

Exploring high-order network dynamics in brains and stock markets

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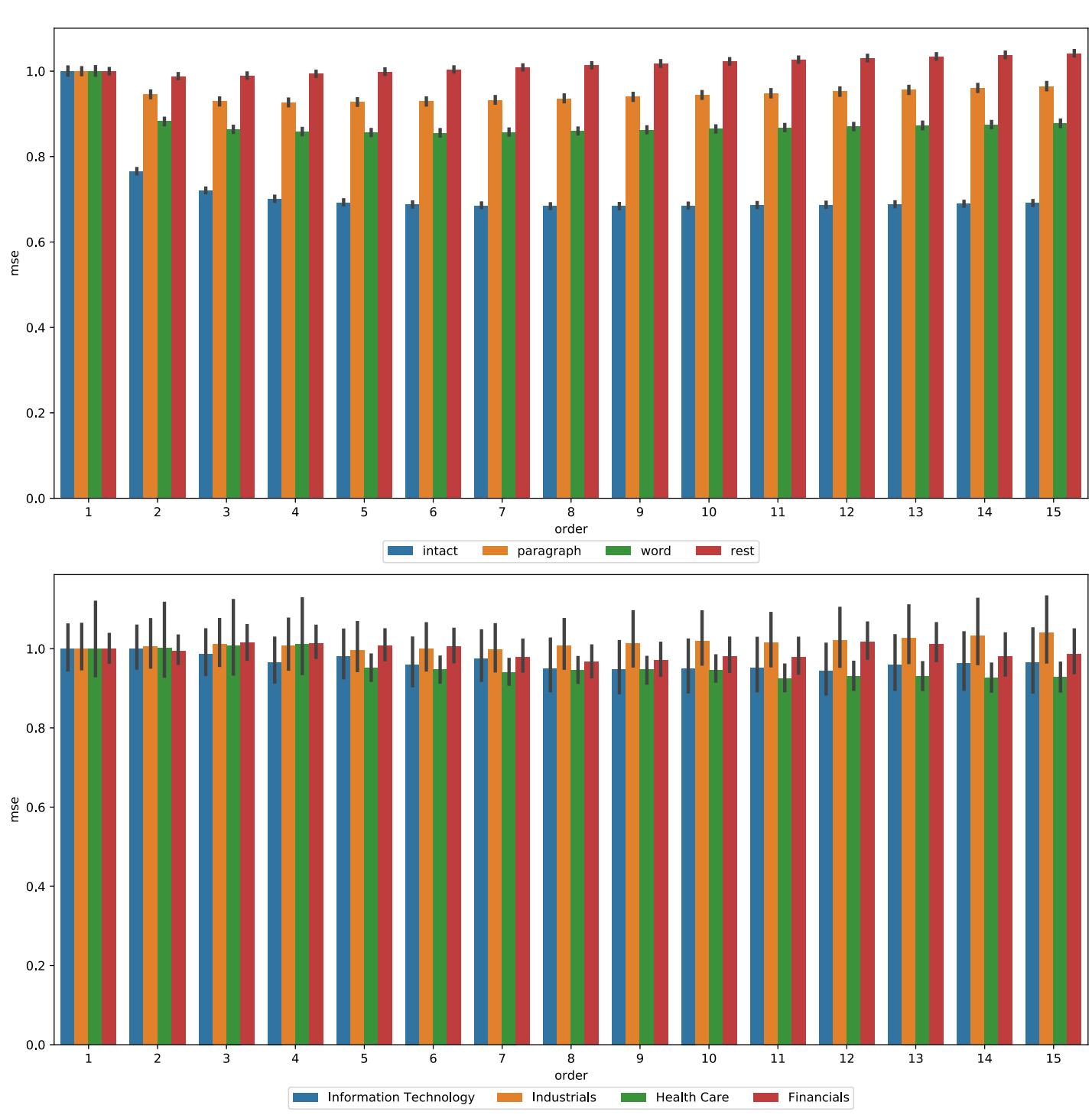
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tl;dr

- We used a model-based approach to estimate **high-order network dynamics** in timeseries data
- We examined two datasets: an **fMRI dataset** recorded as people listened to stories, and **stock market data** from the S&P 500
- We asked which orders of network dynamics were **most informative about future values**, in both datasets
- We found that **higher order network patterns were more informative than lower-order network patterns** in both datasets

