Cut-And-Stitch
Efficient Parallel Learning of Linear Dynamical Systems on SMPs

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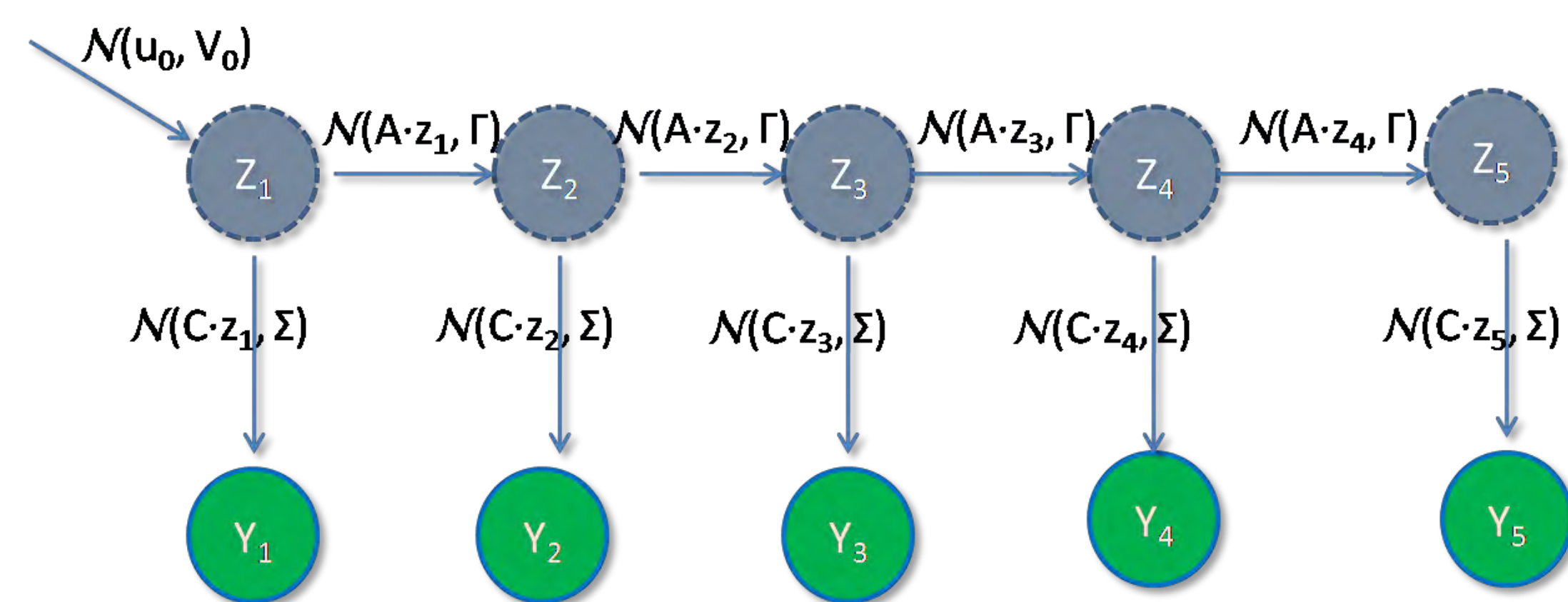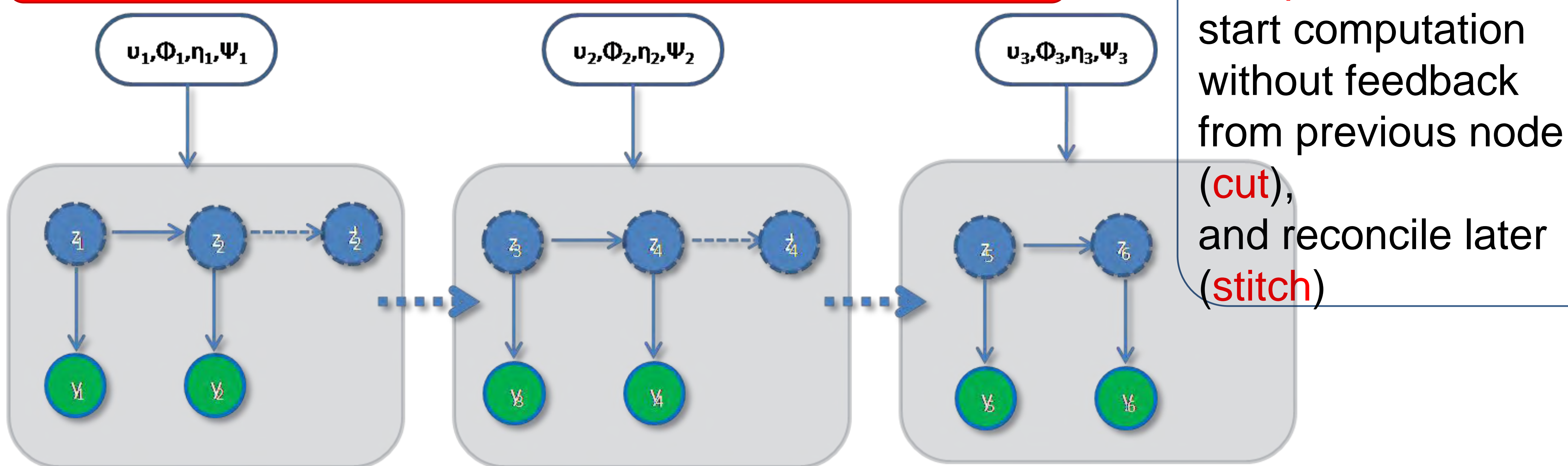**School of Computer Science**

