

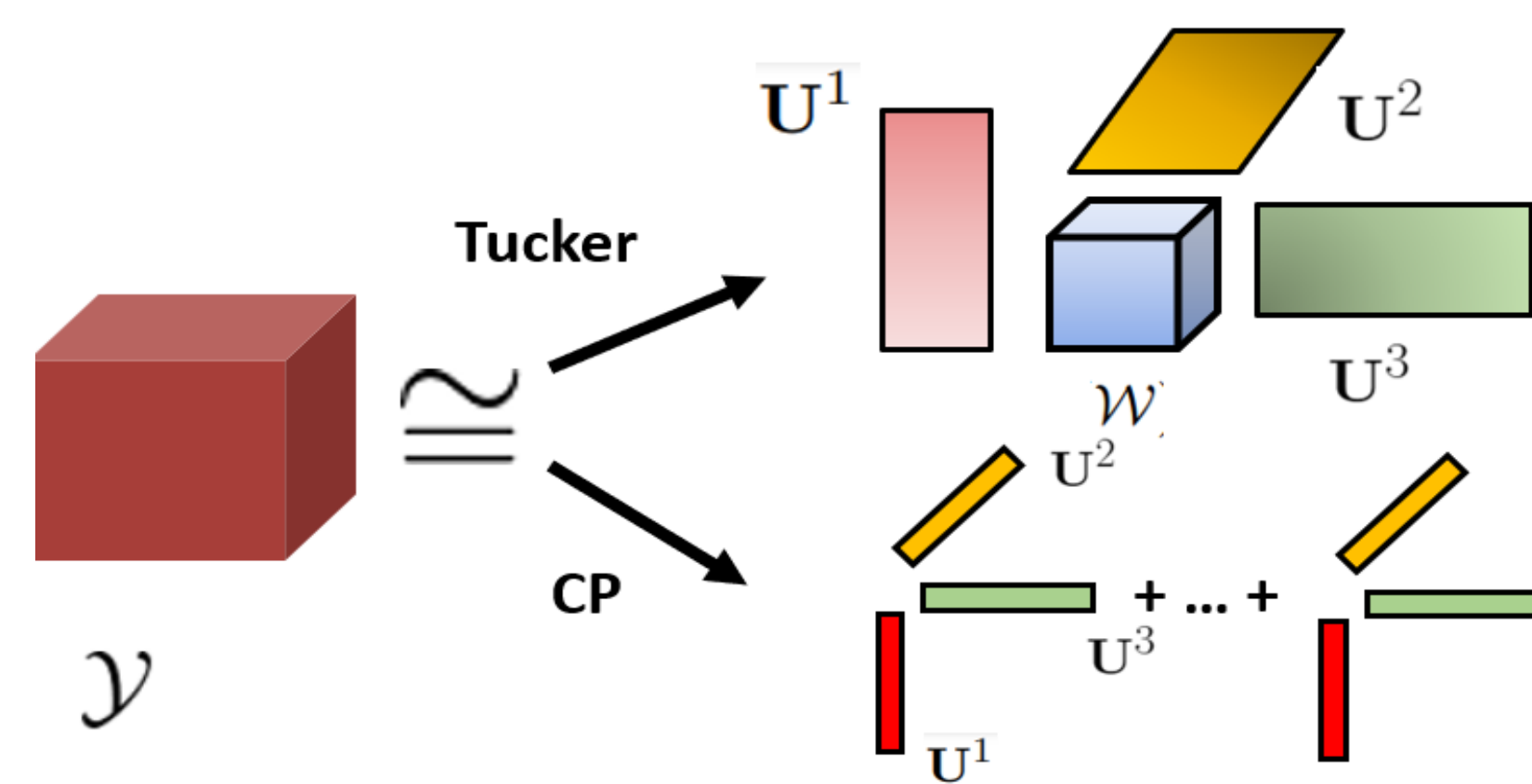
➤ Temporal Tensor Data

• Tensor-valued time series!



➤ Tensor Decomposition

• Low-rank representation learning!



