



# PREVISÃO DE VAZÕES USANDO MODELOS HÍBRIDOS E PUROS DE MACHINE LEARNING

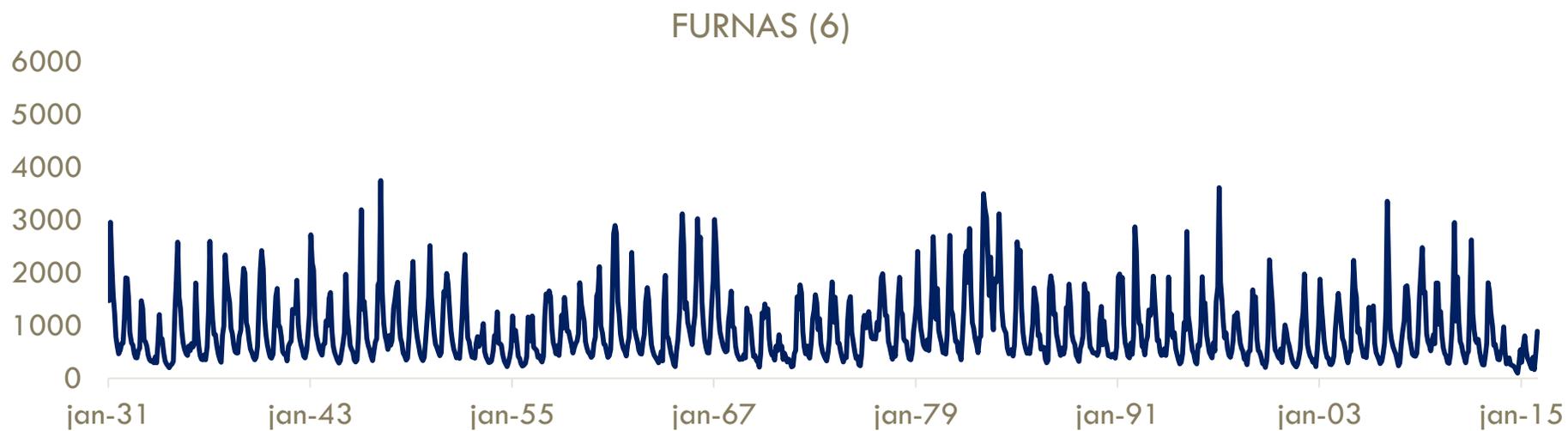
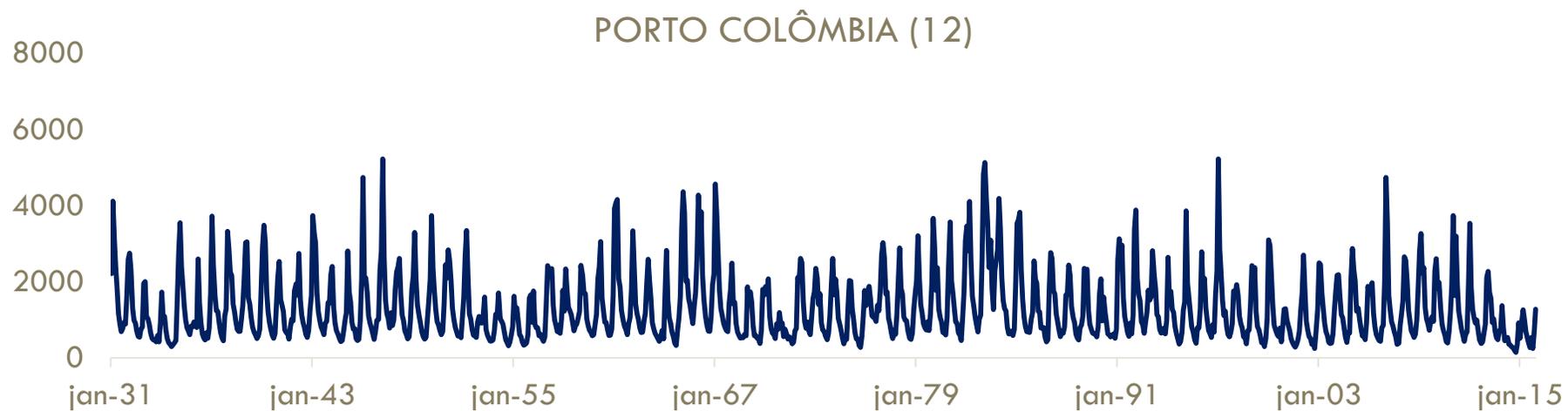
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Fernando Cyrino