Problem Definition

- Problem:
  Given a Linear Dynamical System,
  to find the model parameters.
- Traditional Method:
  Maximum Likelihood Estimation via
  Expectation-Maximization(EM) algorithm
- Objective:
  Parallelize the learning algorithm
- Tool:
  OpenMP with shared memory parallelism

Parameters: $\theta = (u_0, V_0, A, \Gamma, C, \Sigma)$
Observation: $y_1 \ldots y_n$
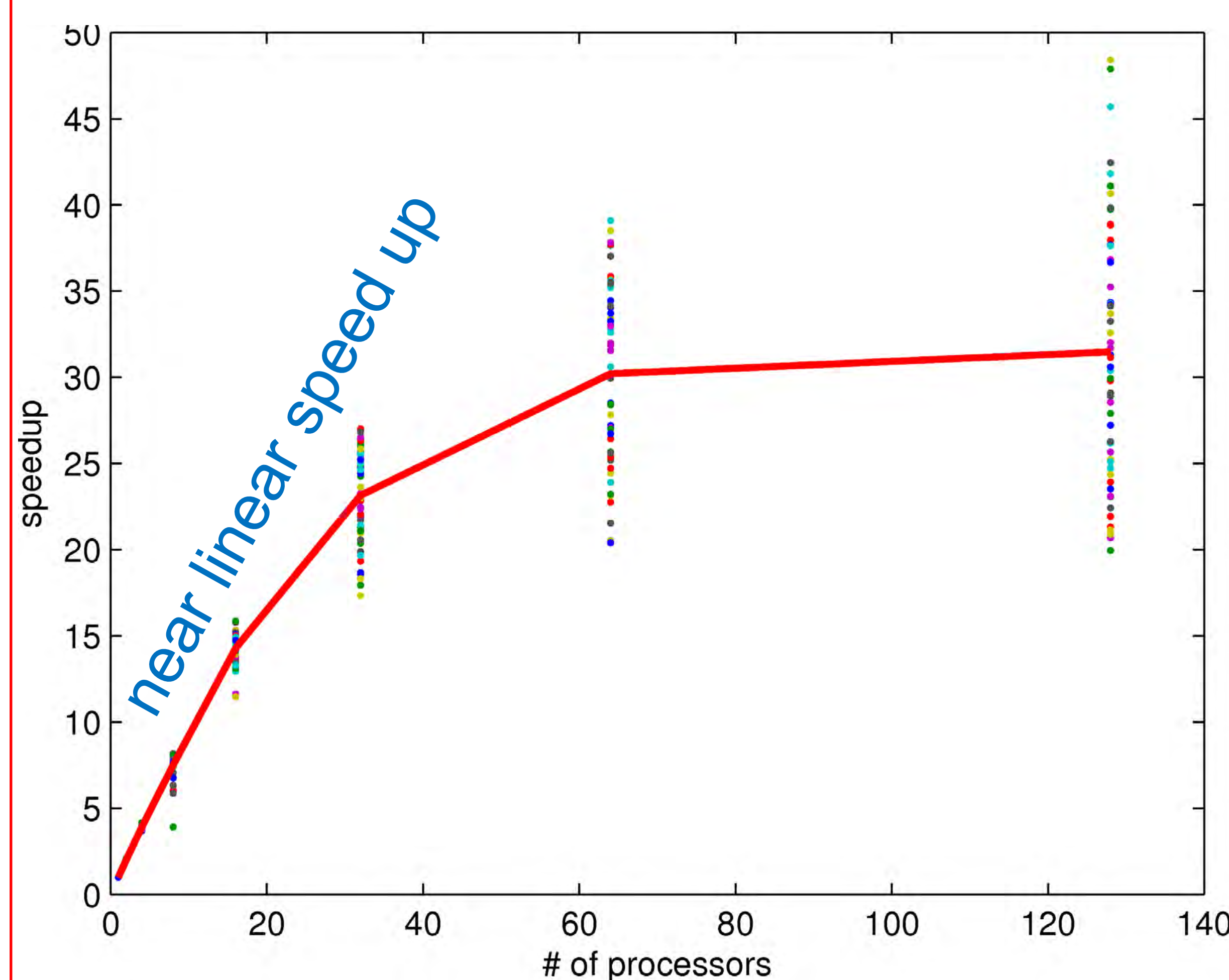Hidden variables: $z_1 \ldots z_n$