➤ Most Existing work:

Evolving weights + **Static Factors**

$$y_i(t) \approx \mathbf{w}(t)^\top \left(\mathbf{u}_{i_1}^1 \circ \dots \circ \mathbf{u}_{i_K}^K \right)$$

• **Over-Simplistic!**

• **Evolving factors** dominate in many cases

➤ SFTL: involving factor trajectories!

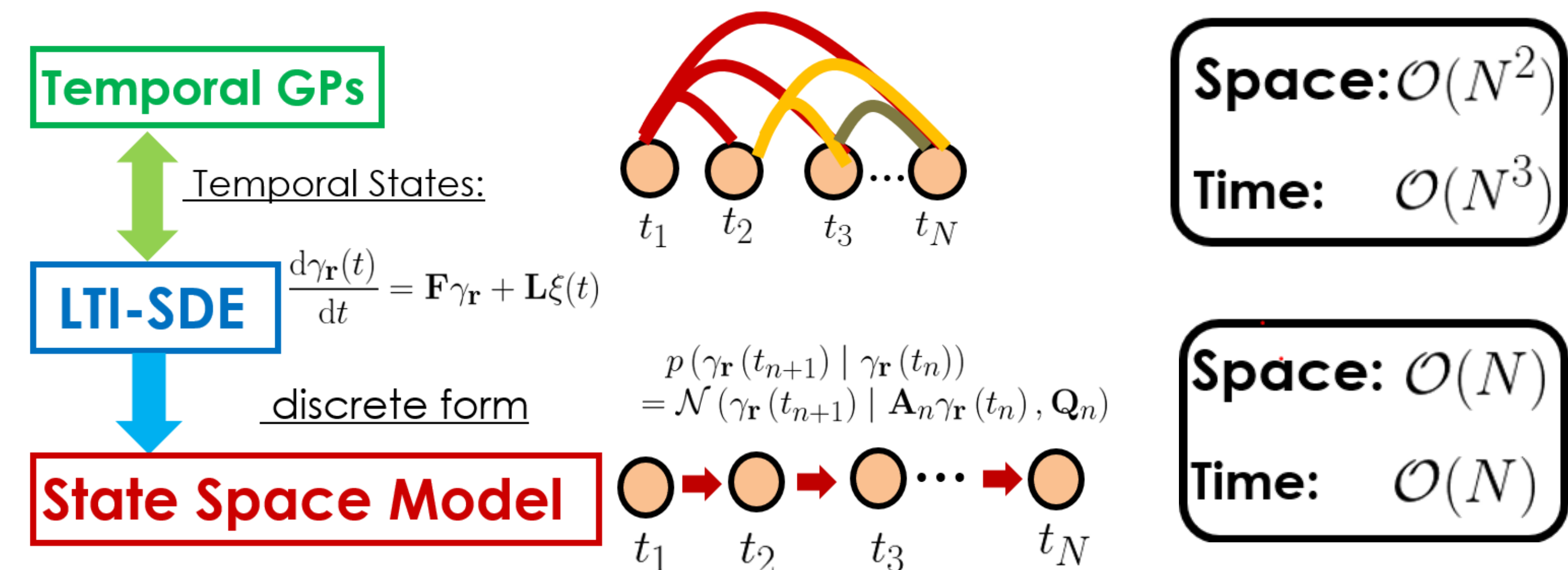
CP: $y_i(t) \approx \mathbf{w}^\top \left(\mathbf{u}_{i_1}^1(t) \circ \dots \circ \mathbf{u}_{i_K}^K(t) \right)^\top$

Tucker: $y_i(t) \approx \text{vec}(\mathcal{W})^\top \left(\mathbf{u}_{i_1}^1(t) \otimes \dots \otimes \mathbf{u}_{i_K}^K(t) \right)$

