

# Tópico 04 - Deep Learning - Redes Recorrentes

Prof. André Gustavo Hochuli

[gustavo.hochuli@pucpr.br](mailto:gustavo.hochuli@pucpr.br)  
[aghochuli@ppgia.pucpr.br](mailto:aghochuli@ppgia.pucpr.br)

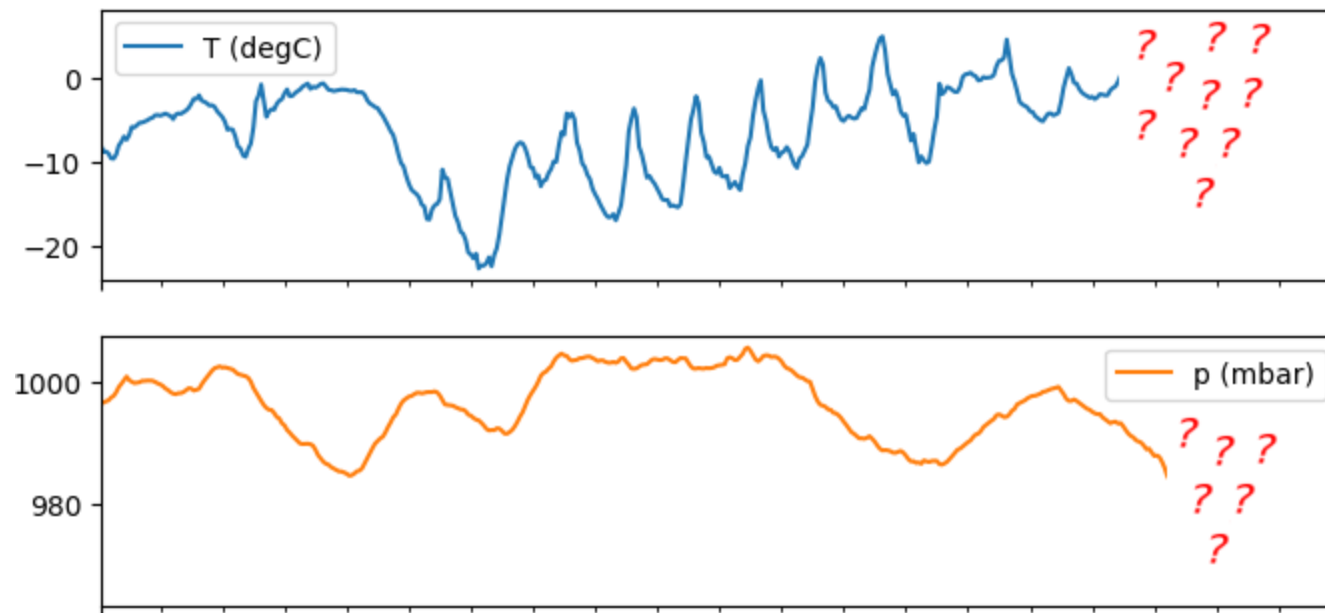
# Tópicos

- Discussão Inicial
- Redes Recorrentes
  - RNN
  - LSTM
- Exercício



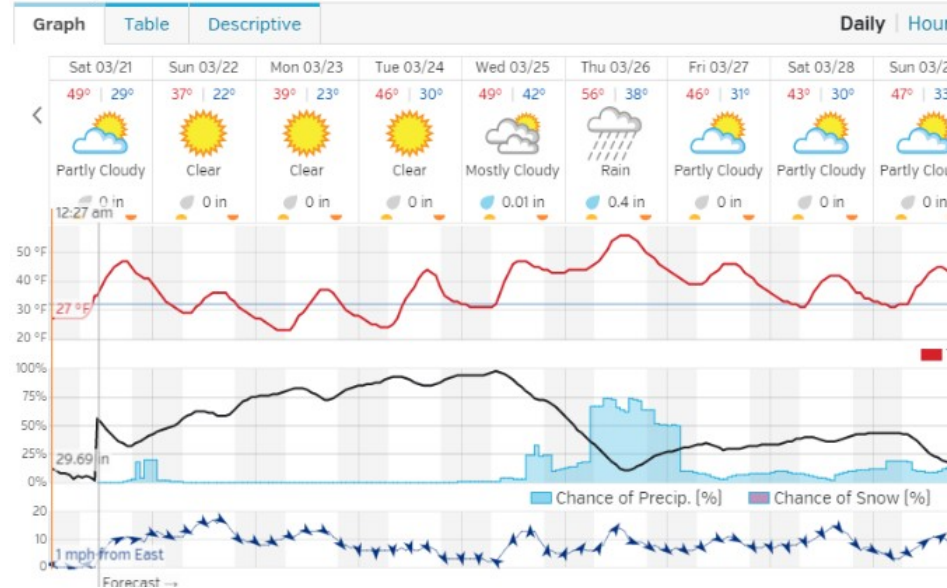
# Discussão Inicial

- E quando temos uma informação temporal ?
  - Ex: previsão do tempo, variação de preços, etc ?
- Em certas aplicações, uma dependência temporal afeta a classe da instância