Proposed Method: Cut-And-Stitch

"Leap of faith" start computation without feedback from previous node (cut), and reconcile later (stitch)

Traditional Learning
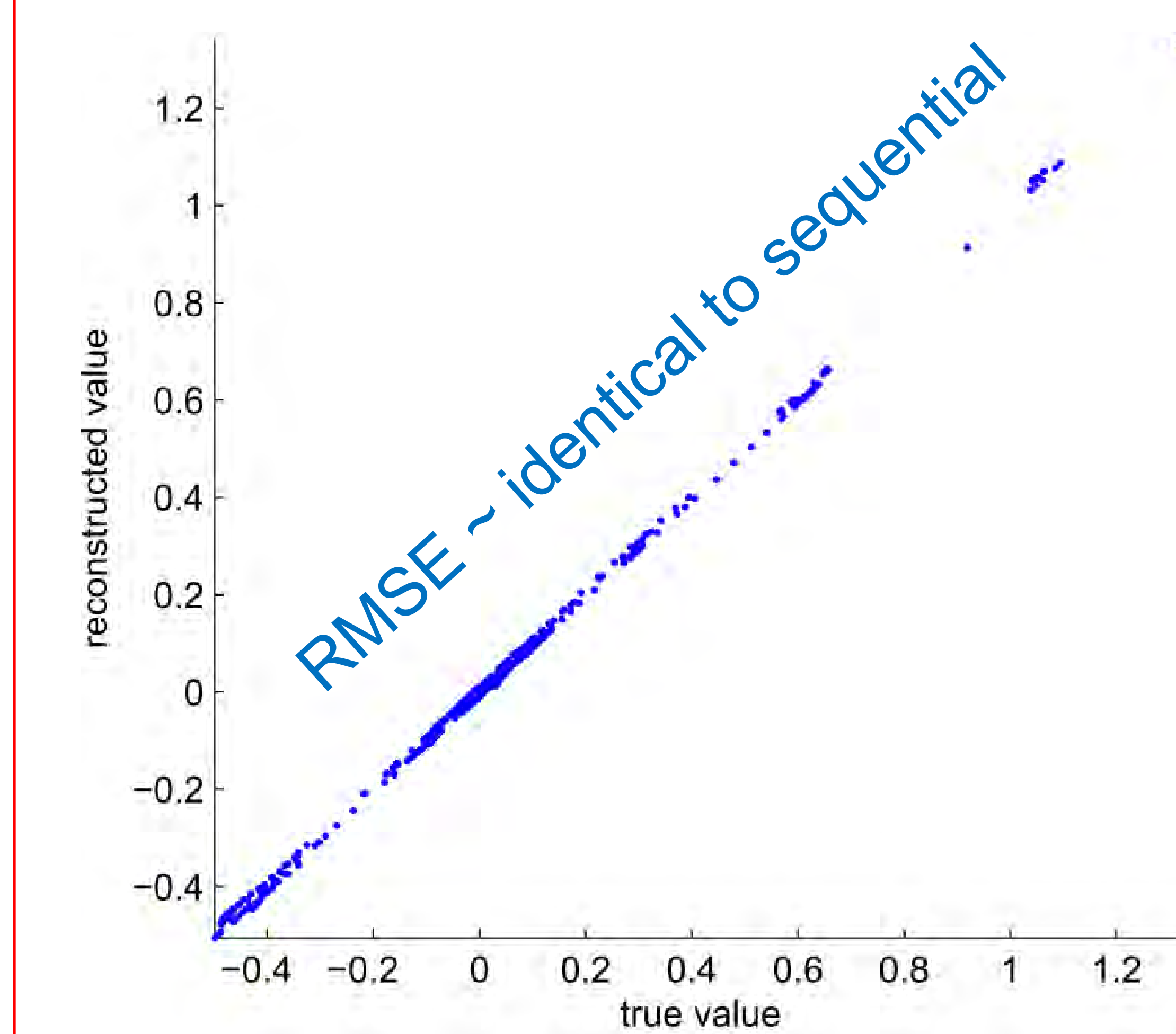### Challenges

Message(Belief) Passing

Experiments

- Dataset:
  58 motion capture sequences.
