**Tables: Data Overview**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Frequency** | **Micro** | **Industry** | **Macro** | **Finance** | **Demographic** | **Other** | **Total** |
| **Yearly** | 6,538 | 3,716 | 3,903 | 6,519 | 1,088 | 1,236 | 23,000 |
| **Quarterly** | 6,020 | 4,637 | 5,315 | 5,305 | 1,858 | 865 | 24,000 |
| **Monthly** | 10,975 | 10,017 | 10,016 | 10,987 | 5,728 | 277 | 48,000 |
| **Weekly** | 112 | 6 | 41 | 164 | 24 | 12 | 359 |
| **Daily** | 1,476 | 422 | 127 | 1,559 | 10 | 633 | 4227 |
| **Hourly** |  |  |  |  |  | 414 | 414 |
| **Total** | 25,121 | 18,798 | 19,402 | 24,534 | 8,708 | 3,437 | 100,000 |

|  |  |
| --- | --- |
| **Frequency** | **Forecast horizon** |
| Yearly | 6 |
| Quarterly | 8 (2 years) |
| Monthly | 18 (1.5 years) |
| Weekly | 13 (3 months) |
| Daily | 14 (2 weeks) |
| Hourly | 48 (2 days) |

**Benchmark methods overview:**

|  |  |  |
| --- | --- | --- |
| **Method** | **Description** | **Type** |
| Naïve 2 | Seasonally adjusted naïve forecast using multiplicative decomposition. | M4 Benchmark used for calculating OWA. |
| Comb | Combination benchmark consisting of three forecasts: SES, Holt, Damped exponential smoothing. Combined using the arithmetic average of the three methods. | M4 Benchmark |
| Legaki & Koutsouri | Theta method after Box-Cox transformation with optimized transformation parameter. | M4 Competition method (Rank 8) |
| ARIMA | Automatically selected ARIMA model. Selection based on information criteria. | Comparison benchmark |
| ETS | Automatically selected exponential smoothing model. Selection based on information criteria. | Comparison benchmark |
| ETSARIMA | Arithmetic average of ETS and ARIMA forecasts. | Comparison benchmark |

**Data: All, freq:{H, D, W, M, Q, Y}, N=100,00; weighted average of frequencies**

**Data: m4\_hourly, freq: H, N=414**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| M4 Hourly (N=414) | | | | | | |
| **Method** | **OWA** | **sMAPE** | **MASE** | **Epochs** | **Batches** | **Passes** |
| **Benchmark Methods** | | | | | | |
| Naïve2 | 1.000 | 0.184 | 2.395 |  |  |  |
| Comb | 1.556 | 0.221 | 4.582 |  |  |  |
| ARIMA | 0.577 | 0.140 | 0.943 |  |  |  |
| ETS | 0.852 | 0.173 | 1.824 |  |  |  |
| ETSARIMA | 0.667 | 0.147 | 1.276 |  |  |  |
| Legaki & Koutsouri | 1.012 | 0.176 | 2.557 |  |  |  |
| **M4 Competition Methods** | | | | | | |
| Smyl | 0.440 | 0.093 | 0.893 |  |  |  |
| Montero-Manso, et al. | 0.484 | 0.115 | 0.819 |  |  |  |
| Doornik | 0.410 | 0.089 | 0.801 |  |  |  |
| **RNN Methods** | | | | | | |
| DeepAR | 0.537 | 0.108 | 1.207 | 500 | 100 | 3864.7 |
| DeepState | 0.635 | 0.137 | 1.2506 | 100 | 50 | 386.5 |
| DF-RNN | 3.812 | 0.346 | 13.753 | 100 | 50 | 386.5 |
| MQ-RNN | 4.513 | 0.465 | 15.884 | 200 | 100 | 1545.9 |