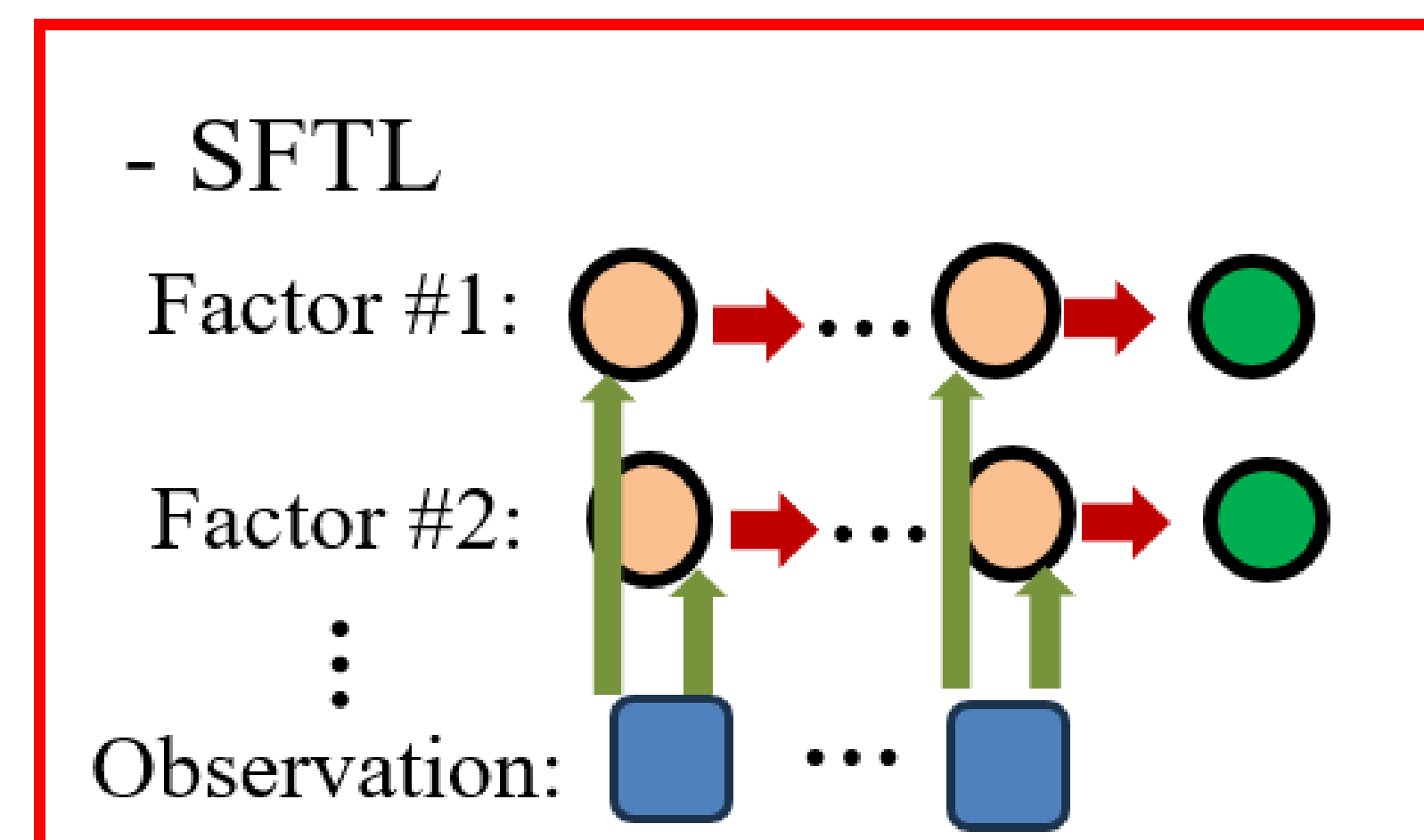