# Discussão Inicial

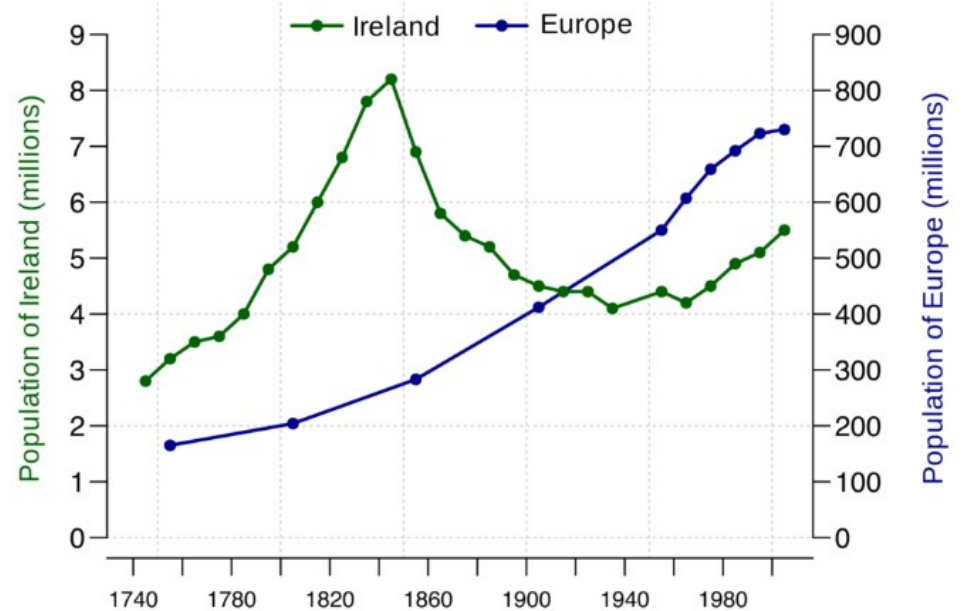
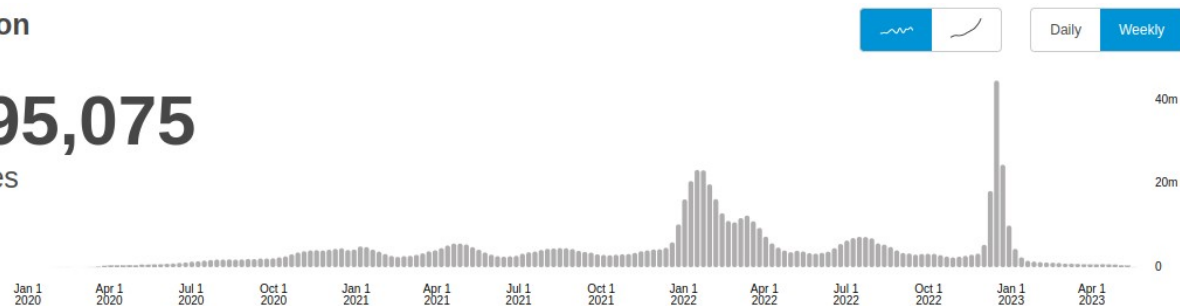
## 10-Day Weather Forecast



