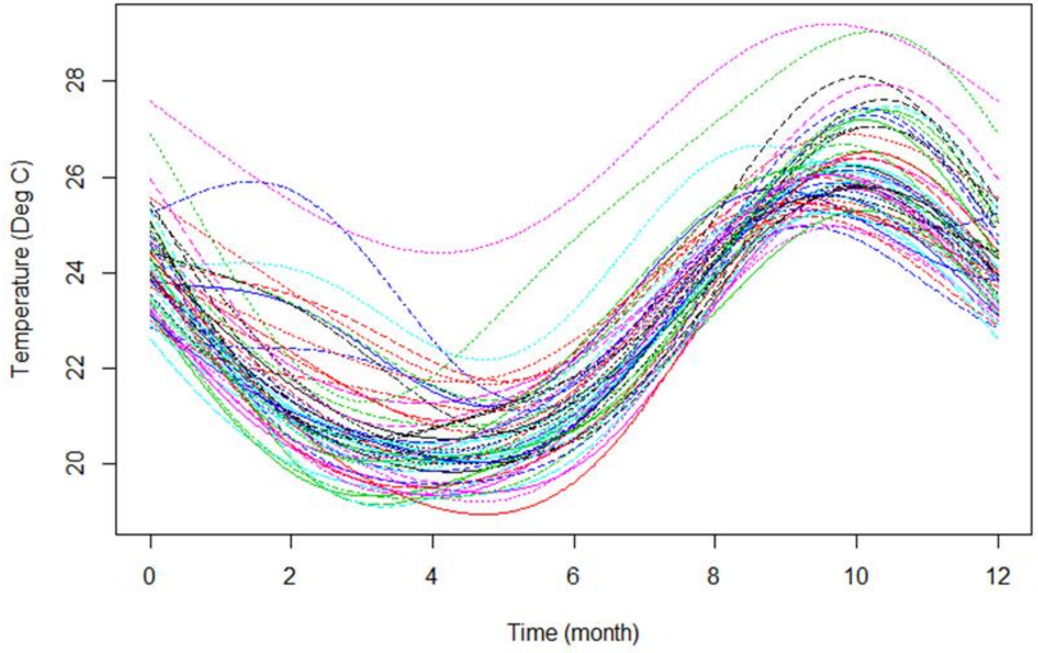

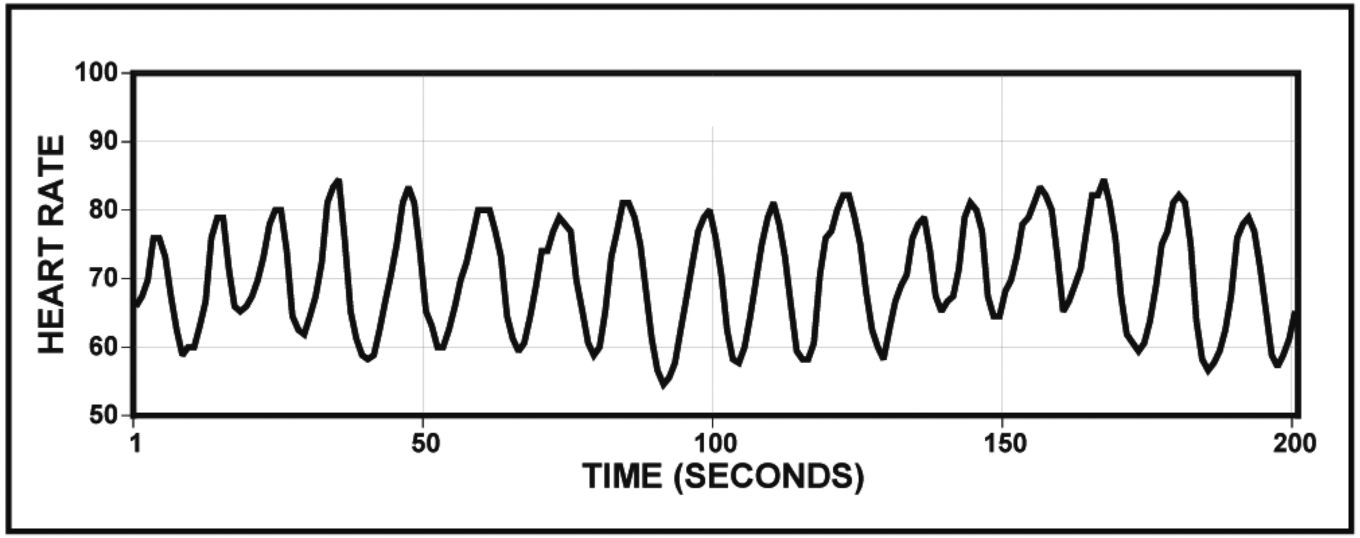

Functional data

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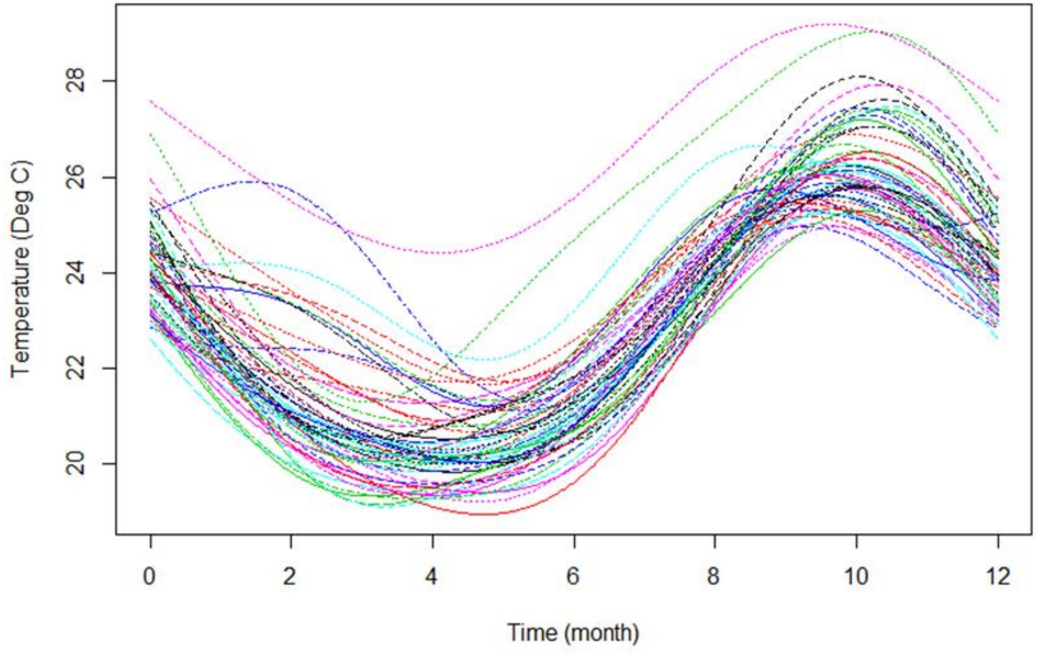

