



Relatório do Projeto de LAPR1

Subtítulo adequado ao âmbito/tema do projeto.

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1. **Introdução**

O trabalho descrito neste documento foi-nos proposto no âmbito da cadeira de LAPR1, e tinha o intuito de que os alunos do primeiro ano de Engenharia Informática pudessem pôr em prática os conhecimentos adquiridos nas cadeiras lecionadas ao longo do primeiro semestre.

Posto isto, a tarefa que nos foi dada consistia na elaboração de uma aplicação em linguagem Java que conseguisse analisar séries temporais, bem como estimar os seus valores futuros. Isto é concretizável devido à possibilidade de se analisar uma série temporal através de fórmulas de filtragens (sendo que existem dois tipos de filtração: uma a partir da Média Móvel Simples e outra a partir da Média Exponencialmente Pesada) e de previsões (existindo também dois métodos semelhantes aos da filtragem).

Para executar este projeto, foram-nos disponibilizadas duas semanas focadas no desenvolvimento do trabalho e no esclarecimento de dúvidas através de:

* Oficinas de trabalho, focadas no progresso do projeto em equipa;
* Reuniões com o cliente, onde era possível esclarecer dúvidas com o próprio cliente;
* Aulas Prático-Laboratoriais, nas quais estavam presentes professores especializados em Algoritmia e Programação ou na área das matemáticas que nos iluminaram em relação a fórmulas ou metodologia do trabalho em Java.

Passadas estas semanas, submetemos, no dia 22 de dezembro, o nosso projeto para que fosse avaliado. Posto isto, o que nos restava fazer era elaborar o relatório e preparar a apresentação do trabalho.

**Sugestão para a configuração padrão do documento do relatório:**

* Espaçamento entre linhas do texto: 1,15 espaço entre linhas
* Tipo e tamanho de letra texto: Calibri, letra tamanho 11, normal[[1]](#footnote-1)
* Tipo e tamanho de letra dos títulos nível 1: Calibri, 14, bold
* Tipo e tamanho de letra dos títulos nível 2: Calibri, 12, bold
* Tipo e tamanho de letra dos títulos nível 3 (caso existam): Calibri 11, bold
* Texto justificado (margem a margem)
* Espaçamento entre parágrafos: 6 pto antes / 6 pto depois (e/ou 1 cm tabulação primeira linha de cada parágrafo)
* Numeração das páginas: rodapé à direita; letra tamanho 10
* Títulos das imagens (Figura) e tabelas (Tabela): centrada, letra tamanho 10

1. **Metodologia de Trabalho**

## **2.1 EduScrum no desenvolvimento do Projeto**

Referir em que consiste a metodologia eduScrum e como a aplicaram ao longo do desenvolvimento do trabalho em equipa**.**

## **2.2 Planeamento e distribuição de tarefas**

A ferramenta que mais nos foi útil para a organização e distribuição das tarefas foi o Trello, onde registámos diariamente a evolução do projeto: as etapas concluídas, os aspetos a melhorar ou a corrigir e quais os membros que mais se focaram em cada tarefa. Com a utilização desta plataforma, foi-nos possível implementar *due dates*, isto é, datas limite para fazer determinada tarefa, de forma a conseguirmos orientar-nos tendo em conta o tempo restante para finalizar o trabalho na sua totalidade.

A distribuição das tarefas era feita no final de cada dia de trabalho, ao fazer o balanço da evolução do projeto. Posto isto, ou por via *Messenger* ou discutindo pessoalmente, distribuíamos as tarefas

Refletir sobre o plano do trabalho na sua totalidade, a organização em equipa, a distribuição de tarefas; referir as ferramentas utilizadas (de planeamento e de comunicação) e sua utilidade.

## **2.3 Reflexão crítica sobre a dinâmica do grupo**

Desde o início que valorizámos a organização. É impossível obter resultados positivos se os objetivos não estiverem bem definidos dentro do grupo. Por isso, achámos mais eficiente fazer um registo diário de todos os progressos feitos. Este foi um passo fundamental para criar boas práticas de organização no desenrolar do projeto.

Passando à comunicação, podemos afirmar ter sido um grupo em que não faltou boa disposição, empenho e cooperação entre todos os membros.