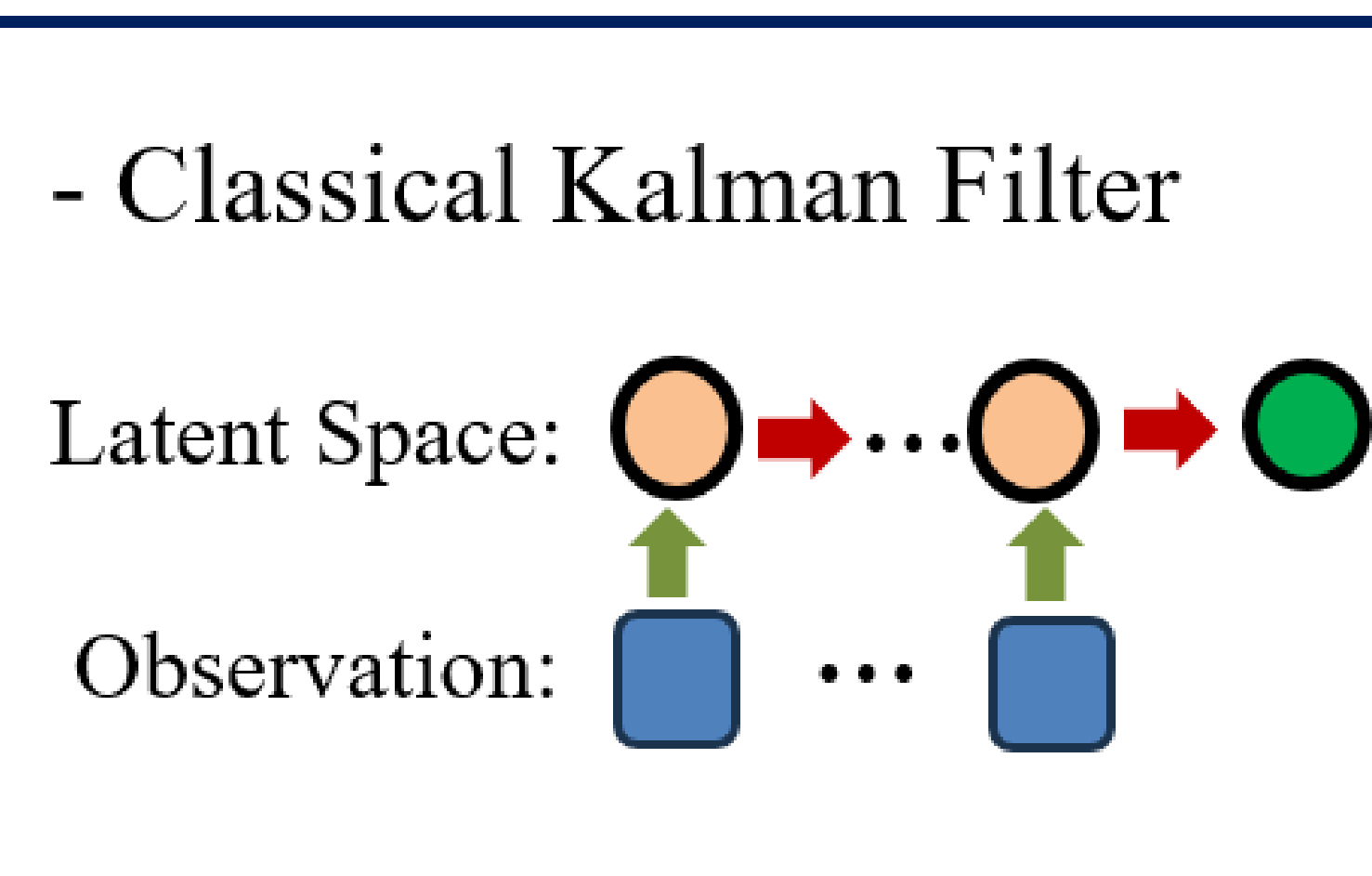
Gaussian Process(GP) $GP(0, k(t, t'))$