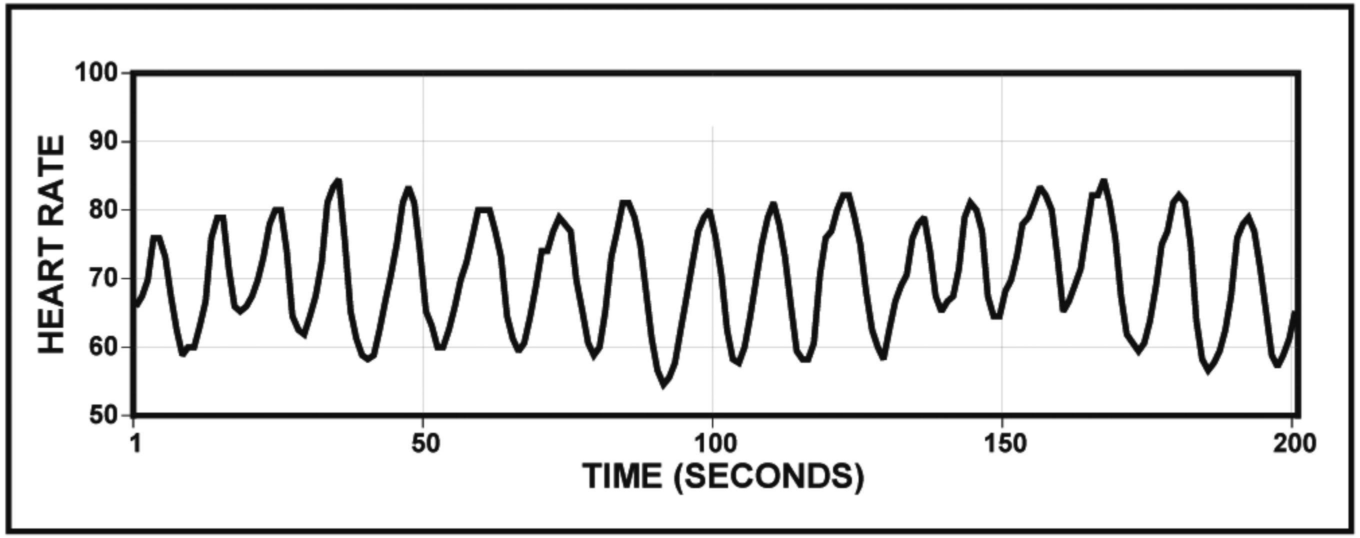

1 individual = 1 curve

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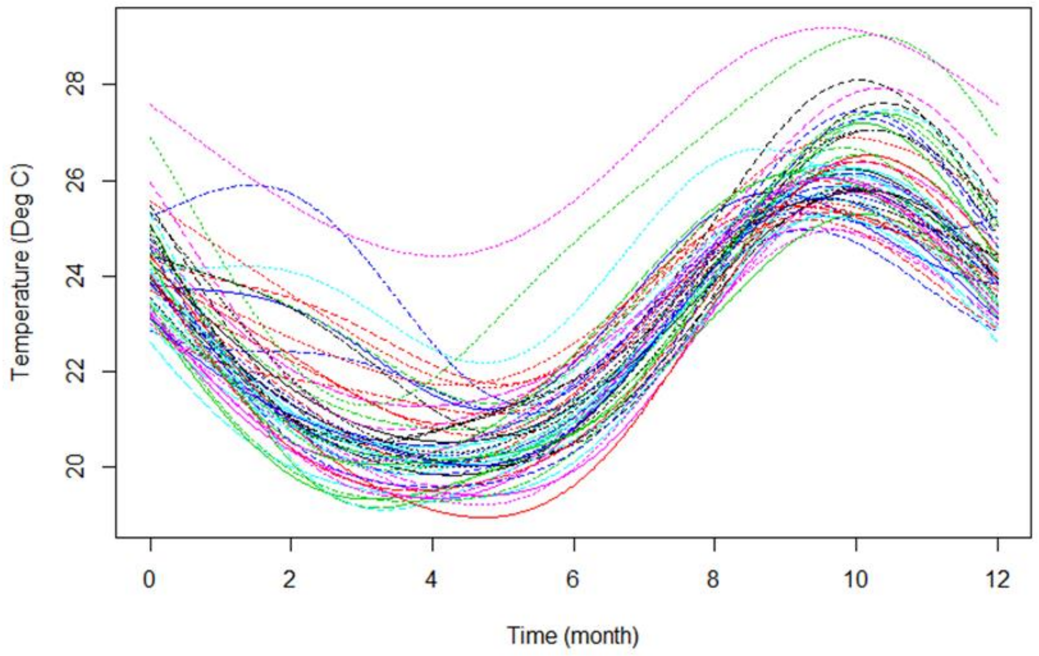

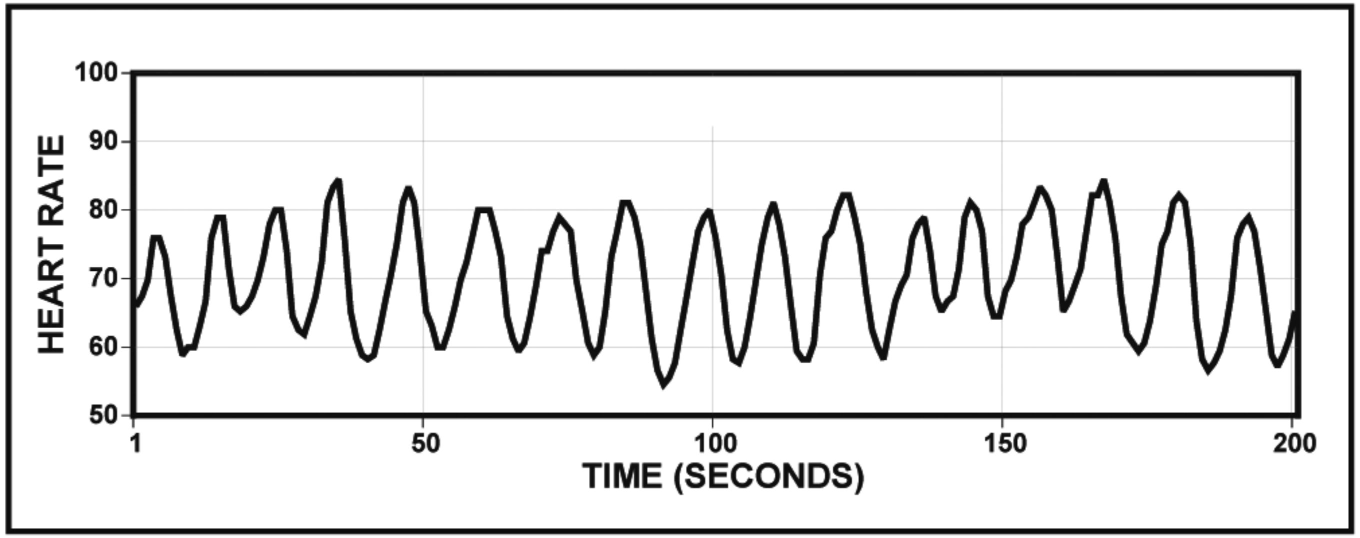

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➔ *Dependency kept* between points

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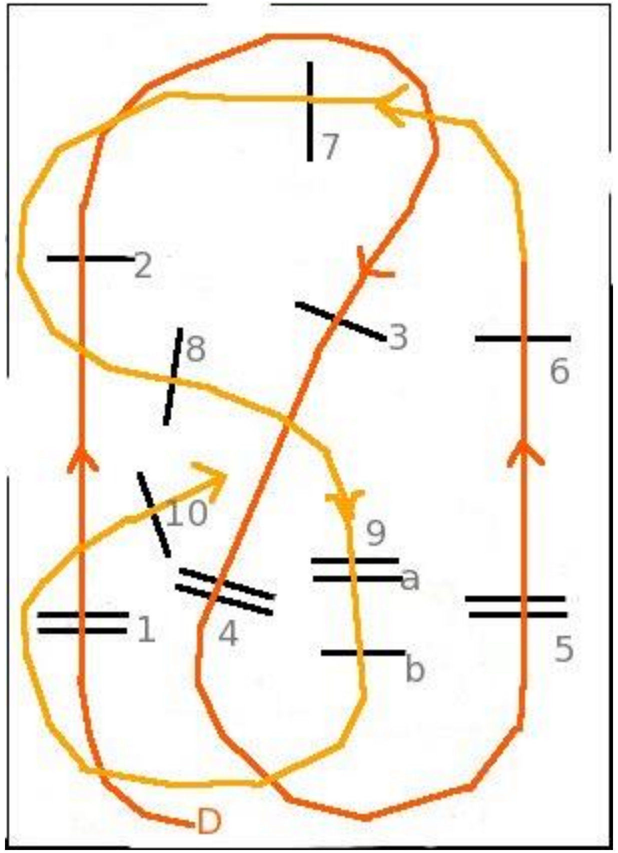
- Timed course, 10-14 obstacles
- Check distances



❖Equestrian sports: Jumping WEG 2018 (Tryon USA)

- Timed course, 10-14 obstacles
- Check distances
- Up to 160 cm high, 450 cm wide

Smart saddle

- Training tool for equestrian sport

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Accelerometer & gyroscope

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Smart saddle

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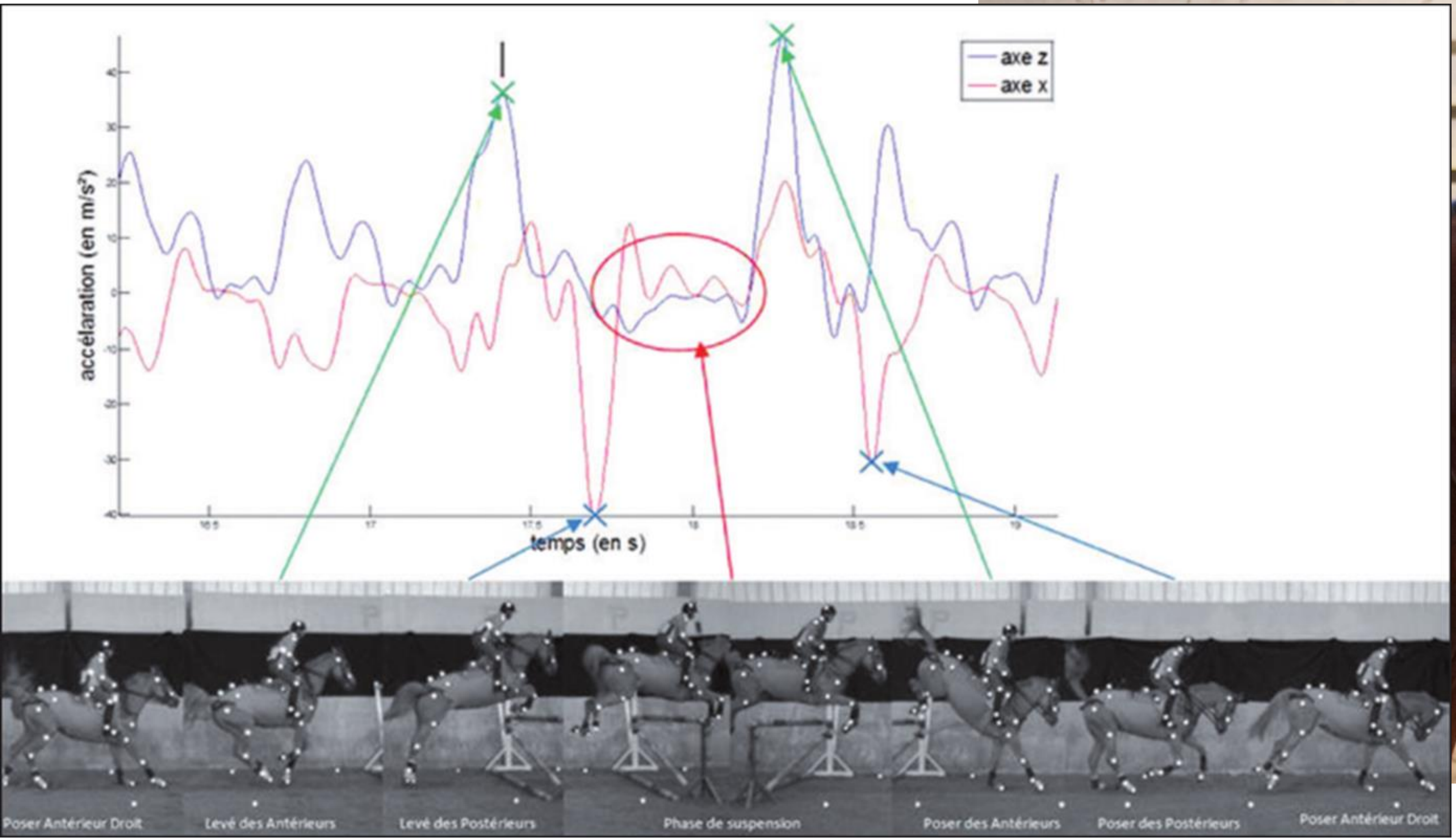

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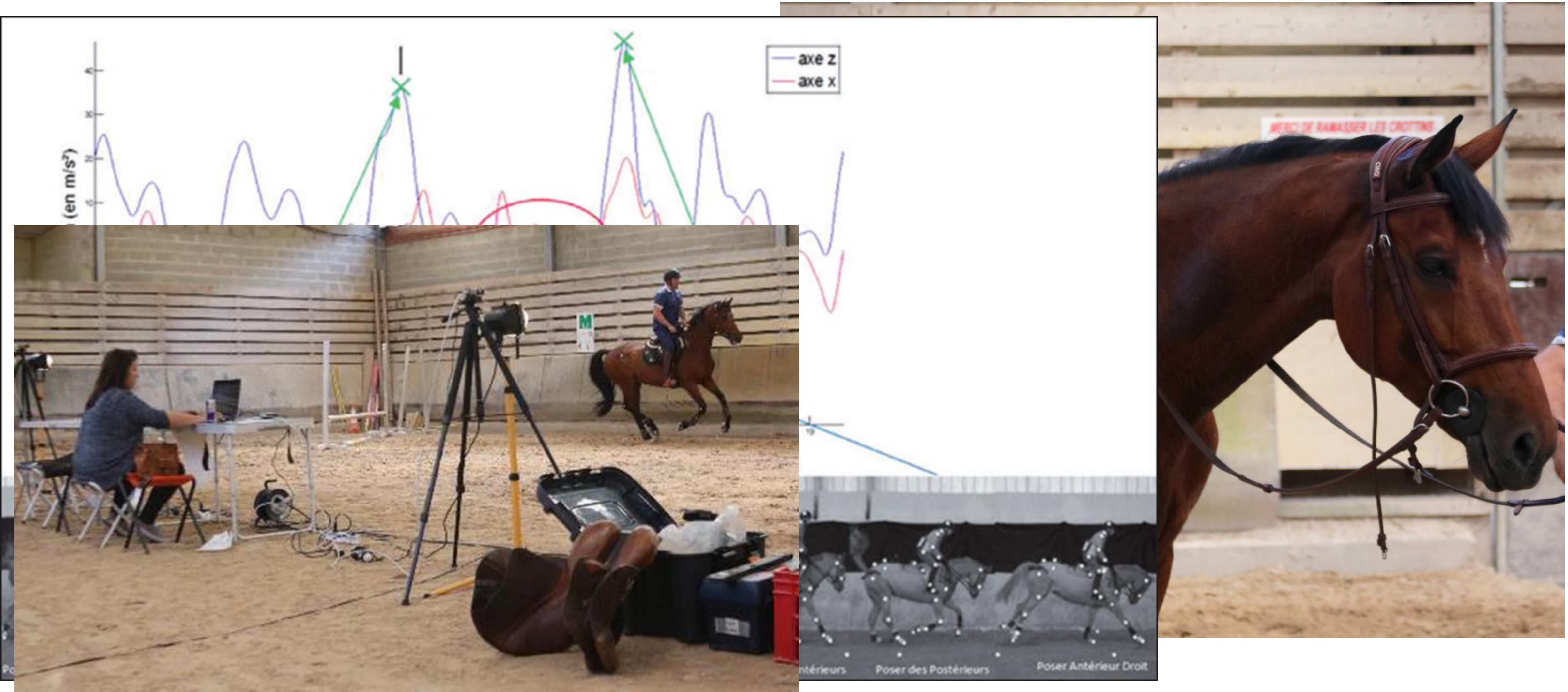

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Clustering method

Objective : **Separate n p-variate curves in K clusters**

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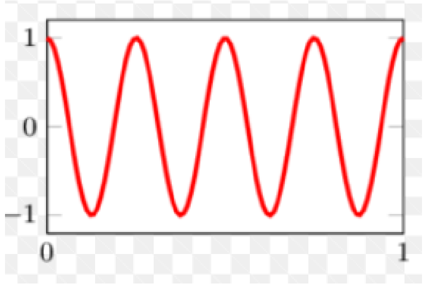

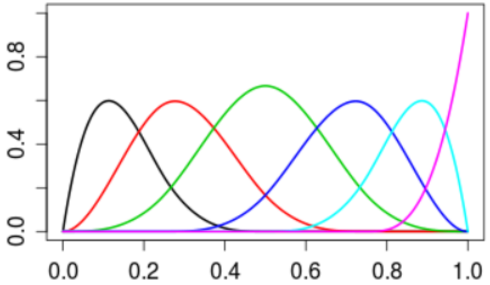

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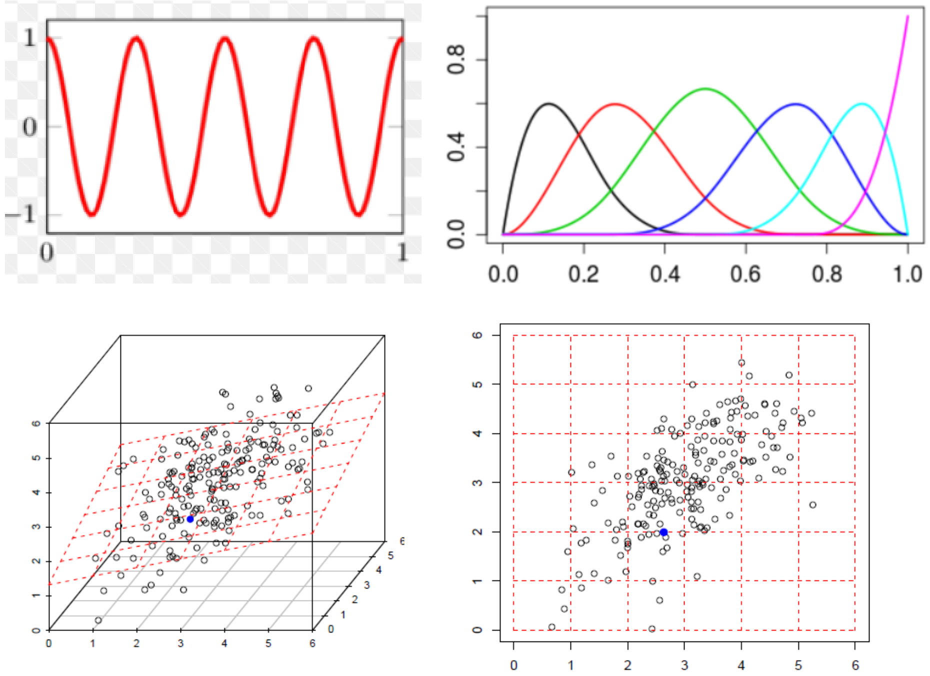

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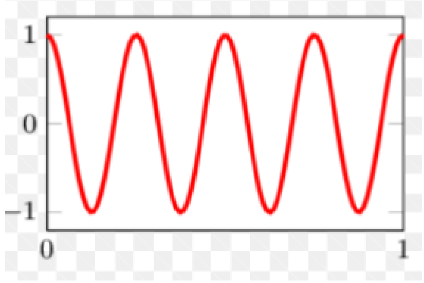

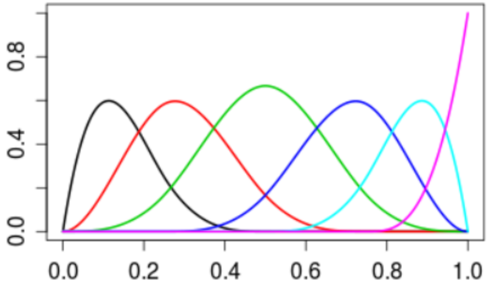

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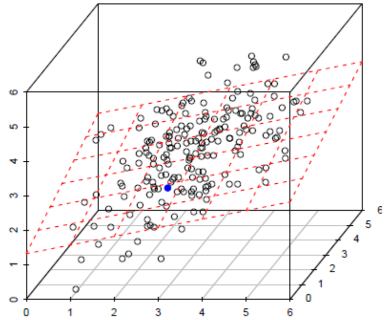

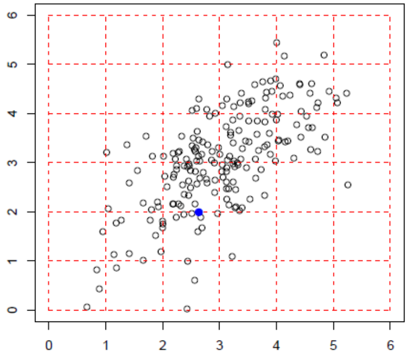

- Mixture model

$$p(\delta) = \sum_{k=1}^{K} \pi_k \, N(\delta; \mu_k, \Delta_k)$$

R package funHDDC

funHDDC: Univariate and Multivariate Model-Based Clustering in Group-Specific Functional Subspaces

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funHDDC(data, K, init, …)
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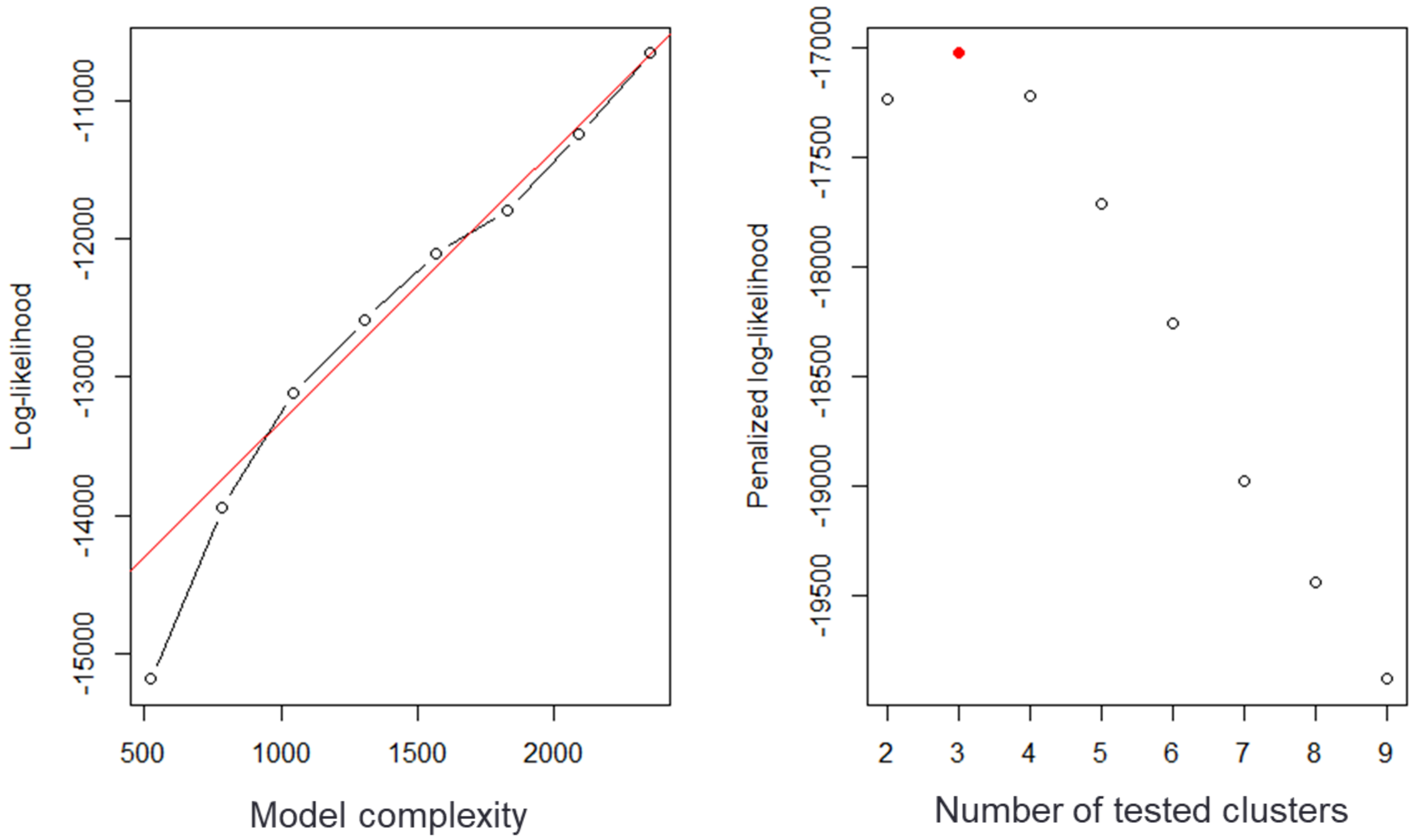