Reflexão crítica (individual ou em grupo) sobre a dinâmica de trabalho na equipa e respetivas consequências.

1. **Análise de Séries Temporais**

Como foi referido anteriormente, o nosso projeto consistia em criar uma aplicação que, com base em dados estatísticos pudesse esboçar uma série temporal e através dela, fazer uma análise da mesma.

A análise iria consistir em utilizar técnicas de suavização e filtragem, para uma melhor compreensão, removendo ruídos e identificar possíveis tendências que a série poderia tomar. Também possível prever acontecimentos seguintes utilizando técnicas de previsão onde, através de um modelo matemático, capture o processo que gerou a série temporal e assim permita prever valores futuros da série utilizando dados anteriores.

Nada disto se tornaria possível se não houvesse um estudo e uma pesquisa relacionada com o tema, no intuito de recolher a maior e melhor quantidade de informação para desenvolver o nosso projeto. Deste forma, iremos tratar toda a teoria e proporcionar uma melhor compreensão sobre o tema abordado neste tópico.

## **3.1. Séries Temporais**

Uma série temporal é uma sequência de observações ordenada cronologicamente que, em geral, são recolhidos em intervalos regulares. A análise de séries temporais pode ser aplicada a qualquer variável que muda ao longo do tempo e, de um modo geral, as observações mais próximas têm valores mais próximos e correlacionados que aqueles valores mais distantes (Hyndman & Athanasopoulos, 2014; SEMATECH, 2019).

A análise de séries temporais é de grande utilidade em vários domínios como a Música, Química, Energia, entre outros, sendo que do seu processamento podem resultar ganhos significativos para o conhecimento do negócio ou planeamento de atividades.

Em seguida, seguem-se exemplos de séries temporais:

![Uma imagem com vedação

Descrição gerada automaticamente](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAeAB4AAD/4RD8RXhpZgAATU0AKgAAAAgABAE7AAIAAAARAAAISodpAAQAAAABAAAIXJydAAEAAAAgAAAQ1OocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEbDoWJpbyBGZXJuYW5kZXMAAAAFkAMAAgAAABQAABCqkAQAAgAAABQAABC+kpEAAgAAAAMyOQAAkpIAAgAAAAMyOQAA6hwABwAACAwAAAieAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Figura 1 - Ruído Branco Gaussiano

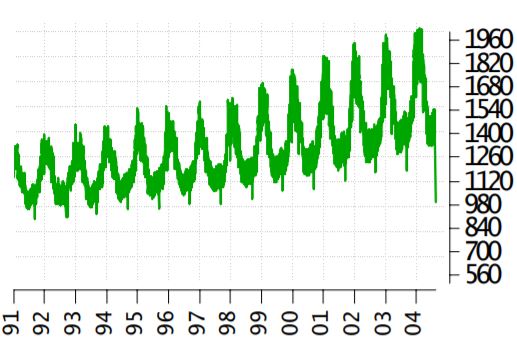


Figura 2 - Consumo Energético

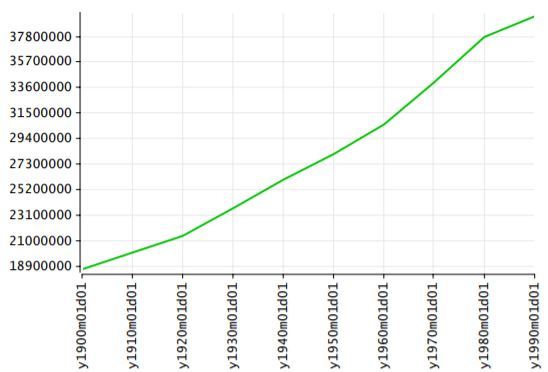


Figura 3 - População de Espanha

Ao analisar uma série temporal, espera-se que nesta exista uma causa relacionada com o tempo, que influenciou os dados e que possam continuar a influenciá-los futuramente.