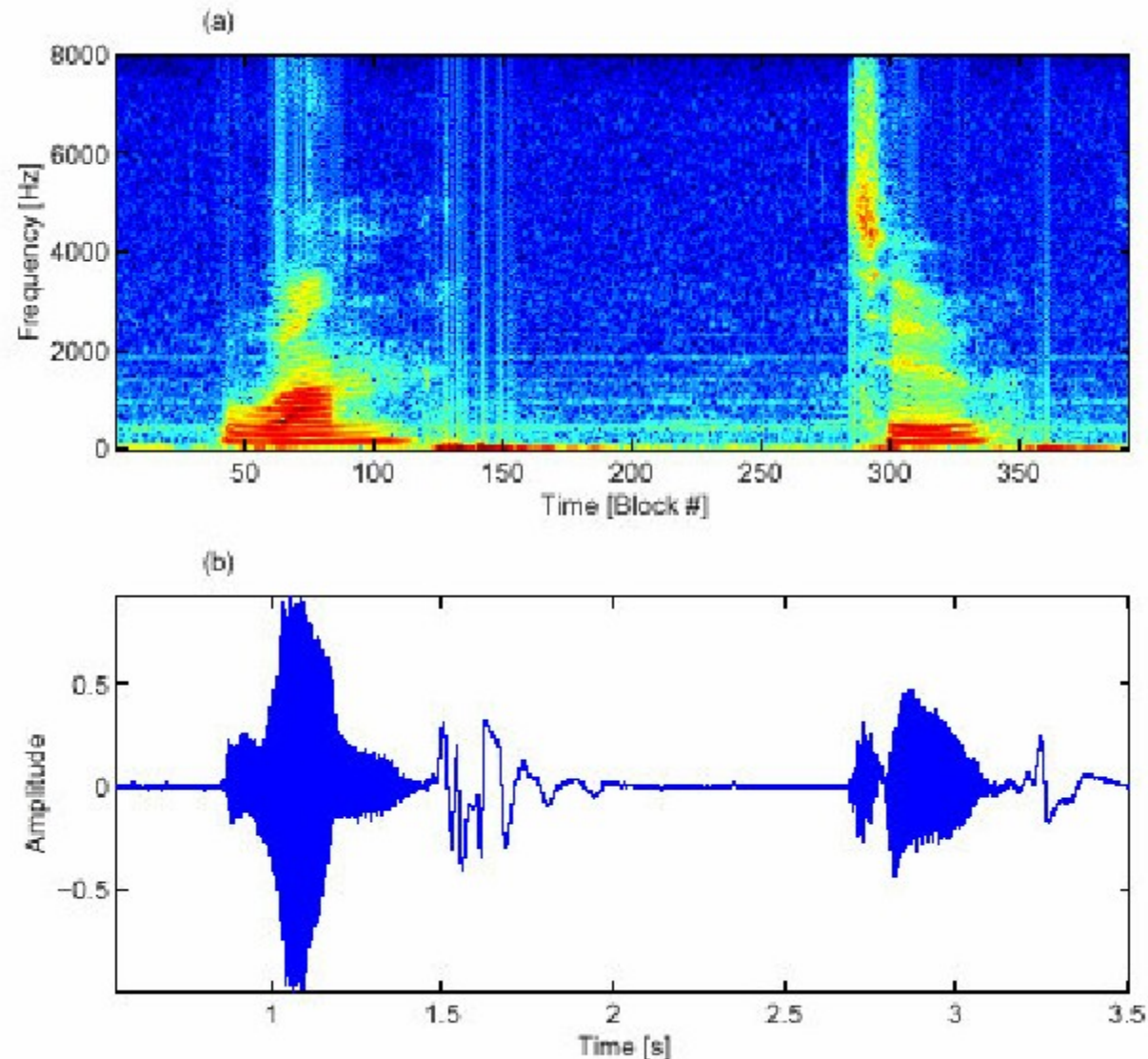
## Global Situation

**766,895,075**

confirmed cases

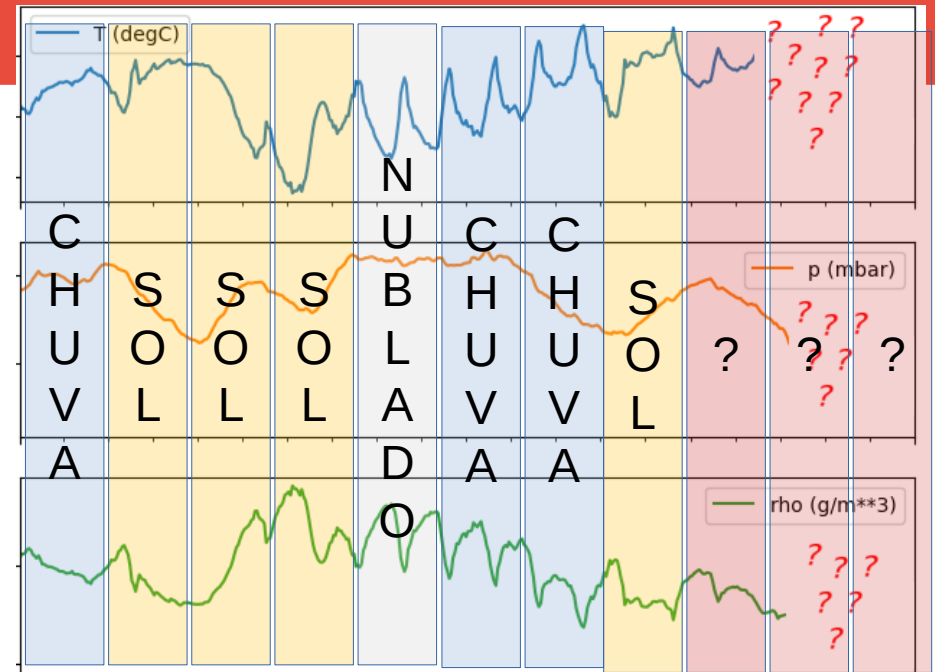


# Discussão Inicial



# Discussão Inicial

- Classificação “Estática”
  - Instâncias são interpretadas isoladamente
- Classificação Recorrente
  - A classe da instância anterior é importante para interpretação da instância atual
- Exemplos
  - Imagem vs Vídeo