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predict(mod, newdata)
```

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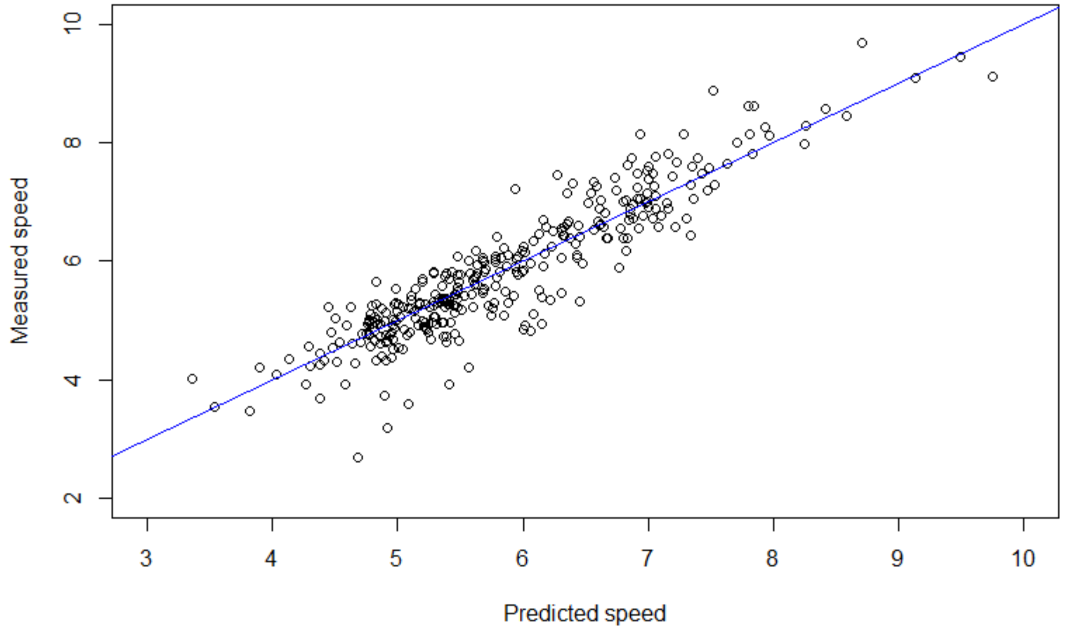

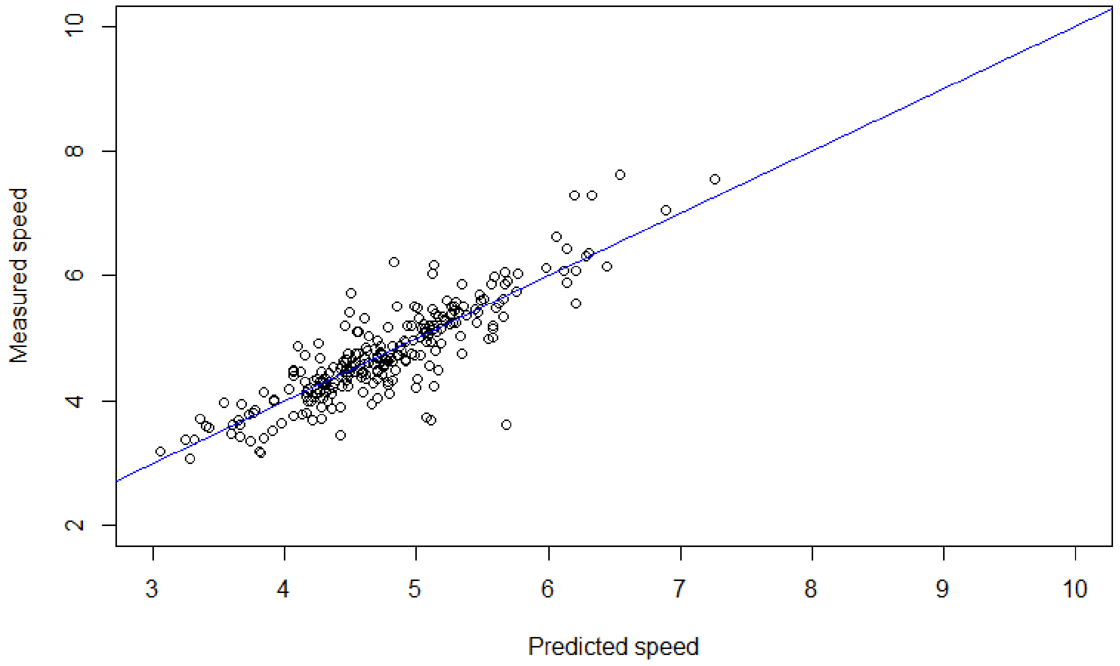

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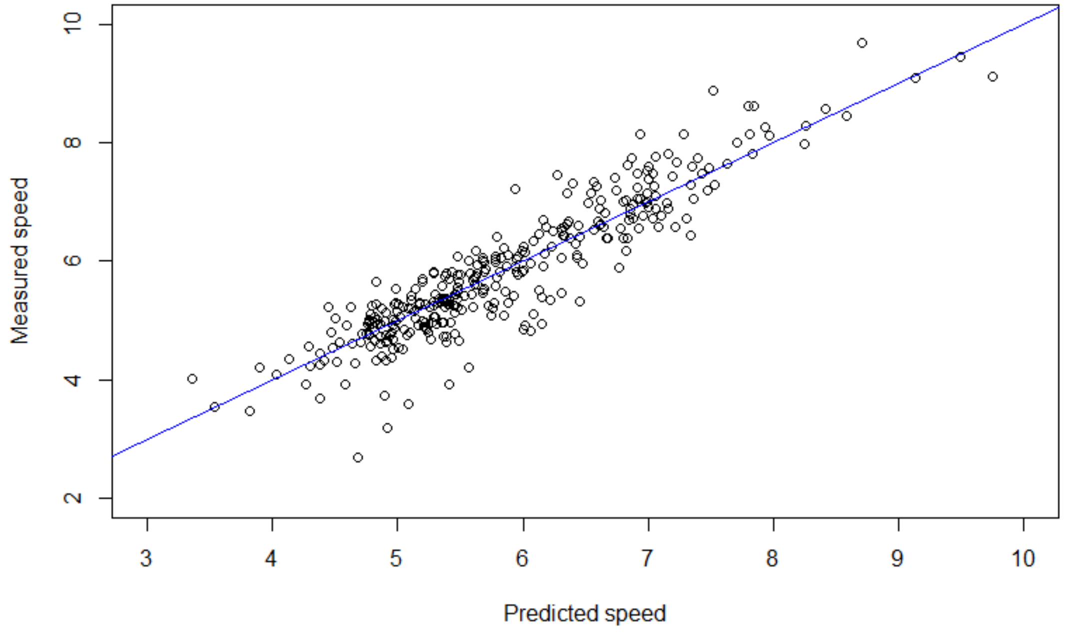

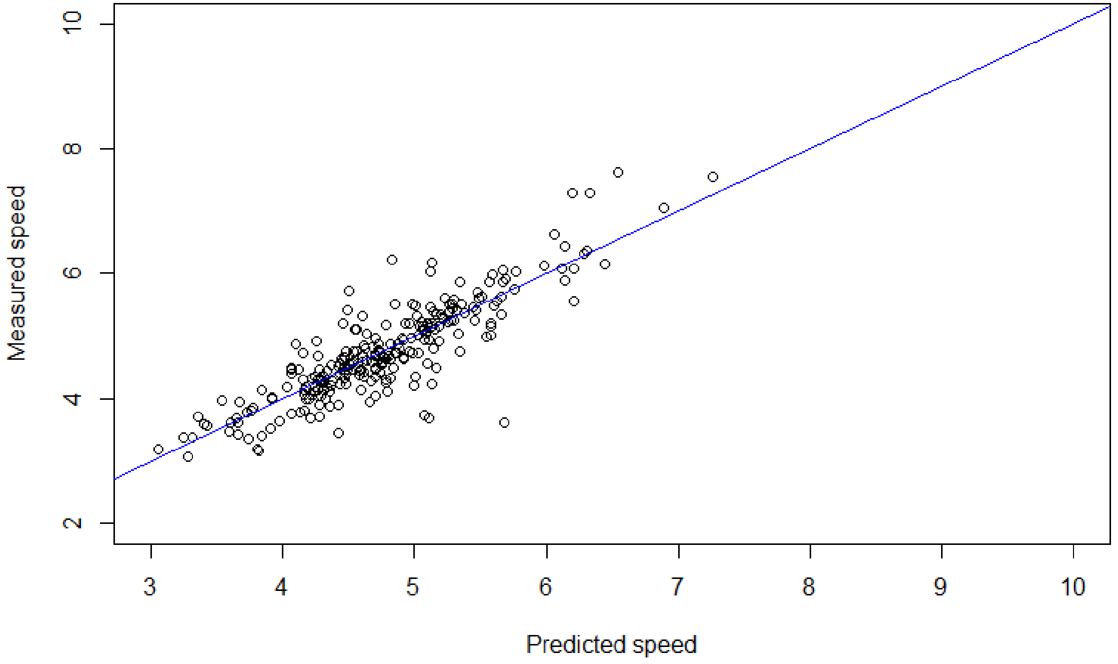

11,6% of errors above 0,6 m/s

Automation in a smartphone app

Objective: **Automate** calculations to provide a **tool** to help riders for their **training**

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- **SVM** per cluster for speed prediction

Weather stations Canada

- 35 cities distributed on all territory
- Temperature and pluviometry for 1 year

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```
res1← funHDDC(list(temp,pluvio), K=2:8,
      model=‘AkjBkQkDk’)
```

