Forecast reconciliation

3. Temporal & cross-temporal forecast reconcilation

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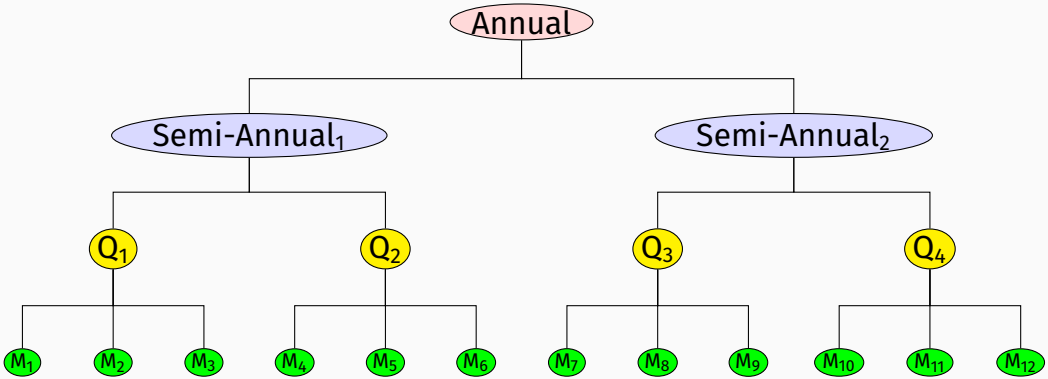
Outline

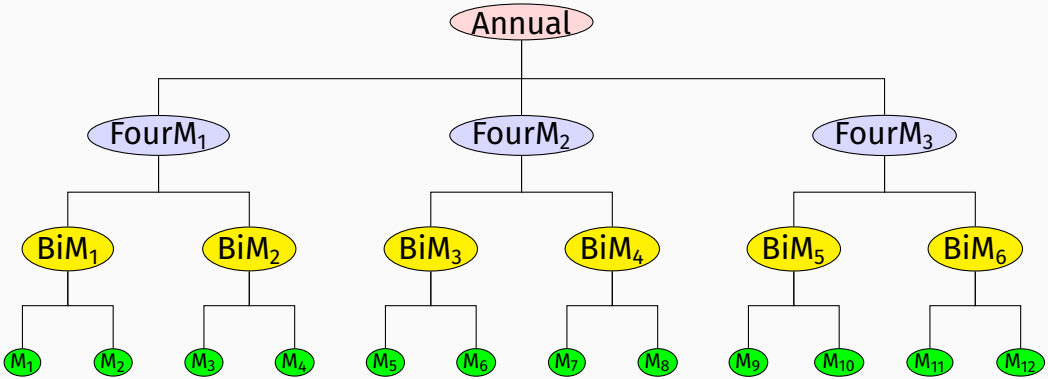
Notation reminder

- Data: $\boldsymbol{y}_t = \boldsymbol{S}\boldsymbol{b}_t$ where $\boldsymbol{S}$ is a summing matrix and $\boldsymbol{b}_t$ is a vector of disaggregated time series
- Base forecasts: $\hat{\boldsymbol{y}}_{T+h|T}$
- Reconciled forecasts: $\tilde{\boldsymbol{y}}_{T+h|T} = \boldsymbol{S}\boldsymbol{G}\hat{\boldsymbol{y}}_{T+h|T}$
- MinT: $\boldsymbol{G} = (\boldsymbol{S}'\boldsymbol{W}_h^{-1}\boldsymbol{S})^{-1}\boldsymbol{S}'\boldsymbol{W}_h^{-1}$ where $\boldsymbol{W}_h$ is covariance matrix of base forecast errors.

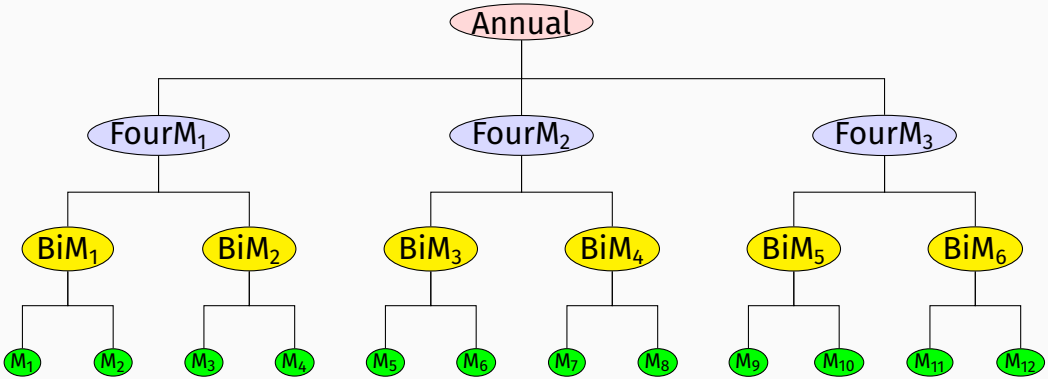
Temporal reconciliation



Temporal reconciliation



Temporal reconciliation



- Forecast series at each available frequency.
- Optimally combine forecasts within the same year.

Temporal reconciliation

For a time series $y_1, \dots, y_T$, observed at frequency m, we generate aggregate series

$$y_j^{[k]} = \sum_{t=1+(j-1)k}^{jk} y_t, \qquad \text{for } j = 1, \dots, \lfloor T/k \rfloor$$

- $k \in F(m) = \{\text{factors of } m\}$.
- A single unique hierarchy is only possible when there are no coprime pairs in $F(m)$.
- $M_k = m/k$ is seasonal period of aggregated series.
- Proposed by Athanasopoulos, Hyndman, Kourentzes, Petropoulos (*EJOR*, 2017)

Cross-temporal reconciliation

- Kourentzes, Athanasopoulos (*ATR*, 2019)
- Punia, Singh, Madaan (*C&IE*, 2020)
- Di Fonzo, Girolimetto (2020)

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ISF talks coming up!

- Mitch O'Hara-Wild: *Probabilistic cross-temporal hierarchies in fable* (in about 3 hours)
- Tommi Di Fonzo: *Non-negative cross-temporal forecast reconciliation. An application to the Australian domestic tourism flows* (in about 11 hours).

Thief

- thief paper

Daniele and Tommy’s papers

References

- Athanasopoulos, G, RJ Hyndman, N Kourentzes, and F Petropoulos (2017). Forecasting with temporal hierarchies. *European J Operational Research* **262**(1), 60–74.
- Di Fonzo, T and D Girolimetto (2023). Cross-temporal forecast reconciliation: Optimal combination method and heuristic alternatives. *International Journal of Forecasting* **39**(1), 39–57.