# Redes Neurais Recorrentes

# Redes Neurais Recorrentes

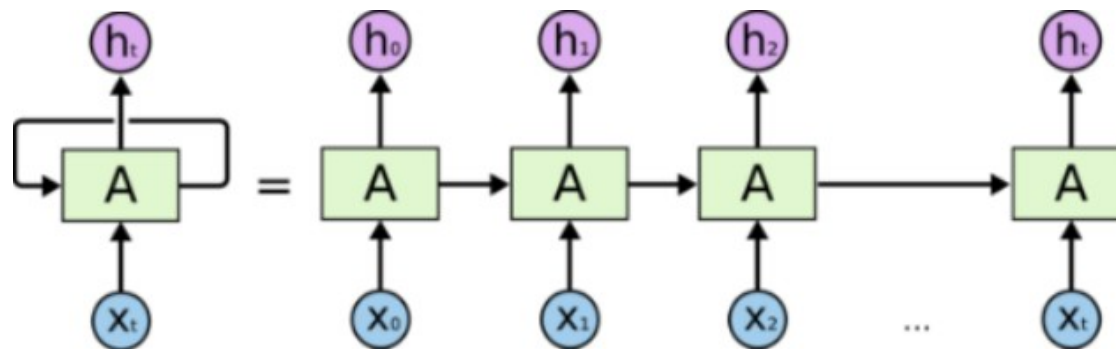
- Modelos capazes de interpretar sequência de dados
- Um conjunto de eventos determina a classe



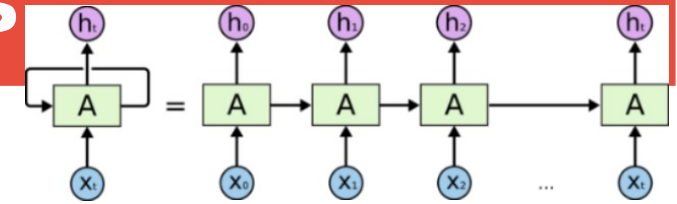


# Redes Neurais Recorrentes

- Modelos 'estáticos' não codificam adequadamente a informação contextual de instâncias anteriores (série temporal)
- Solução: Recurrent Neural Networks
  - RNA propagando pesos + atributos
  - O estado  $H_t$  é produzido com base em  $X_t + W_{t-1}$
  - Aprende a relação entre as instâncias e classes

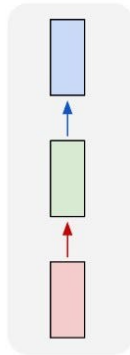


# Redes Neurais Recorrentes

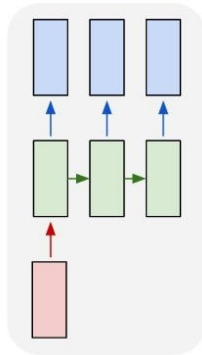


Abordagens:

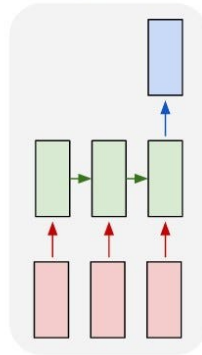
one to one



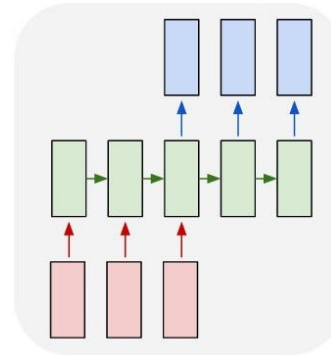
one to many



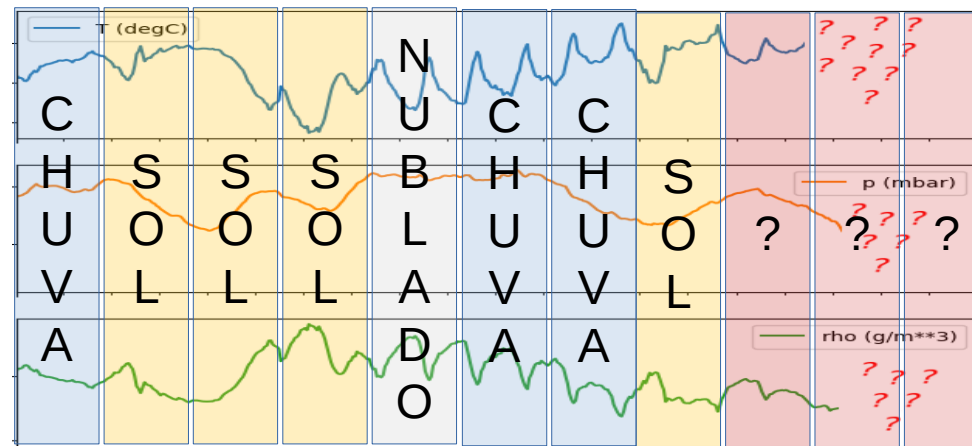
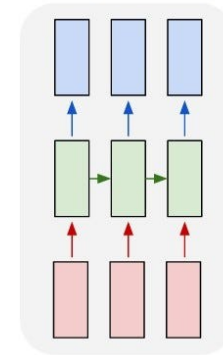
many to one