Approach

- For each dataset, we estimated (up to) order 15 network interactions in **sliding windows**
- We used different combinations of features (including different orders of patterns) to **predict the next held-out value** of each raw data feature using ridge regression
- We computed **estimation errors** (MSE) as a function of which orders of network dynamics were used to form the predictions
- We **compared the errors** across experimental conditions (brain data) and market sectors (stock market data)

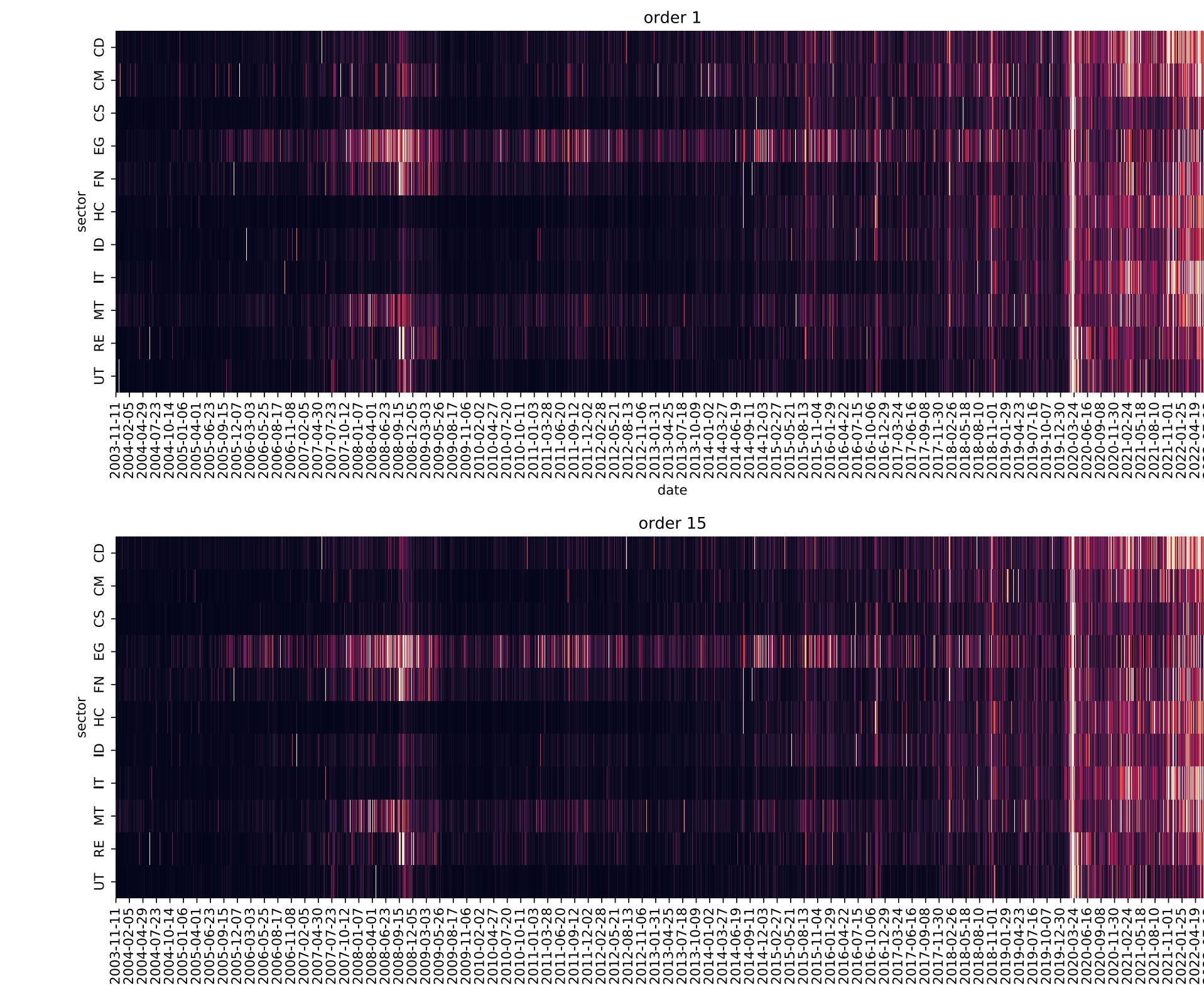
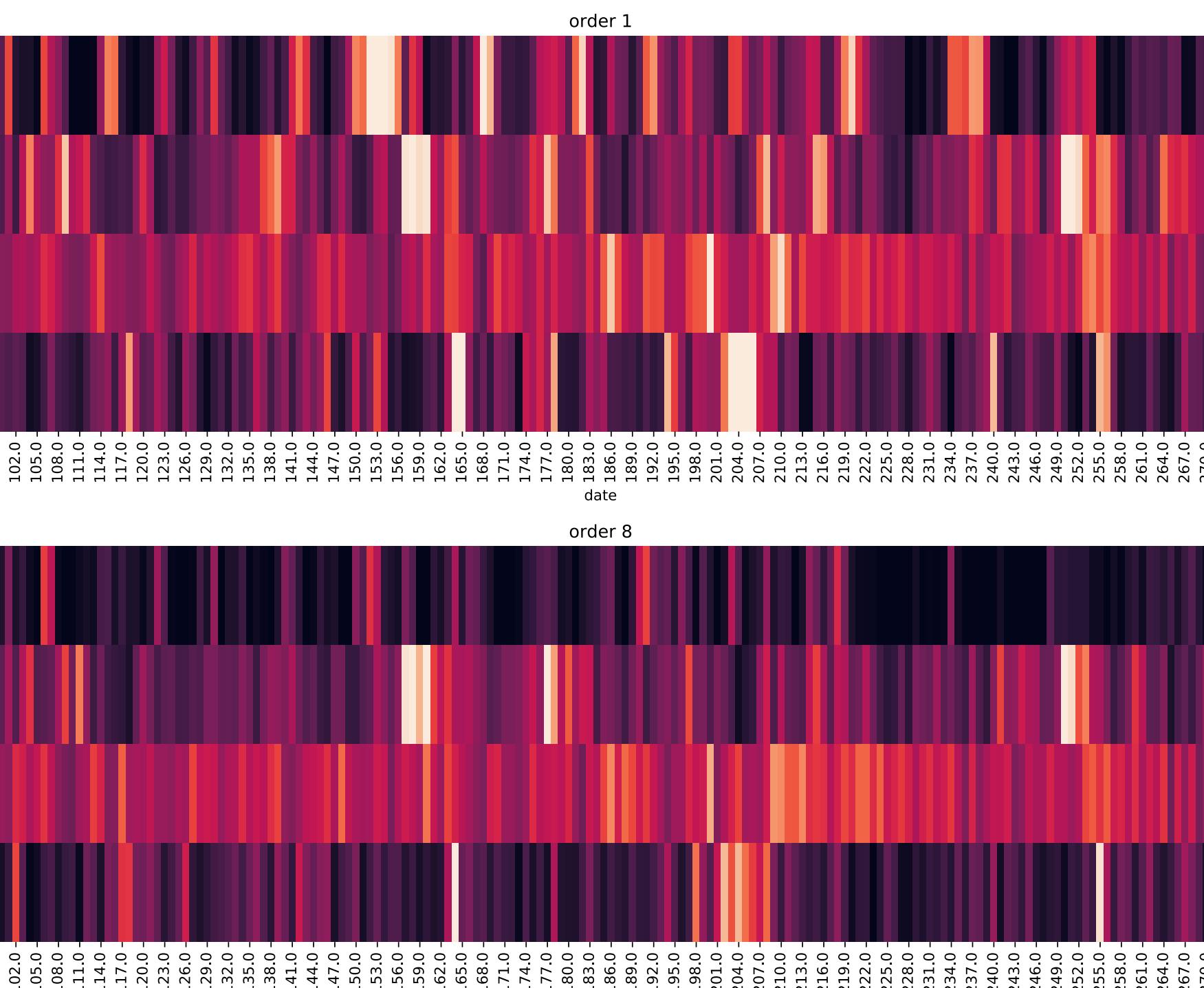