# A QUESTÃO DA ESTACIONARIEDADE

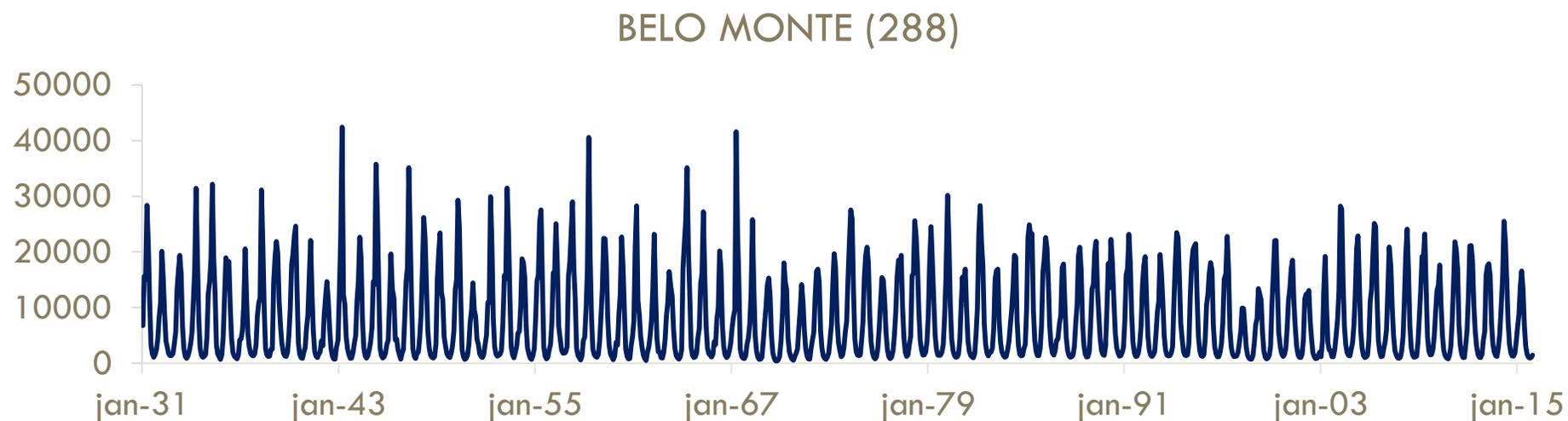
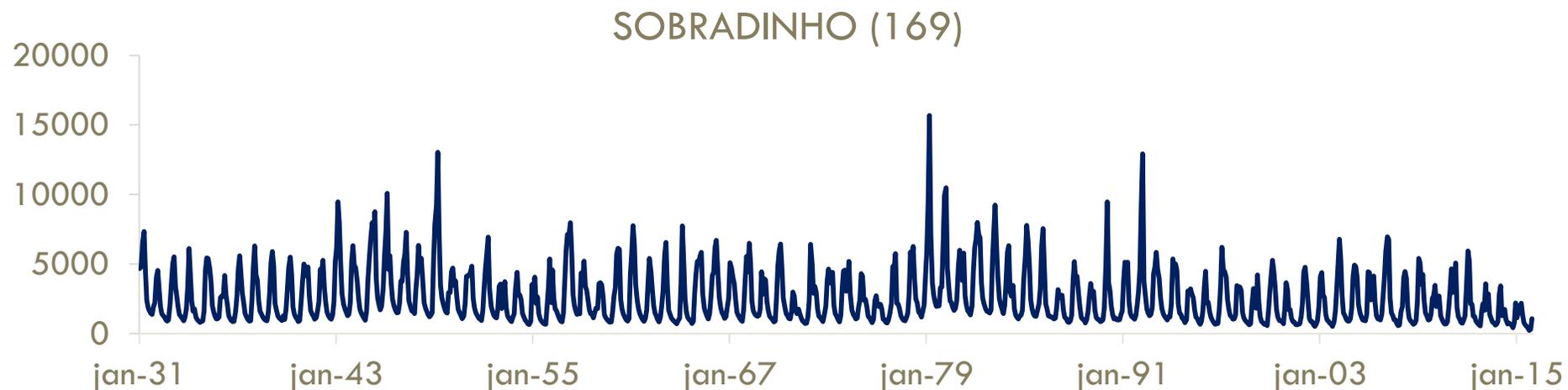


- Modelos Box-Jenkins – Premissa: estacionariedade de segunda ordem
- Teste de Mann-Kendall (Avalia mudanças graduais de tendência):
  - A maioria das séries históricas de vazão brasileiras são NÃO estacionárias !!!