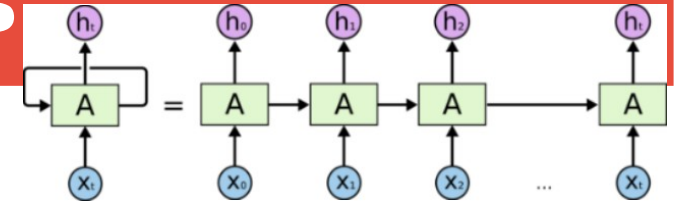
many to many



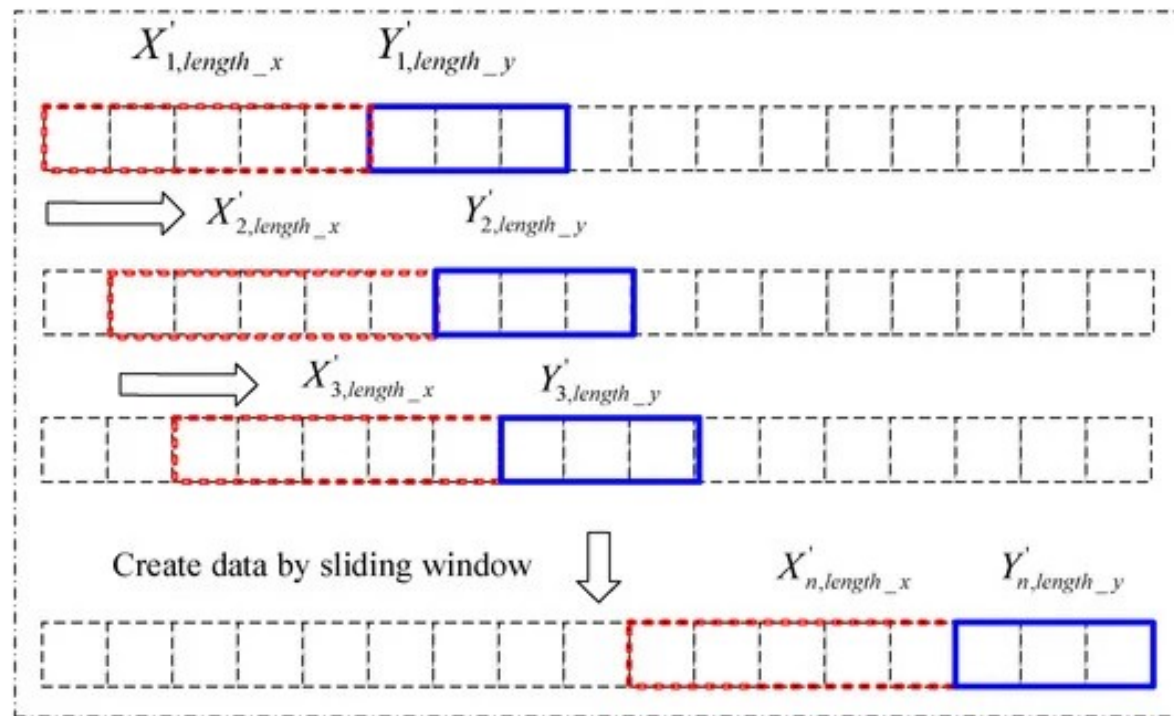
many to many



# Redes Neurais Recorrentes

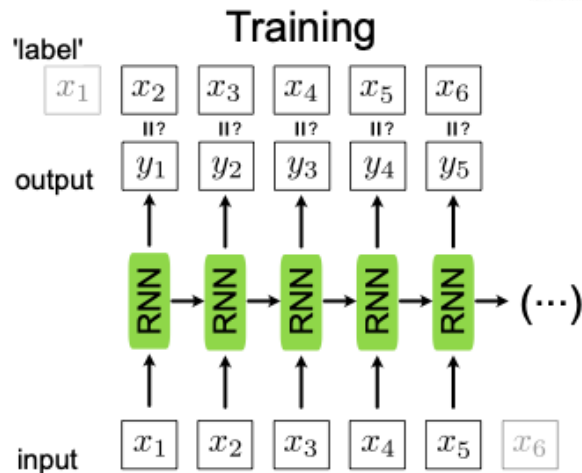
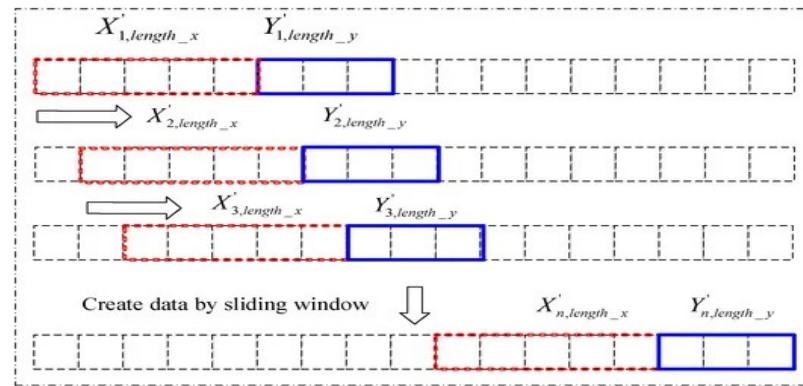
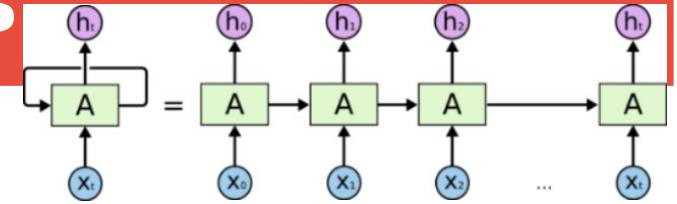