Weather stations Canada

- 35 cities distributed on all territory
- Temperature and pluviometry for 1 year

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```

```
slopeheuristic(res1)
```

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- 35 cities distributed on all territory
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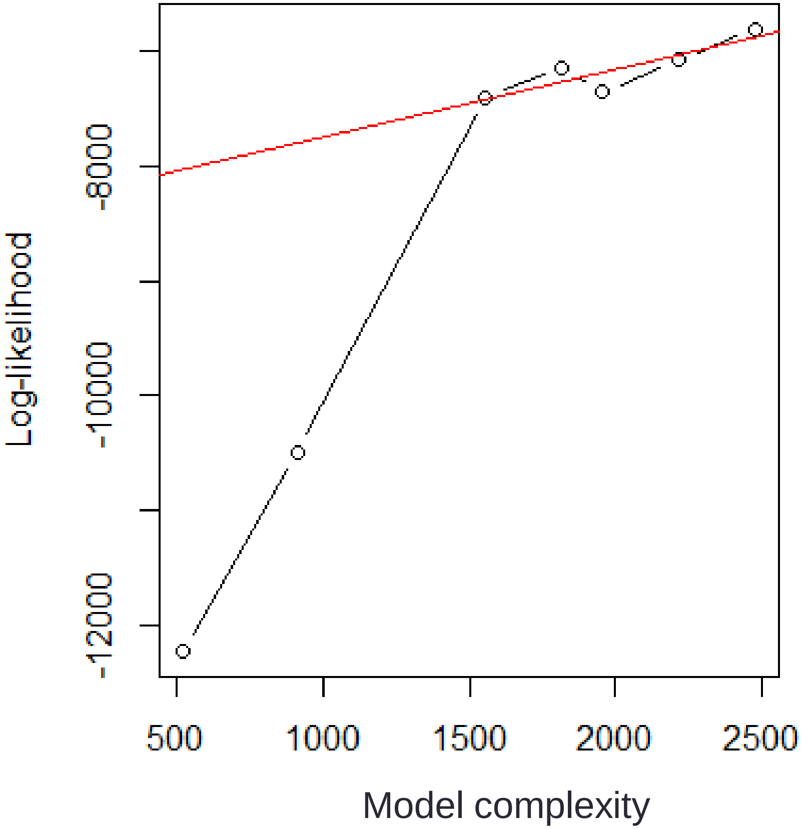
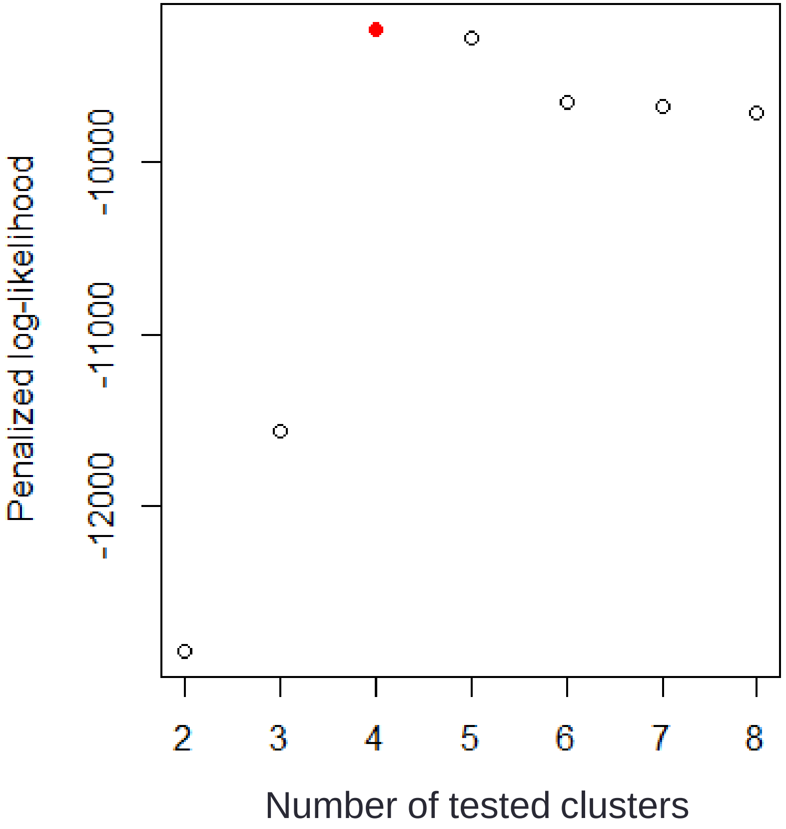
```
res1← fur

slopeheurist
```





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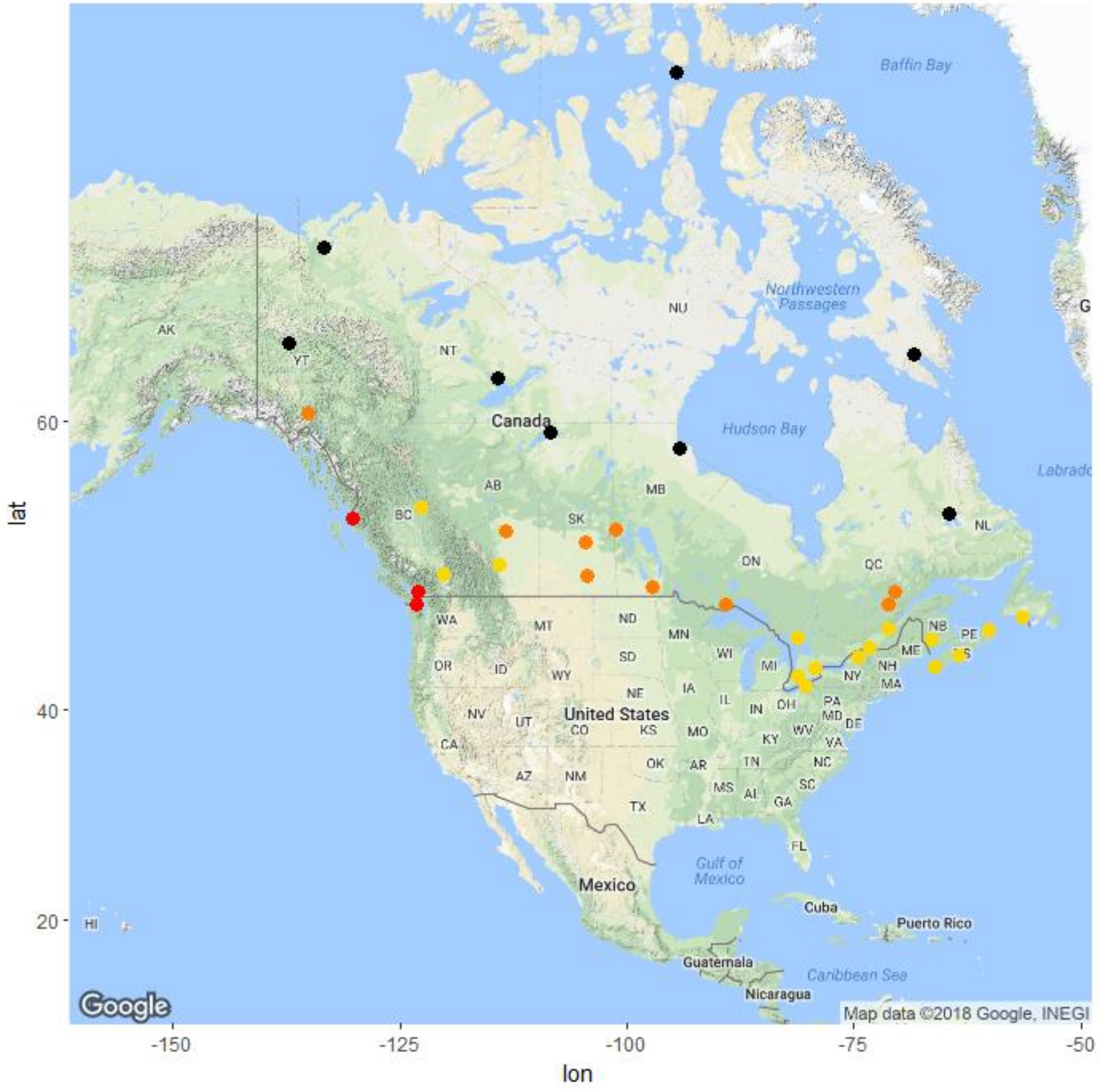

