

# Forecast reconciliation

## 3. Temporal & cross-temporal forecast reconciliation

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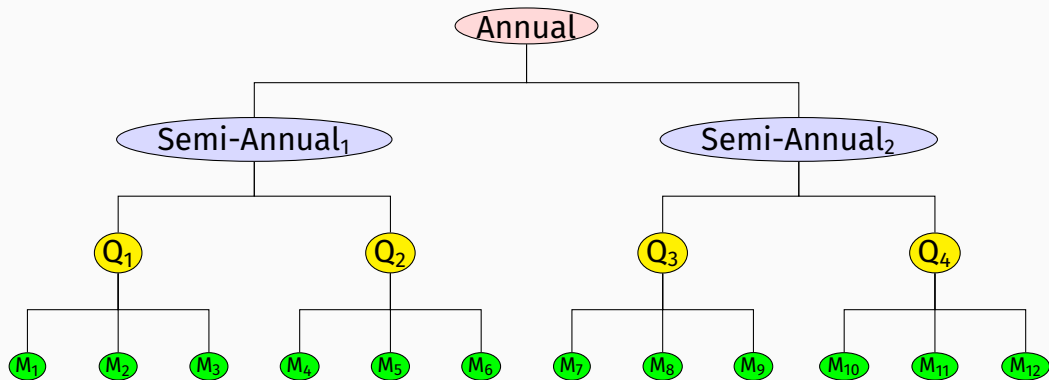
MONASH University

# Outline

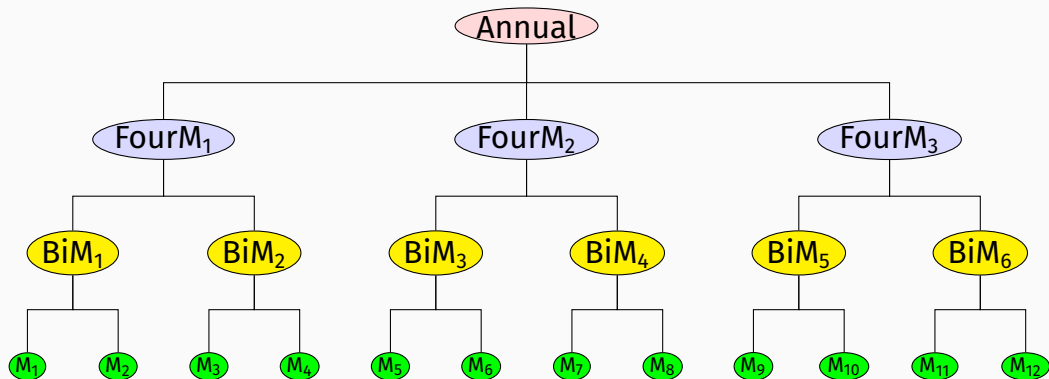
# Notation reminder

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

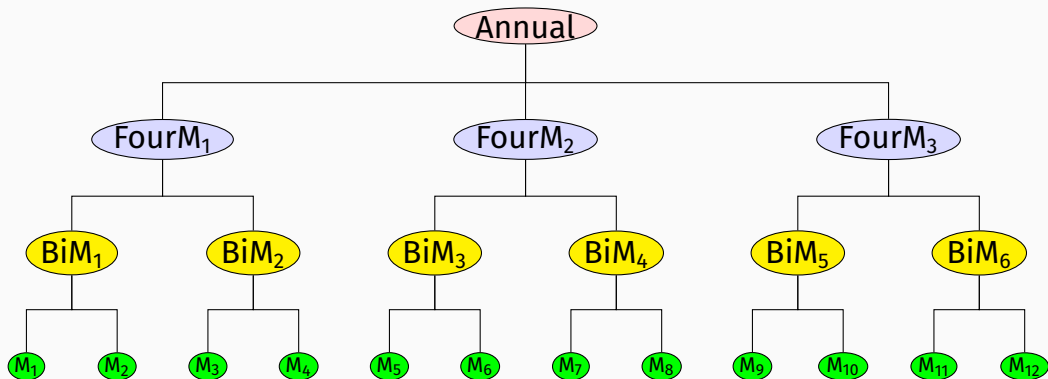
# Temporal reconciliation



# Temporal reconciliation



# Temporal reconciliation



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

# Temporal reconciliation

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

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

- $k \in F(m) = \{\text{factors of } m\}$ .
- 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.