- Parâmetro: Tamanho da Janela
- Determina a relação entre observação e predição

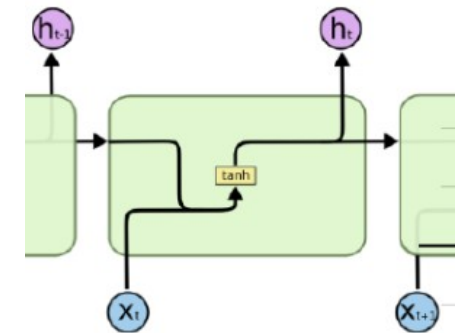
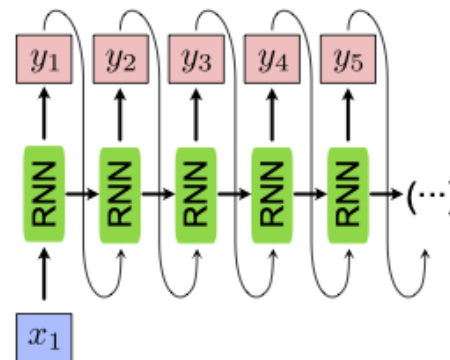


# Redes Neurais Recorrentes

- Treinamento / Teste
  - Base de amostras são geradas deslizando a janela

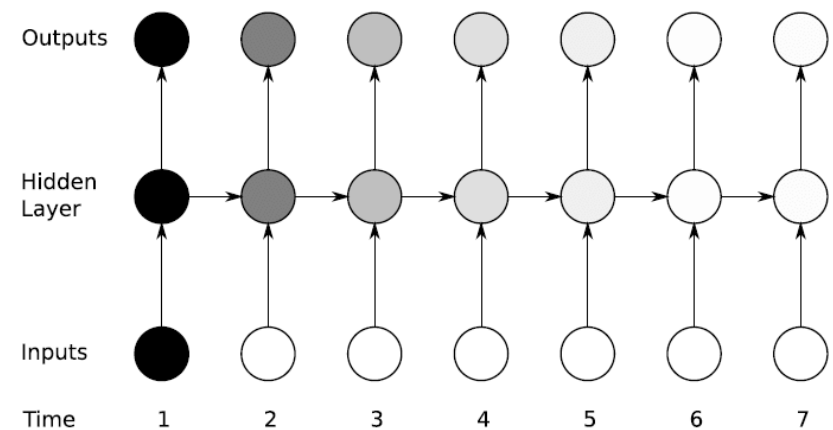
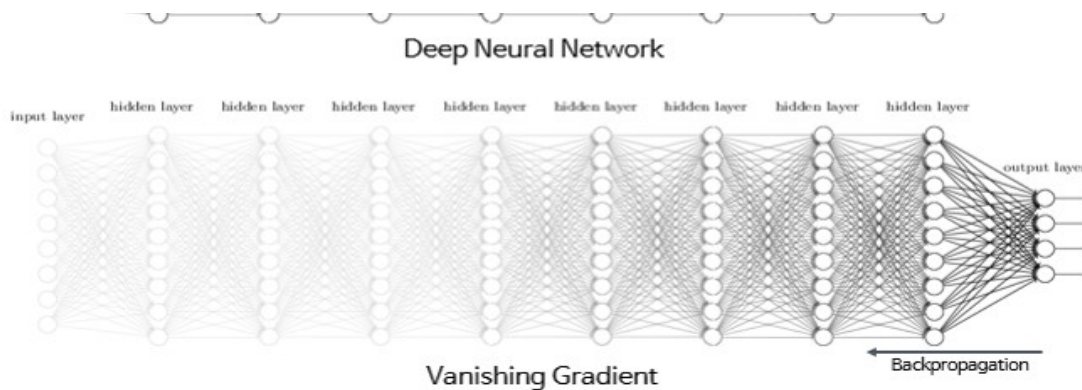
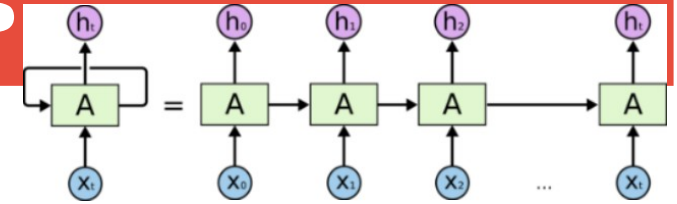