# A QUESTÃO DA ESTACIONARIEDADE



# A QUESTÃO DA ESTACIONARIEDADE



# CONTEXTUALIZAÇÃO



Theor Appl Climatol (2017) 128:875–903  
DOI 10.1007/s00704-016-1735-8

2017

ORIGINAL PAPER

## Application of soft computing based hybrid models in hydrological variables modeling: a comprehensive review

Farzad Fahimi<sup>1</sup> · Zaher Mundher Yaseen<sup>1</sup> · Ahmed El-shafie<sup>2</sup>

Crescente uso de modelos de  
Inteligência Artificial em hidrologia!



ELSEVIER

2013

Contents lists available at [ScienceDirect](#)

Journal of Hydrology

journal homepage: [www.elsevier.com/locate/jhydrol](http://www.elsevier.com/locate/jhydrol)

Review Paper

## Applications of hybrid wavelet–Artificial Intelligence models in hydrology: A review

Vahid Nourani<sup>a,\*</sup>, Aida Hosseini Baghanam<sup>a</sup>, Jan Adamowski<sup>b</sup>, Ozgur Kisi<sup>c</sup>



ELSEVIER

2015

Contents lists available at [ScienceDirect](#)

Journal of Hydrology

journal homepage: [www.elsevier.com/locate/jhydrol](http://www.elsevier.com/locate/jhydrol)

Review Paper

## Artificial intelligence based models for stream-flow forecasting: 2000–2015

Zaher Mundher Yaseen<sup>a,\*</sup>, Ahmed El-shafie<sup>a,b</sup>, Othman Jaafar<sup>a</sup>, Haitham Abdulmohsin Afan<sup>a</sup>, Khamis Naba Sayl<sup>a</sup>

# CONTEXTUALIZAÇÃO



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Journal of Hydrology 2015

journal homepage: [www.elsevier.com/locate/jhydrol](http://www.elsevier.com/locate/jhydrol)

Are hybrid models integrated with data preprocessing techniques suitable for monthly streamflow forecasting? Some experiment evidences

Xiaoli Zhang, Yong Peng\*, Chi Zhang, Bende Wang



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Contents lists available at [ScienceDirect](#)

Journal of Hydrology 2017

journal homepage: [www.elsevier.com/locate/jhydrol](http://www.elsevier.com/locate/jhydrol)

Research papers

The incorrect usage of singular spectral analysis and discrete wavelet transform in hybrid models to predict hydrological time series

Kongchang Du <sup>a,b</sup>, Ying Zhao <sup>a,\*</sup>, Jiaqiang Lei <sup>a</sup>

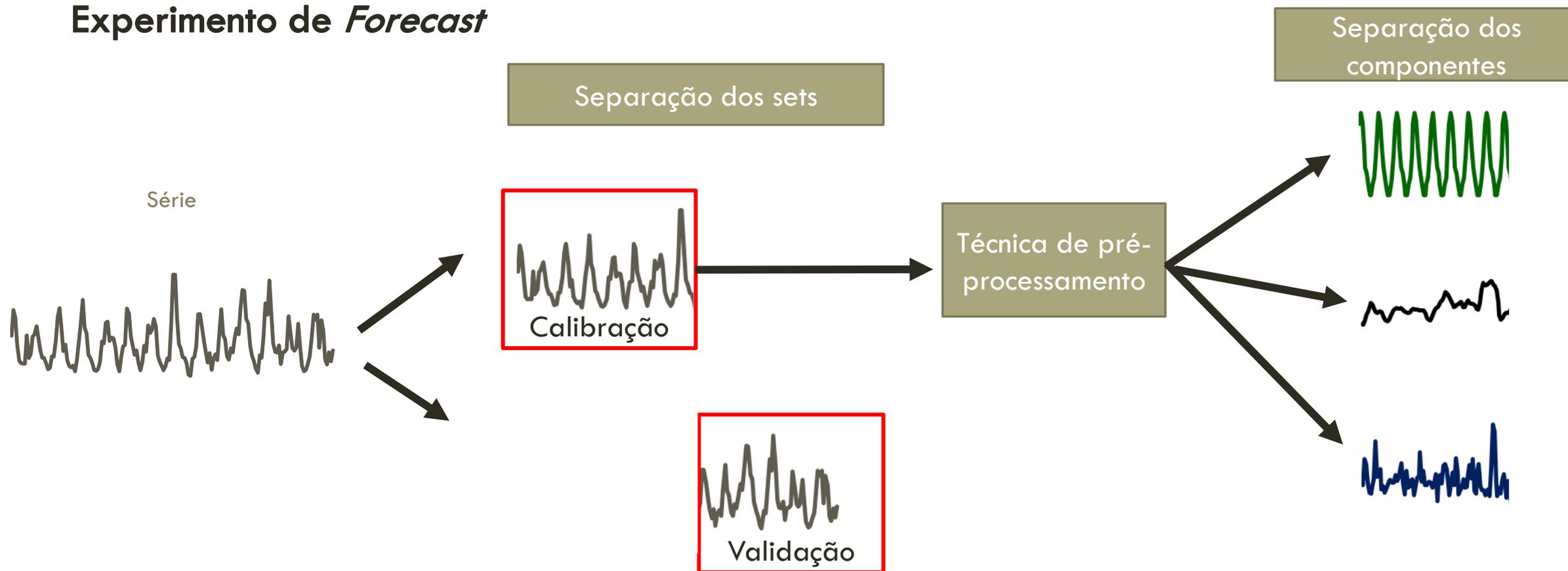
# CONTEXTUALIZAÇÃO



- Modelos híbridos X Modelos Puros: Falta de consenso na literatura
- Modelos híbridos com técnicas de pré-processamento de dados: Informação futura
- Experimento de Hindcast (“Inner”) X Experimento de Forecast (“Outer”)