## **3.2. Objetivo das séries temporais**

Segundo MORETTIN e TOLOI (1981) e CHAFTFIELD (2000), os objetivos de analisar uma série temporal são os seguintes:

1. Descrição: Determinar as propriedades de uma série como, por exemplo, o padrão de tendência, a existência de alterações estruturais e sazonalidades. Antes de modelar ou prever uma determinada série de tempo, é necessário ter uma ideia preliminar dos dados, para obter e descrever algumas das suas principais propriedades. O que terá uma enorme contribuição no processo de modelação.
2. Explicitação ou Modelação: Encontrar um modelo estatístico adequado que permita explicar o comportamento da série no período observado.
3. Previsão: Estimar valores futuros de uma Série Temporal, com base em valores anteriores.
4. Controlo de processos: Boas previsões permitem ao estatístico, tomar medidas de forma a controlar um determinado processo.

## **3.3. Técnicas para análise de séries temporais**

Entre as técnicas de filtragem mais utilizadas e simples estão a Média Móvel Simples e a Média Móvel Exponencialmente Pesada (SEMATECH, 2019), ambas utilizadas para efetuar os métodos de suavização implementados na nossa aplicação.

### **3.3.1. Média Móvel Simples**

A Média Móvel Simples (Simple Moving Average) é uma média móvel[[2]](#footnote-2) aritmética calculada adicionando preços recentes e, em seguida, dividindo-os pelo número de períodos de tempo na média de cálculo.

As médias de curto prazo respondem rapidamente a mudanças no preço do subjacente, enquanto as médias de longo prazo demoram a reagir.

A Média Móvel Simples é um indicador técnico para determinar se um preço do ativo continuará ou reverterá uma tendência e é definida através da equação:

onde:

xi – termos que representam a série original;

yi – série resultante da aplicação da filtragem;

n – ordem da média móvel.

A Média Móvel Simples é personalizável na medida em que pode ser calculada por um número diferente de períodos de tempo.

Quanto maior a ordem da média móvel, mais suave a média móvel simples. Uma média móvel de curto prazo é mais volátil, mas a sua leitura está mais próxima dos dados de origem.

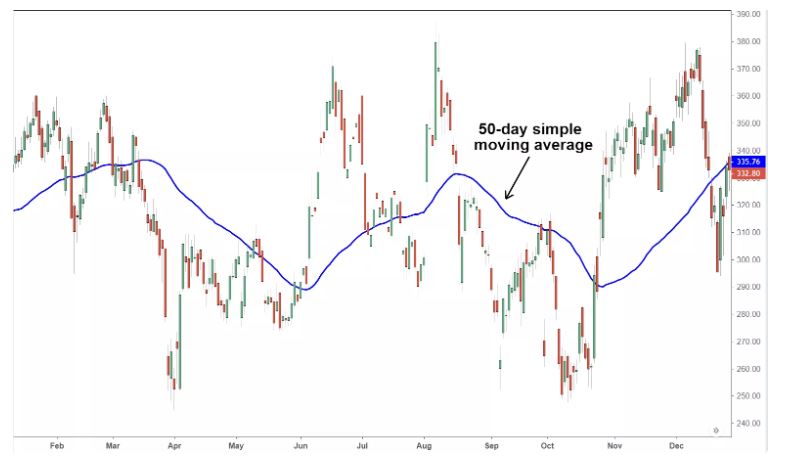


Figura 4 - Exemplo da aplicação da Média Móvel Simples

### **3.3.2. Média Móvel Exponencialmente Pesada**

Uma média móvel exponencial (Exponencial Moving Average) é um tipo de média móvel que coloca maior peso e significância nos pontos de dados mais recentes. A média móvel exponencial também é referida como média móvel exponencialmente ponderada.

A média móvel exponencialmente ponderada reage mais significativamente a mudanças recentes de preços do que uma média móvel simples (Simple Moving Average), que aplica um peso igual a todas as observações no período.

Como todas as médias móveis, esse indicador técnico é usado para produzir sinais de compra e venda com base em cruzamentos e divergências em relação à média histórica e é definida através da equação:

onde:

xi – termos que representam a série original;

yi – série resultante da aplicação da filtragem;

α – constante que varia entre ]0,1].

Todas as médias móveis comummente usadas na análise técnica são, por sua própria natureza, indicadores de atraso[[3]](#footnote-3), atrasados. Consequentemente, as conclusões tiradas da aplicação de uma média móvel a um gráfico de mercado específico devem ser para confirmar uma movimentação do mercado ou para indicar a sua força.

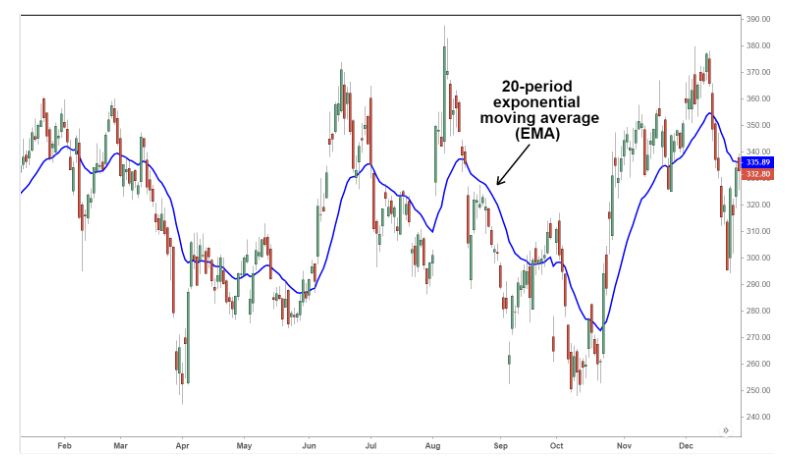


Figura 5 - Exemplo da aplicação da Média Móvel Exponencialmente Pesada

## **3.4. Previsão**

Previsão é um método usado extensivamente em análise de séries temporais para predizer uma variável de resposta como lucro mensal, desempenho dos estoques ou índices de desemprego para um período de tempo especificado. Previsões são baseadas em padrões nos dados existentes.

De forma a responder uma das tarefas propostas do enunciado que nos foi colocado, utilizamos dois métodos de previsão que foram mencionados anteriormente, contudo, com algumas alterações nas fórmulas:

## **3.4.1. Média Móvel Simples**

onde:

xi – termos que representam a série original;

yi + 1 – representa uma previsão utilizando dados anteriores;

n – ordem da média móvel.

## **3.4.2. Média Móvel Exponencialmente Pesada**

onde:

xi – termos que representam a série original;

yi+1 - representa uma previsão utilizando dados anteriores;

α - constante que toma valores no intervalo ]0, 1].

1. **Desenvolvimento e Implementação da Aplicação**

Para o desenvolvimento da aplicação, empregámos o conceito de modularização no nosso código, de modo a otimizá-lo e a facilitar a sua leitura e interpretação.

Nesta secção devem apresentar os métodos principais utilizados para implementar o que desenvolveram em **ambas as iterações**, justificando as opções tomadas e interligando com os anexos que incluírem sobre esta questão.

Têm de subdividir esta secção de acordo com a exposição/descrição que considerarem mais adequada ao vosso trabalho.

1. **Resultados**

Nesta secção têm de expor claramente os resultados do trabalho desenvolvido (outputs) e incluir uma subsecção onde fazem a análise desses resultados (5.1).

## **Análise dos resultados**

Xxxxxx

1. **Conclusão**

Xxxxxxxxxxxx xxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

A conclusão tem de:

* + - Resumir os pontos principais explicitados no corpo central do relatório;
    - Realçar os principais resultados alcançados;
    - Refletir sobre o trabalho desenvolvido, fazer sugestões de melhoria.

# **Referências**

Seguindo as regras da APA (American Psychology Association).

# **ANEXOS**

**ANEXOS**

## **ANEXO A \_ Testes Unitários**

(Incluir os anexos que considerarem relevantes.)

1. Notas de rodapé: tamanho 10 pt; espaçamento entre linhas: simples (1). [↑](#footnote-ref-1)
2. Uma média móvel (MA) é um indicador utilizado na análise técnica que ajuda a suavizar a ação do preço filtrando o "ruído" de flutuações aleatórias de preços de curto prazo. É um indicador de tendência atrasado porque é baseado em preços passados. [↑](#footnote-ref-2)
3. Um indicador de atraso é qualquer variável mensurável ou observável que se move ou muda de direção depois de uma mudança que ocorre em uma variável alvo. [↑](#footnote-ref-3)