Generation



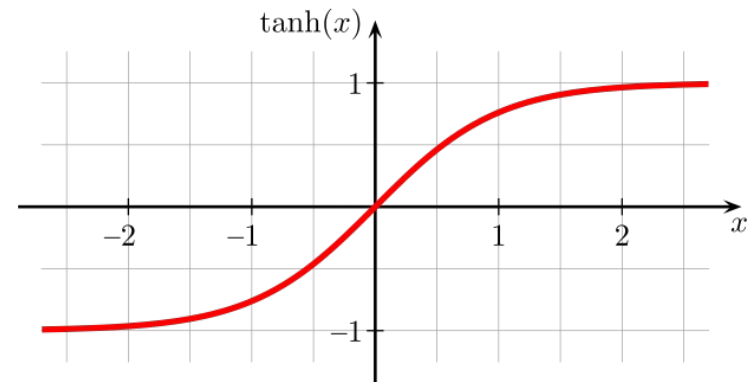
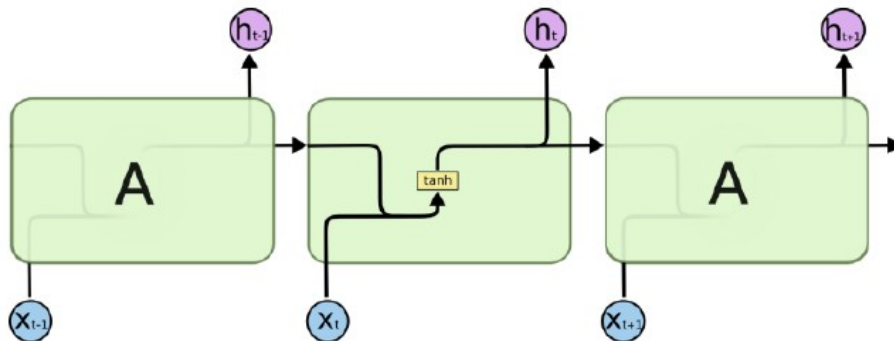
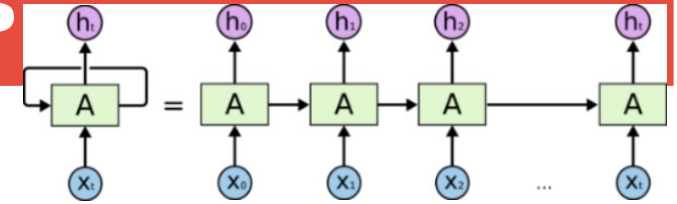
# Redes Neurais Recorrentes

- Problema – Vanish Gradient
  - Em sequências grandes, o gradiente desaparece
  - O peso da informação ‘antiga’ decresce ao longo do tempo



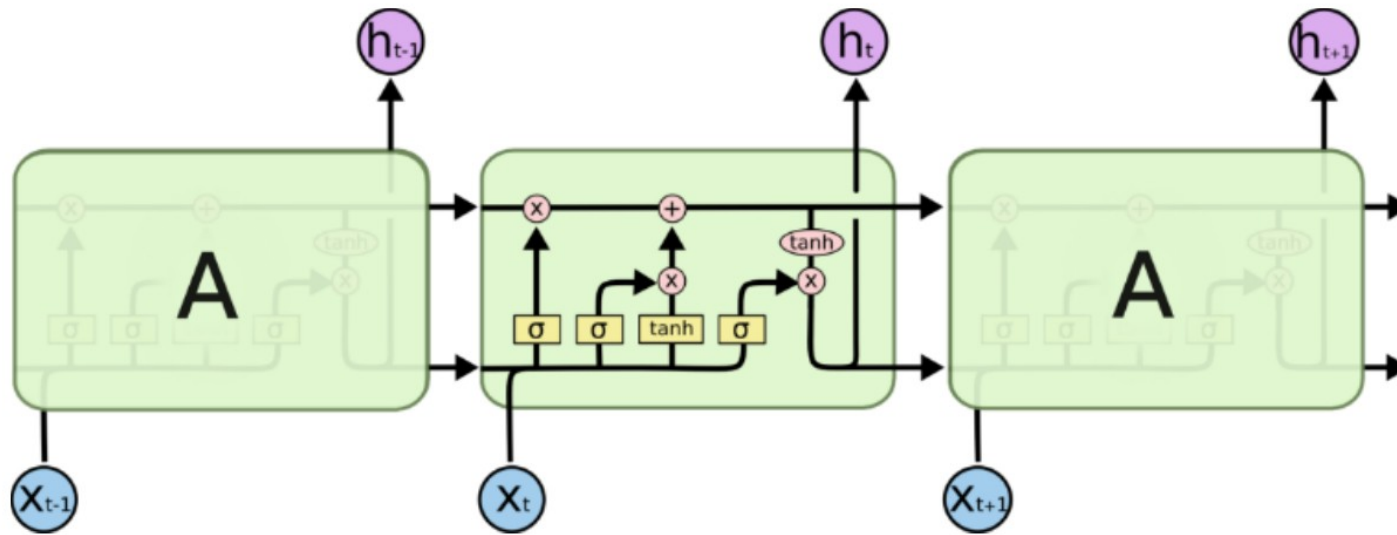
# Redes Neurais Recorrentes

- Problema – Vanish Gradient
  - Tanh é uma função lenta



# Redes Neurais Recorrentes

- Long-Short-Term-Memory (LSTM)
  - Fluxo Superior – Memória Longa
    - Multiplicação e **Soma** dos Pesos
  - Fluxo Inferior – Memória Curta
    - Multiplicação dos Pesos