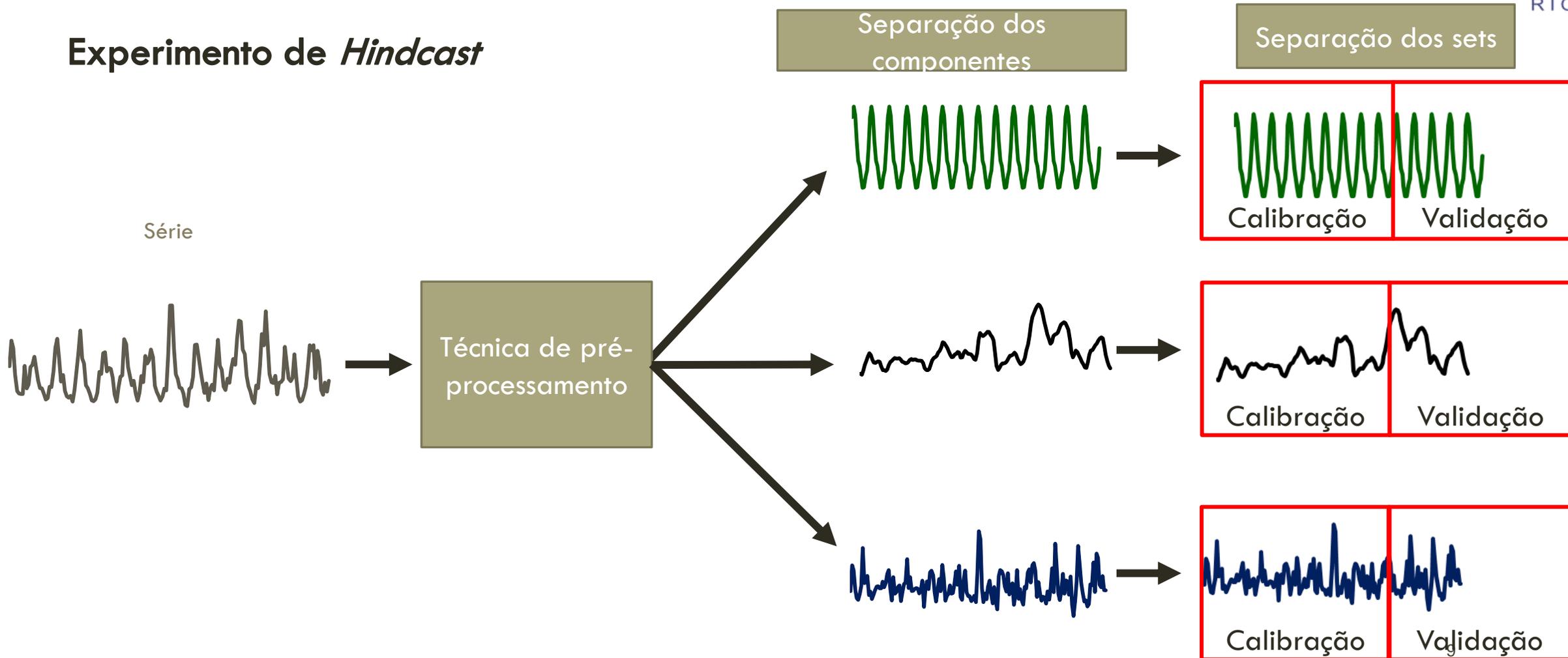
# CONTEXTUALIZAÇÃO

## Experimento de *Forecast*



# CONTEXTUALIZAÇÃO

## Experimento de *Hindcast*



# OBJETIVO



Comparar a performance dos modelos puros e híbridos para as séries de vazões Sobradinho e Belo Monte.

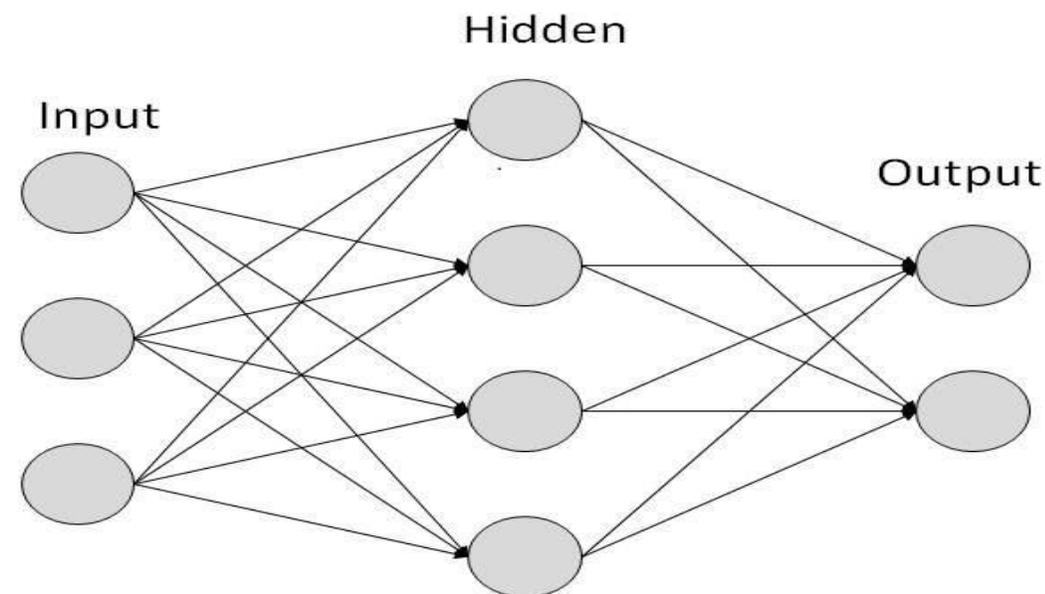
# METODOLOGIA

## 1. Técnicas de modelagem:

### Autorregressivo Integrado de Médias Móveis

$$\text{ARIMA } \underbrace{(p, d, q)}_{\substack{\uparrow \\ \text{Non-seasonal part} \\ \text{of the model}}} \underbrace{(P, D, Q)_m}_{\substack{\uparrow \\ \text{Seasonal part} \\ \text{of the model}}}$$

### Redes Neurais Artificiais (RNA)



# METODOLOGIA



## 2. Técnicas de pré-processamento de dados:

- **Singular Spectrum Analysis (SSA):**

$$Z_t \approx R_1 + \dots + R_m$$

- **Seasonal and Trend decomposition based on Loess (STL):**

$$Z_t = T_t + S_t + R_t$$

# METODOLOGIA



## 3. Experimento

### Modelos Puros

ARIMA

RNA

### Modelos Híbridos

SSA-ARIMA

SSA-RNA

STL-ARIMA

STL-RNA

# PRÓXIMOS PASSOS



1. Implementação dos modelos
2. Análise de Resultados

**Obrigada pela atenção!**

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