**Data: m4\_daily, freq:D, N=4227**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| M4 Daily (N=4227) | | | | | | |
| **Method** | **OWA** | **sMAPE** | **MASE** | **Epochs** | **Batches** | **Passes** |
| **Benchmark Methods** | | | | | | |
| Naïve2 | 1.000 | 0.030 | 3.278 |  |  |  |
| Comb | 0.978 | 0.030 | 3.203 |  |  |  |
| ARIMA | 1.044 | 0.032 | 3.410 |  |  |  |
| ETS | 0.996 | 0.030 | 3.253 |  |  |  |
| ETSARIMA | 1.005 | 0.031 | 3.271 |  |  |  |
| Legaki & Koutsouri | 0.996 | 0.030 | 3.254 |  |  |  |
| **M4 Competition Methods** | | | | | | |
| Smyl | 1.046 | 0.032 | 3.446 |  |  |  |
| Montero-Manso, et al. | 1.019 | 0.031 | 3.344 |  |  |  |
| Tartu (D#2) | 0.930 | 0.029 | 3.025 |  |  |  |
| **RNN Methods** | | | | | | |
| DeepAR | 1.063 | 0.033 | 3.459 | 200 | 100 | 151.4 |
| DeepState | 1.194 | 0.037 | 3.884 | 100 | 50 | 37.9 |
| DF-RNN | 1.958 | 0.0583 | 6.563 | 500 | 100 | 378.5 |
| MQ-RNN | 1.773 | 0.047 | 6.619 | 500 | 100 | 378.5 |

**Data: m4\_weekly, freq:W, N=359**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| M4 Weekly (N=359) | | | | | | |
| **Method** | **OWA** | **sMAPE** | **MASE** | **Epochs** | **Batches** | **Passes** |
| **Benchmark Methods** | | | | | | |
| Naïve2 | 1.000 | 0.092 | 2.777 |  |  |  |
| Comb | 0.926 | 0.089 | 2.430 |  |  |  |
| ARIMA | 0.932 | 0.087 | 2.556 |  |  |  |
| ETS | 0.931 | 0.087 | 2.527 |  |  |  |
| ETSARIMA | 0.906 | 0.084 | 2.471 |  |  |  |
| Legaki & Koutsouri | 0.968 | 0.091 | 2.601 |  |  |  |
| **M4 Competition Methods** | | | | | | |
| Smyl | 0.851 | 0.07817 | 2.356 |  |  |  |
| Montero-Manso, et al. | 0.796 | 0.07625 | 2.108 |  |  |  |
| Darin & Stellwagen (W#1) | 0.739 | 0.06582 | 2.107 |  |  |  |
| **RNN Methods** | | | | | | |
| DeepAR | 0.917 | 0.084 | 2.527 | 500 | 100 | 4456.8 |
| DeepState | 0.934 | 0.075 | 2.940 | 100 | 50 | 445.7 |
| DF-RNN | 1.822 | 0.134 | 6.048 | 200 | 100 | 1782.7 |
| MQ-RNN | 1.711 | 0.115 | 6.161 | 500 | 100 | 4456.8 |

**Data:** **m4\_monthly, freq: M, N=48,000**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| M4 Monthly (N=48,000) | | | | | | |
| **Method** | **OWA** | **sMAPE** | **MASE** | **Epochs** | **Batches** | **Passes** |
| **Benchmark Methods** | | | | | | |
| Naïve2 | 1.000 | 0.144 | 1.063 |  |  |  |
| Comb | 0.920 | 0.134 | 0.966 |  |  |  |
| ARIMA | 0.903 | 0.134 | 0.93 |  |  |  |
| ETS | 0.915 | 0.135 | 0.948 |  |  |  |
| ETSARIMA |  |  |  |  |  |  |
| Legaki & Koutsouri | 0.905 | 0.130 | 0.966 |  |  |  |
| **M4 Competition Methods** | | | | | | |
| Smyl | 0.836 | 0.121 | 0.884 |  |  |  |
| Montero-Manso, et al. | 0.858 | 0.126 | 0.893 |  |  |  |
| **RNN Methods** | | | | | | |
| DeepAR | 0.961 | 0.136 | 1.047 | 500 | 100 |  |
| DeepState |  |  |  |  |  |  |
| DF-RNN |  |  |  |  |  |  |
| MQ-RNN |  |  |  |  |  |  |

**Data:** **m4\_quarterly, freq: Q, N=24,000**

**Data:** **m4\_yearly, freq: Y, N=23,000**