# Redes Neurais Recorrentes

- Gatilhos
  - Esquecimento (\*)
  - Entrada (+)
  - Saída (\*)

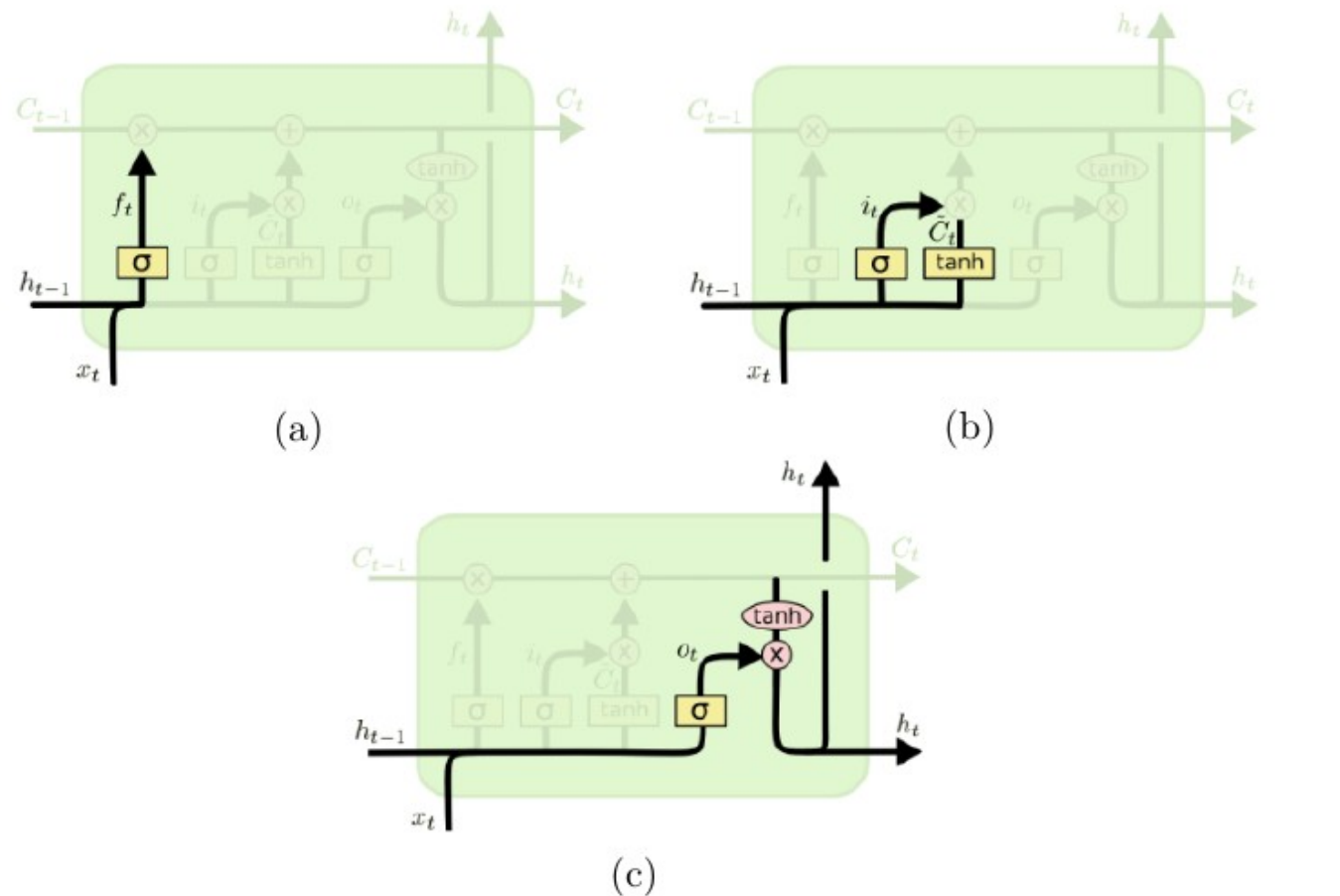


Figura 2.14: Gatilhos LSTM: (a) Esquecimento ( $f_t$ ), (b) Entrada ( $i_t$ ) e (c) Saída ( $o_t$ ).



# Redes Neurais Recorrentes

- Let's Code!
- [\[LINK\]](#)