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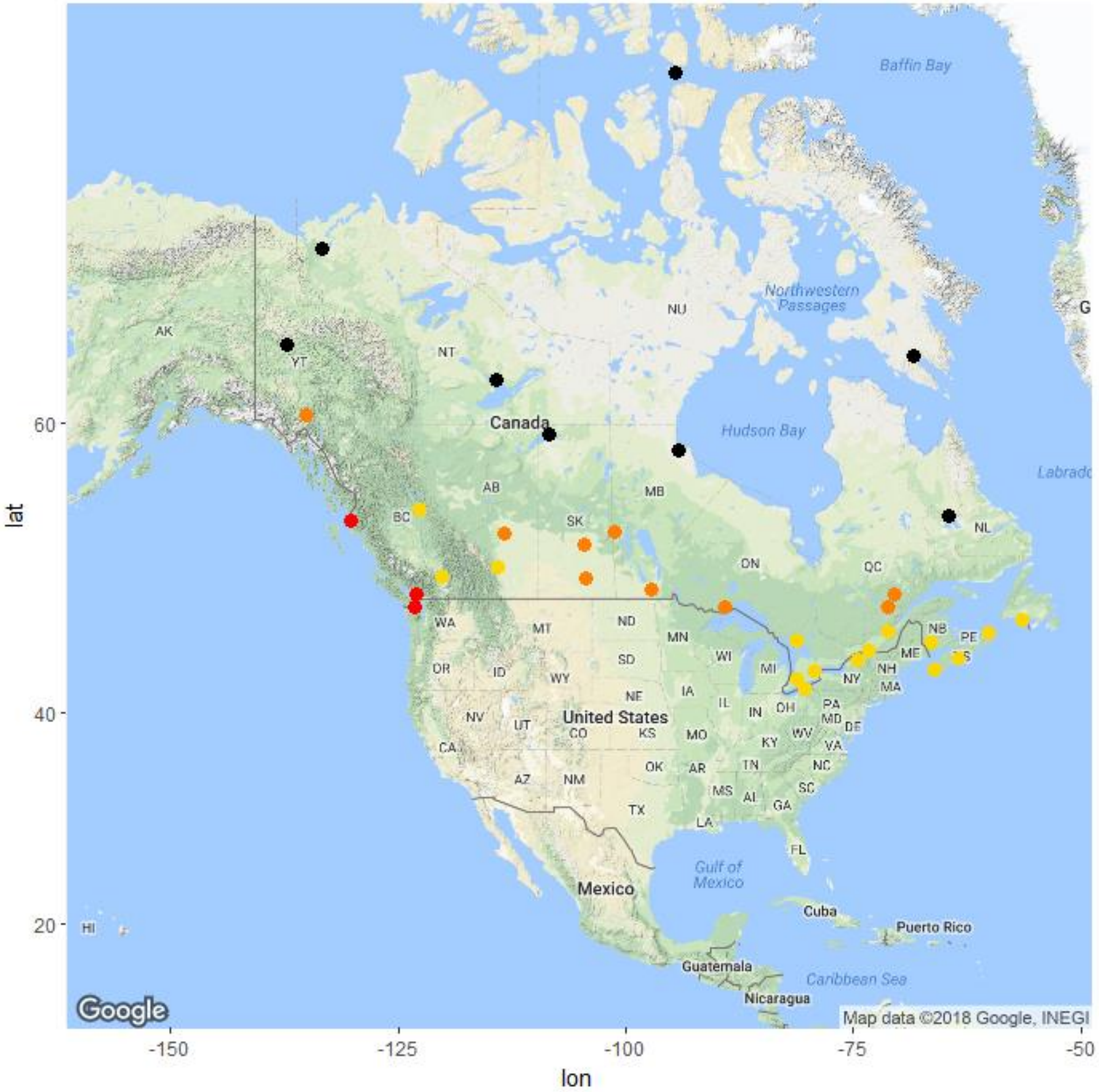

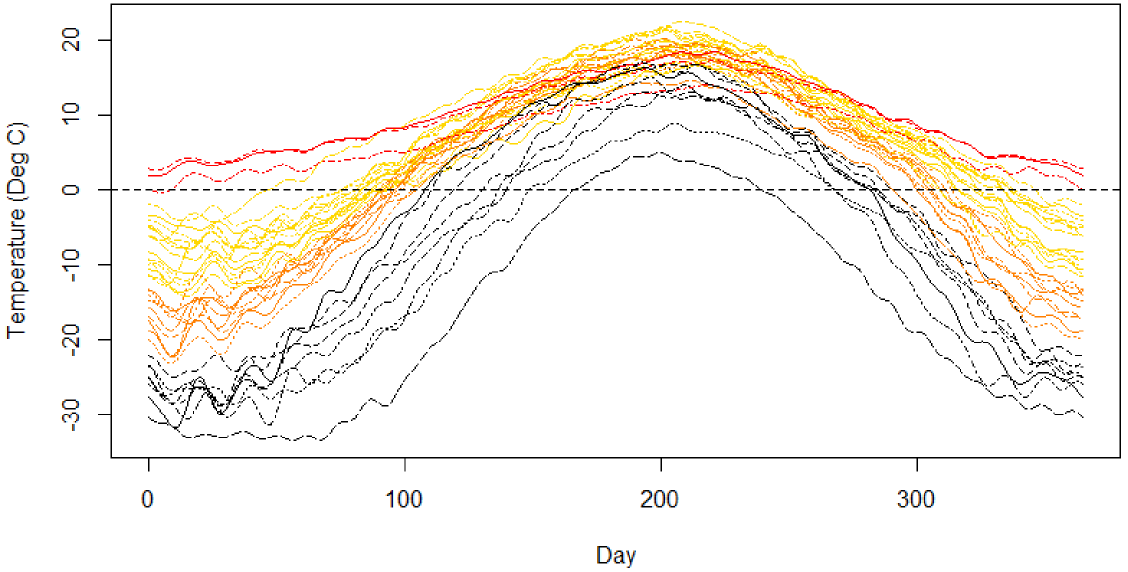

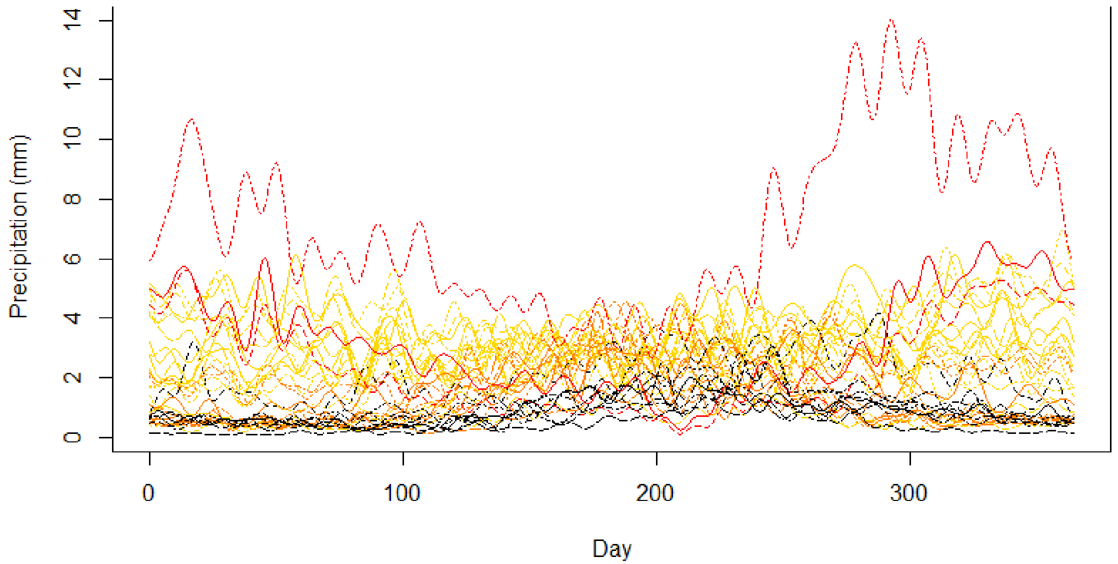

Weather stations Canada

- Main sources of variation

```
res.pca ← mfpca(list(daytempfd,dayprecfd))
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res.pca ← mfpca(list(daytempfd,dayprecfd))
plot(res.pca)
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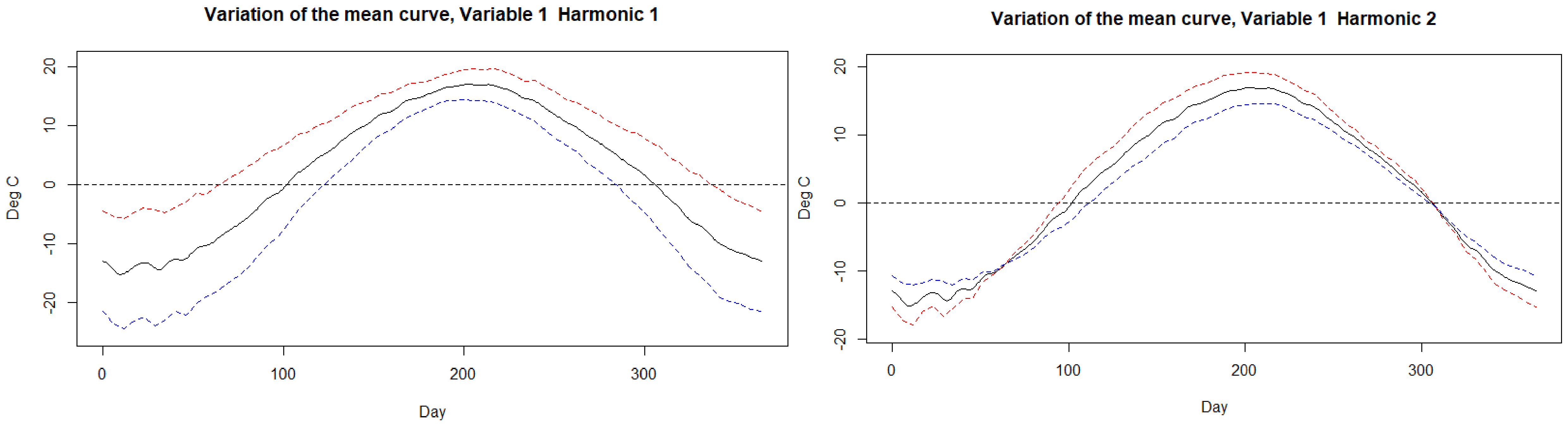
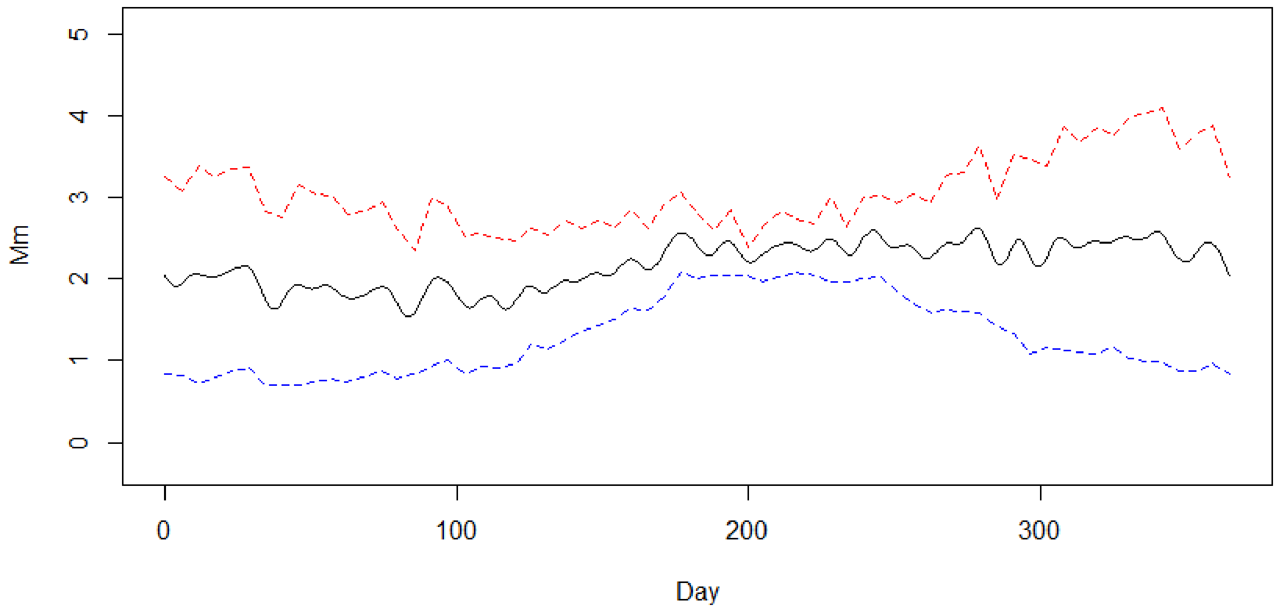
Temperature variation



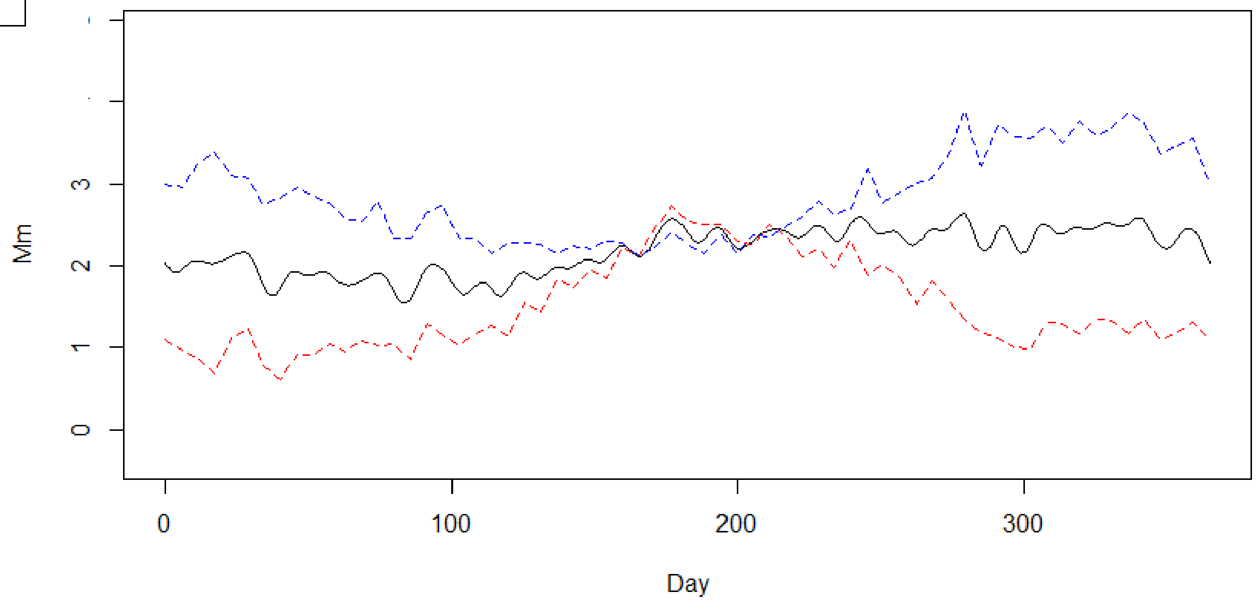
Weather stations Canada

Variation of the mean curve, Variable 2 Harmonic 1



Pluviometry variation

Variation of the mean curve, Variable 2 Harmonic 2



→ Amplitude variation

Contents

Conclusion

- **New model** which allows *univariate* and *multivariate* functional clustering
  - Paper & Simulations available on HAL

- **Designing** an R package available on:

  https://cran.r-project.org/web/packages/funHDDC/index.html

- Coming:

Extension to co-clustering