• **Non-parametric(flexible)** + **Non-scalable: $O(N^3)$**

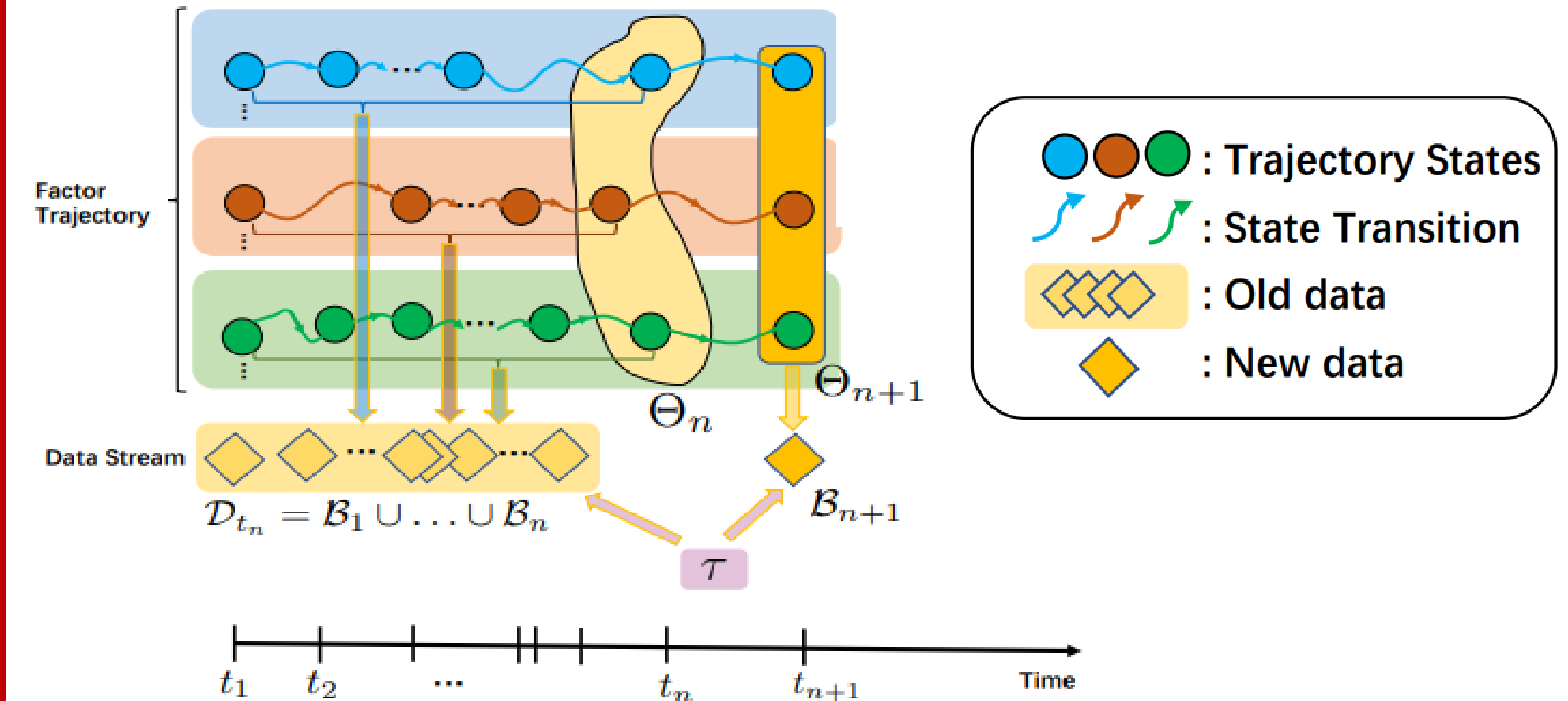
➤ State-Space GP: linear-cost + chain-structure



➤ Streaming Infer: Kalman Filter + Moment-Match



➤ Efficient online algorithm :



➤ Prediction results and learned trajectories

	RMSE	FitRecord
Static	PTucker	0.656 ± 0.147
	Tucker-ALS	0.846 ± 0.005
	CP-ALS	0.882 ± 0.017
	CT-CP	0.664 ± 0.007
	CT-GP	0.604 ± 0.004
	BCTT	0.518 ± 0.007
	NONFAT	0.503 ± 0.002
Stream	THIS-ODE	0.526 ± 0.004
	POST	0.696 ± 0.019
	ADF-CP	0.648 ± 0.008
	BASS-Tucker	0.976 ± 0.024
	SFTL-CP	0.424 ± 0.014
SFTL-Tucker	0.430 ± 0.010	