  Each with 93 dimensions (bone positions).
- Setup:
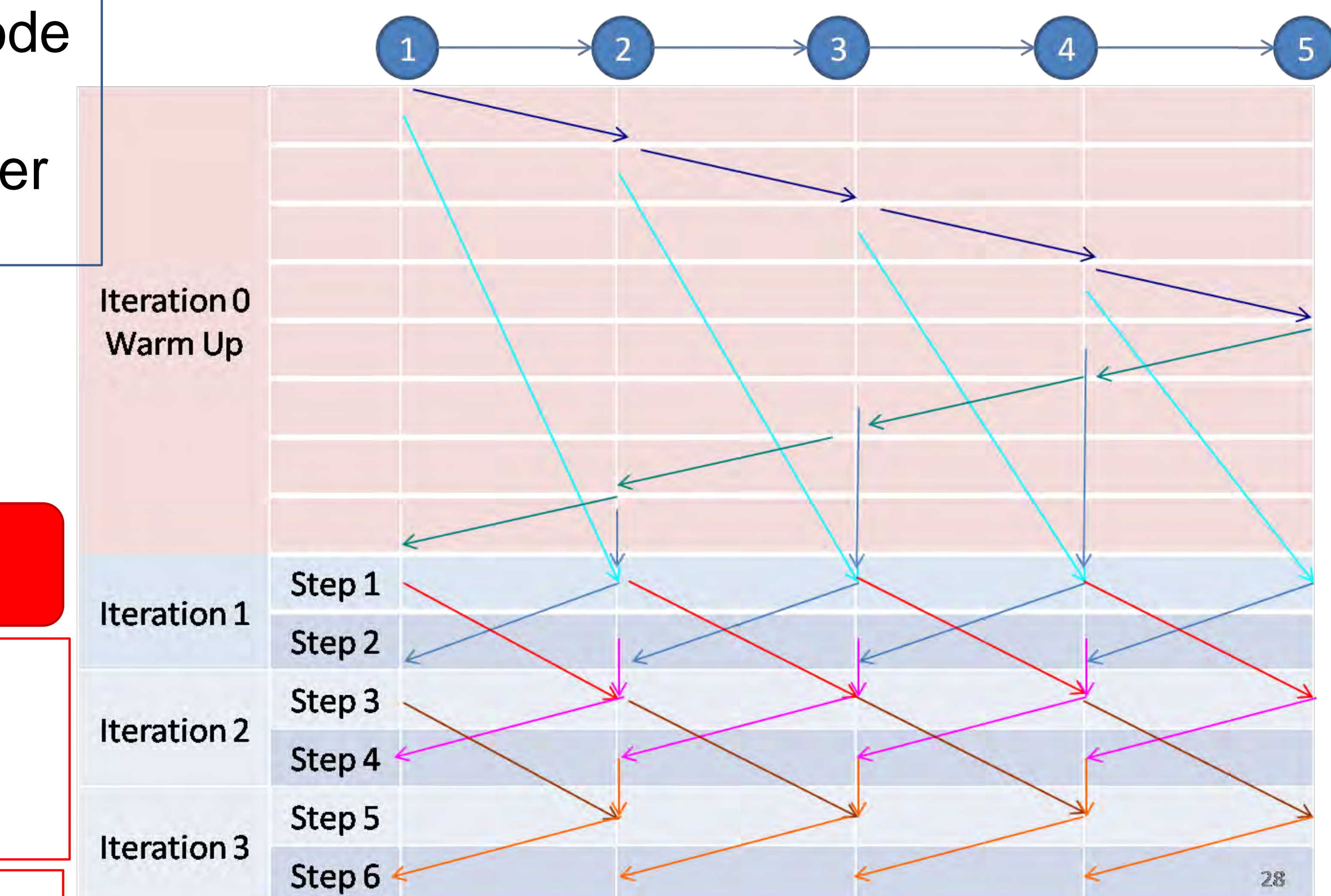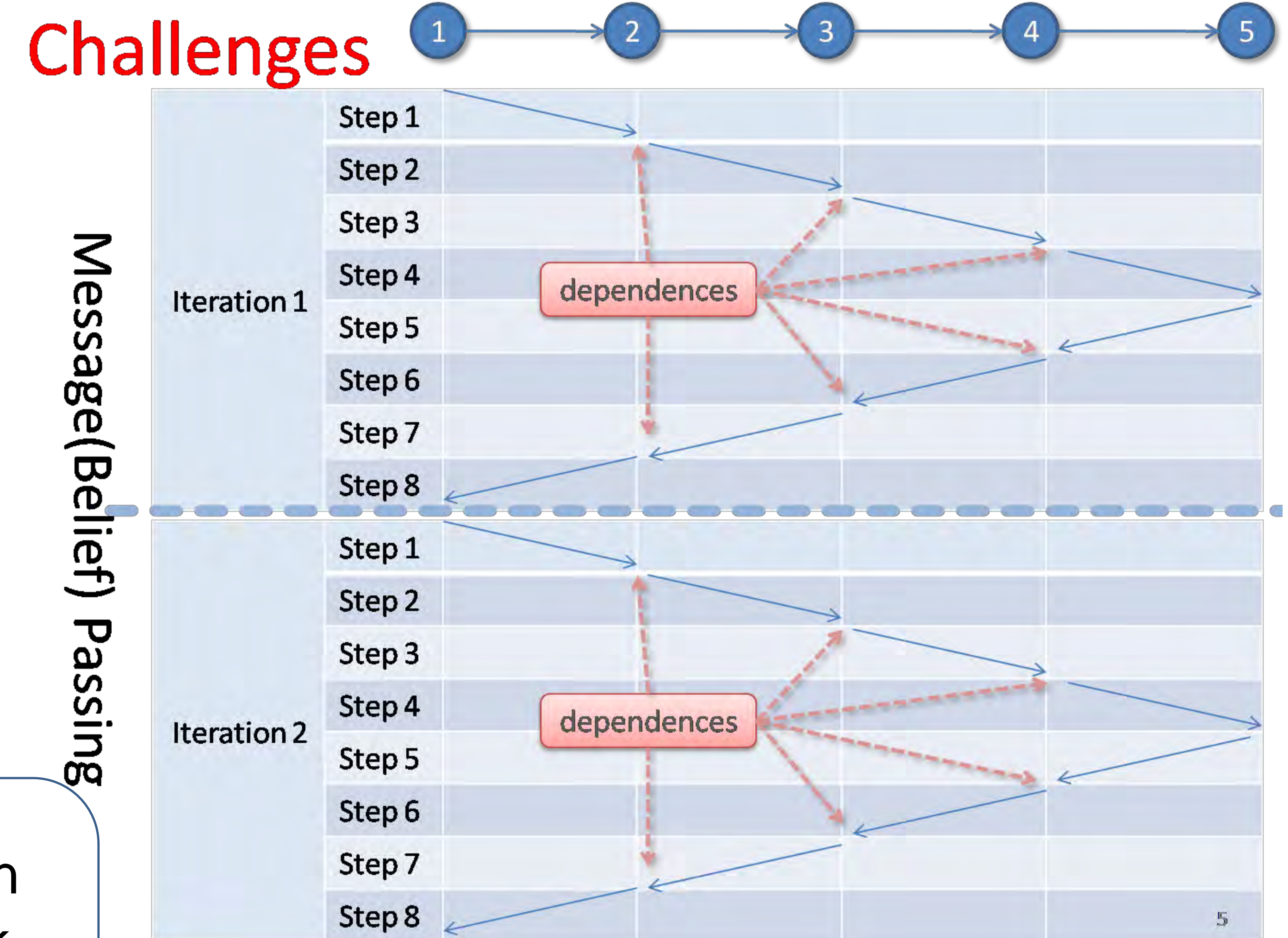 tested on both SMP (SGI Altix) and desktop multicore (4-core)

Speed up over the sequential algorithm

near linear speed up

Quality: Reconstructed v.s. Real

RMSE ~ identical to sequential

Conclusion

- General approximate parallel learning algorithm for LDS
- Near linear speed up
- Quality (RMSE): ~ identical to sequential learning
- Promising Extensions:
  - Cut-And-Stitch for HMM
  - Cut-And-Stitch for general Markov models

Dataset and software available at
http://www.cs.cmu.edu/~leili/paralearn/