Prediction errors as a function of order for brain (top) and stock (bottom) data

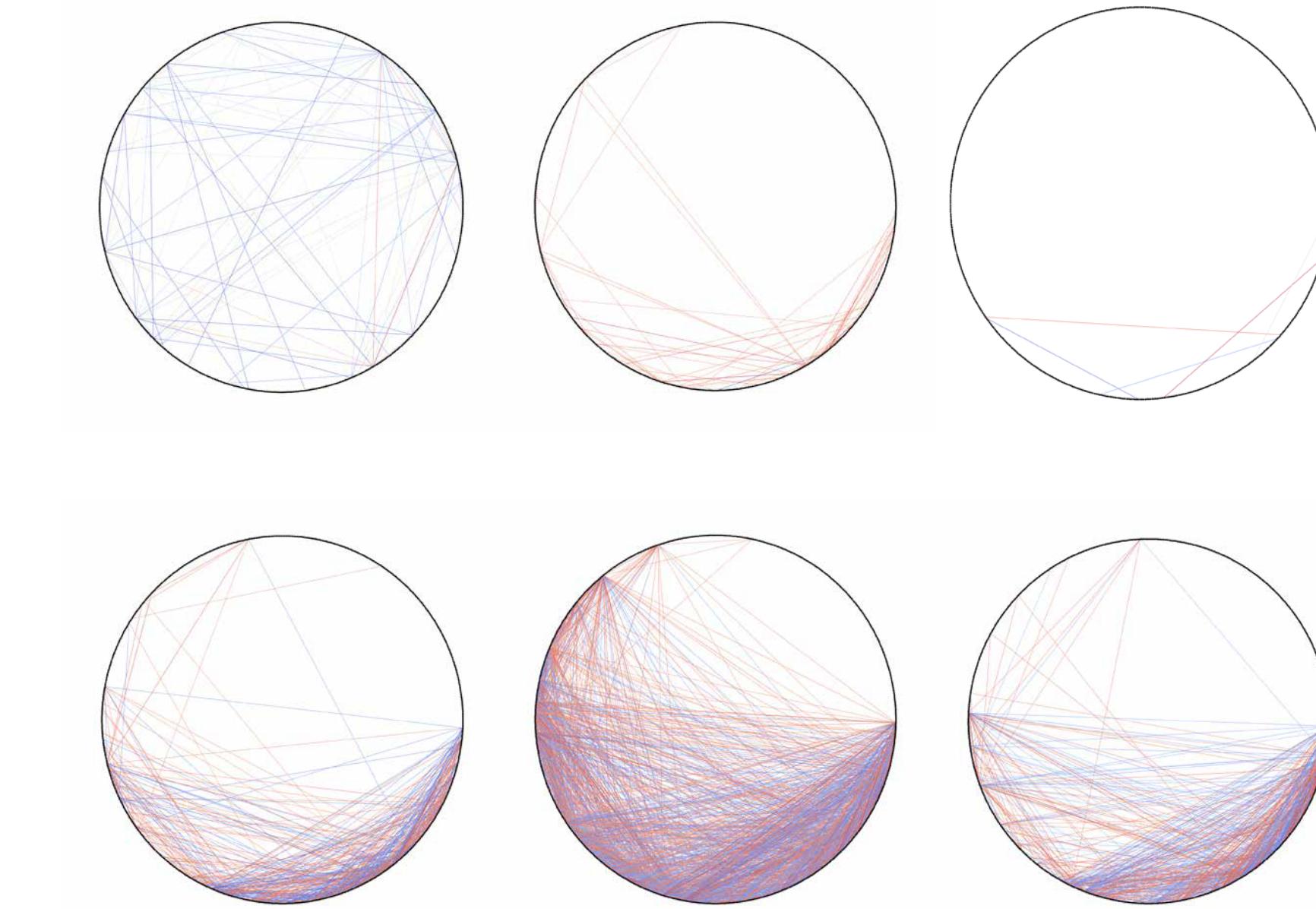
Results

- The “optimal” order for predicting future values changes across **experimental conditions** and **market sectors**
- Large jumps in estimation errors appear to occur during **key narrative moments** (brain data) or **historical events** (stock market data)
- Brain data predictions appear to benefit more from including high-order features than stock market predictions

Prediction errors in brain data as a function of time using first order (top) and eighth order (bottom) features



Prediction errors in stock market data as a function of time using first order (top) and fifteenth order (bottom) features



Brain network dynamic summaries.
Top: average order 1, 2, and 8 networks.
Bottom: order 2 networks at timepoints 12, 147, and 241

Discussion

- We wondered if the stock market might be acting like an **“artificial brain”** whose “thoughts” reflect trading patterns
- If so, the “stock market brain” does **not** appear to exhibit the same complex dynamics as a human brain

Future directions

- We’d like to understand which **specific brain areas** and **market sectors** are driving our results under different cognitive and market conditions
- We also plan to explore **different predictive models** to test the robustness of our findings

Bibliography

- Owen, Chang, Manning (2021) High-level cognition during story listening is reflected in high-order dynamic correlations in neural activity patterns. *Nature Communications* 12: 5728
- Stallen, Borg, Knutson (2021) Brain activity foreshadows stock price dynamics. *The Journal of Neuroscience* 41(14): 3266-3274