```python
In [1]:  import numpy as np
         import pandas as pd
         import matplotlib.pyplot as plt
```

```python
In [2]:  mu = 10
         phi1 = 0.5
         phi2 = 0.3
         n = 20
```

```python
In [3]:  np.random.seed(42)
         epsilon = np.random.randint(-3, 4, size=n)
```

```python
In [4]:  f_t_ma1 = np.zeros(n)
         f_t_ma2 = np.zeros(n)
```

```python
In [5]:  for t in range(1, n):
             f_t_ma1[t] = mu + phi1 * epsilon[t-1] # MA(1)
             if t >= 2:
                 f_t_ma2[t] = mu + phi1 * epsilon[t-1] + phi2 * epsilon[t-2] # MA(2)
             else:
                 f_t_ma2[t] = mu + phi1 * epsilon[t-1]
```

```python
In [6]:  df = pd.DataFrame({
         "t": np.arange(1, n+1),
         "ε_t": epsilon,
         "MA(1)": f_t_ma1,
         "MA(2)": f_t_ma2
         })
```

```python
In [7]:  print(df)
```

```
        t  ε_t  MA(1)  MA(2)
    0   1    3    0.0    0.0
    1   2    0   11.5   11.5
    2   3    1   10.0   10.9
    3   4    3   10.5   10.5
    4   5   -1   11.5   11.8
    5   6    1    9.5   10.4
    6   7    1   10.5   10.2
    7   8    3   10.5   10.8
    8   9   -2   11.5   11.8
    9  10   -1    9.0    9.9
    10 11    3    9.5    8.9
    11 12   -1   11.5   11.2
    12 13   -1    9.5   10.4
    13 14    1    9.5    9.2
    14 15    0   10.5   10.2
    15 16   -1   10.0   10.3
    16 17    2    9.5    9.5
    17 18    1   11.0   10.7
    18 19   -2   10.5   11.1
    19 20    0    9.0    9.3
```
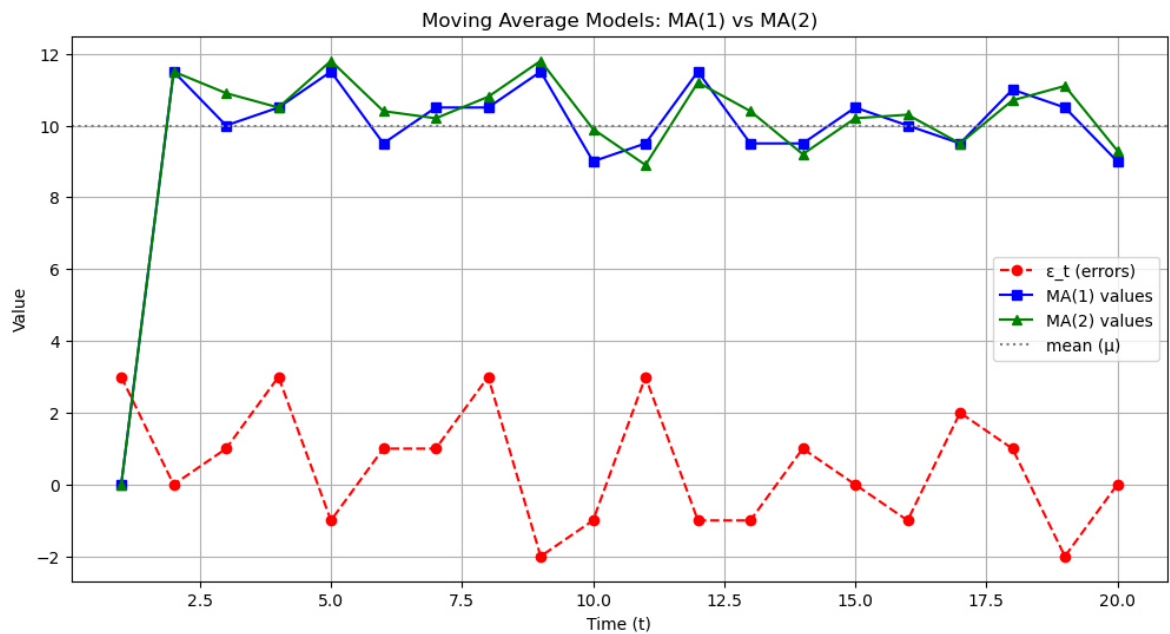
```python
In [8]:  # Plot
         plt.figure(figsize=(12,6))
```

```
plt.plot(df["t"], df["ε_t"], marker="o", linestyle="--", color="red", label="ε_t
plt.plot(df["t"], df["MA(1)"], marker="s", linestyle="-", color="blue", label="M
plt.plot(df["t"], df["MA(2)"], marker="^", linestyle="-", color="green", label="

plt.axhline(mu, color="gray", linestyle=":", label="mean (μ)")
plt.xlabel("Time (t)")
plt.ylabel("Value")
plt.title("Moving Average Models: MA(1) vs MA(2)")
plt.legend()
plt.grid(True)
plt.show()
```


In [ ]: