

Estimating the State of Robot with Dynamic Bayesian Network

Zhuofu Bai
Nov 19 2010

Purpose Of Project

☐ About the Robot

- http://www.youtube.com/watch?v=2yplqpR-mjA&feature=player_embedded

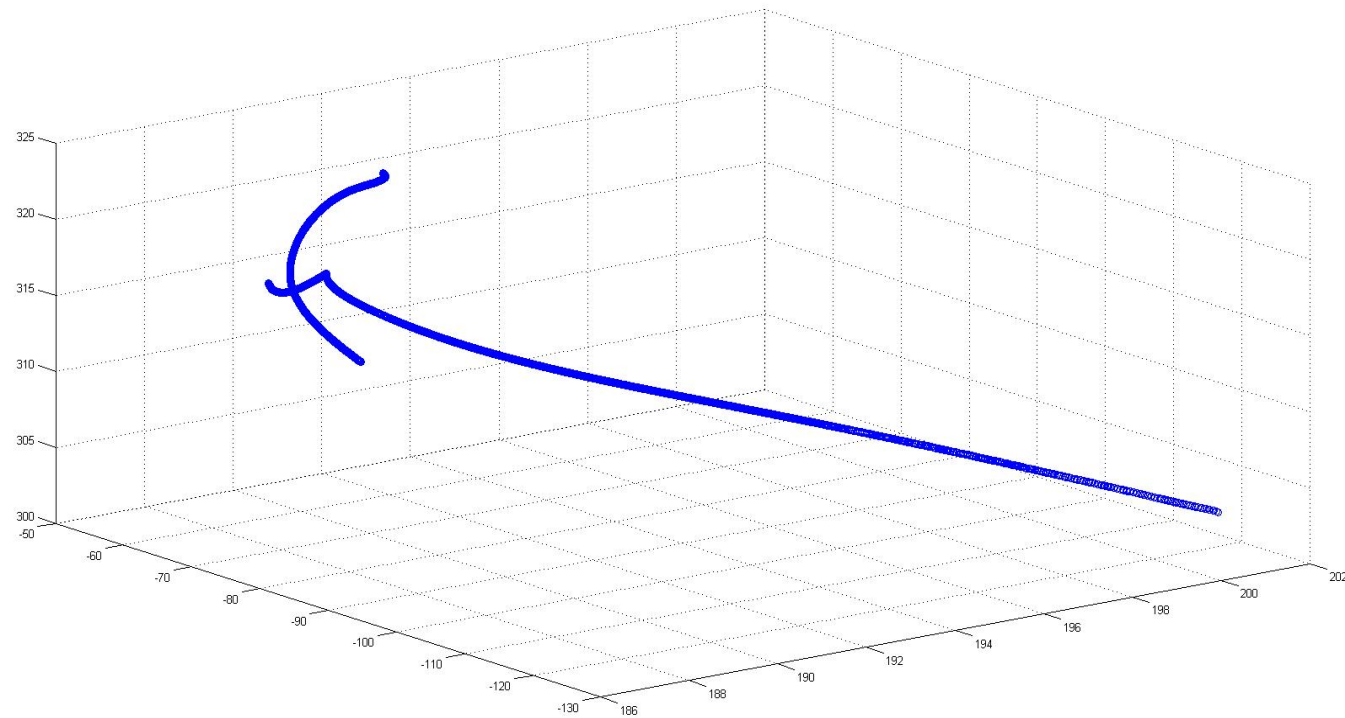
☐ The Data of the Project

- A 34-dimensional vector represents the state of the robot at time t .
- Noise and Noise free

☐ Goal

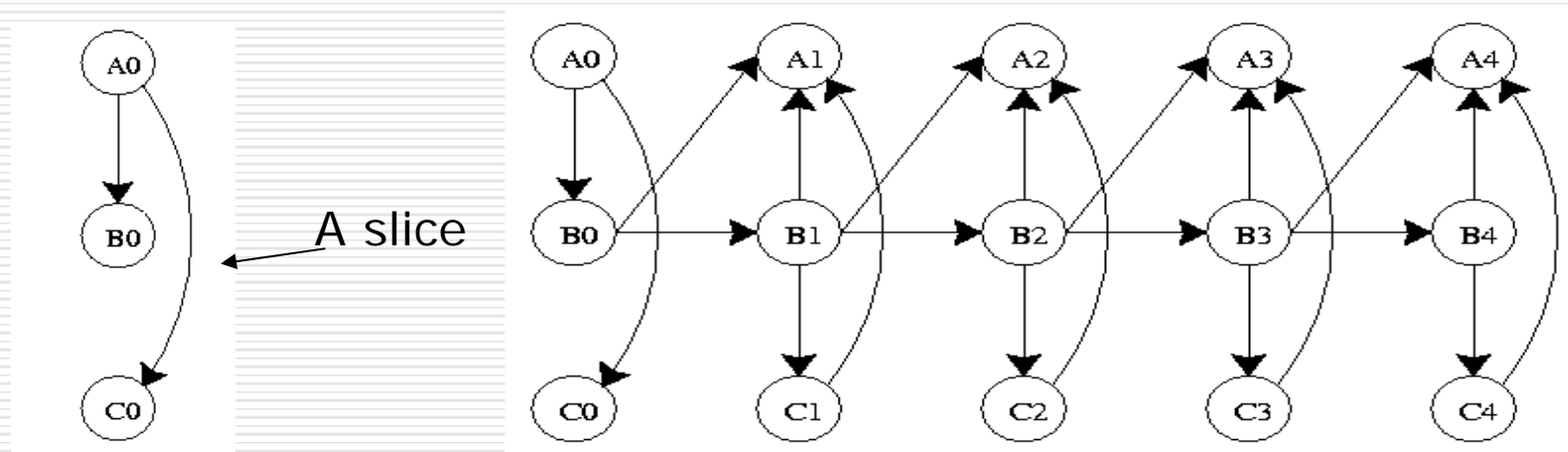
- Estimate the robot state with Dynamic Bayesian Network
-

The purpose of the Project



Definition

- A dynamic Bayesian network, or DBN, is a Bayesian network that represents a temporal probability model of the kind described by the figure below.
- Every Slice of DBN is a Bayesian Network.

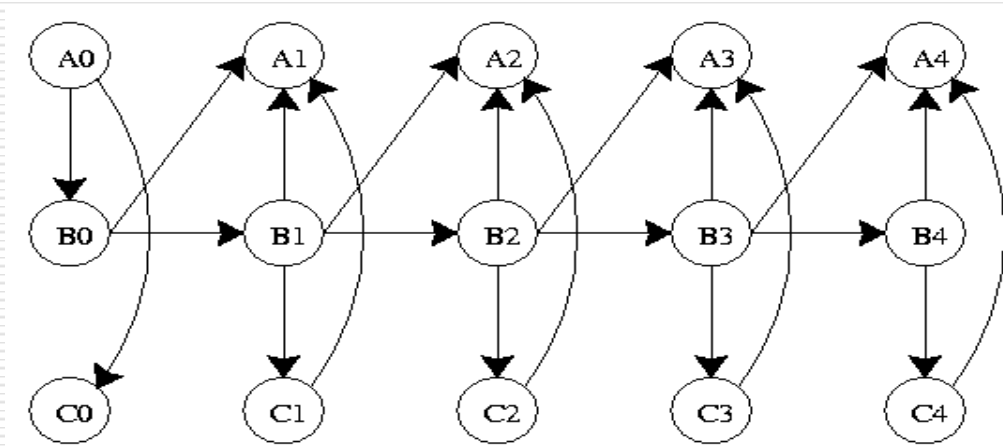


Semantic of DBN

- First-order markov assumption: the parents of a node can only be in the same time slice or the previous time slice, i.e., arcs do not across slices

$$P(X_t | X_{t-1}) = \prod_{i=1}^N P(X_t^i | Pa(X_t^i))$$

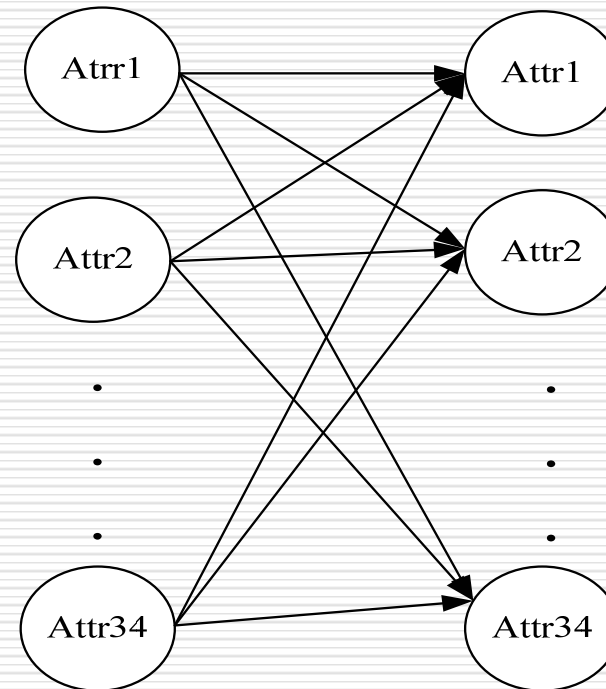
- Inter-slice arcs are all from left to right, reflecting the time
- Intra-slice arcs can be arbitrary as long as the DBN is a DAG



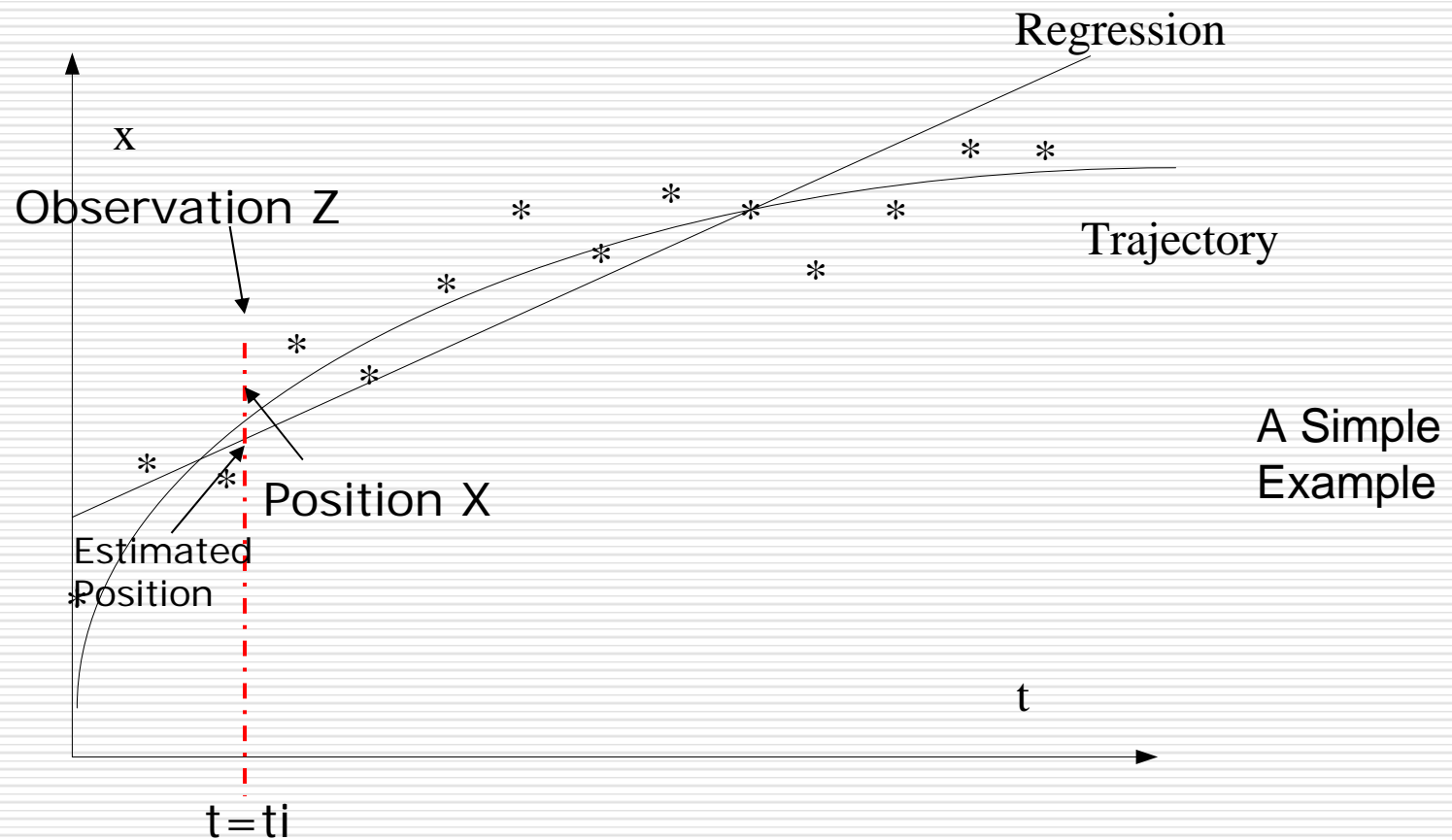
DBN for Robot

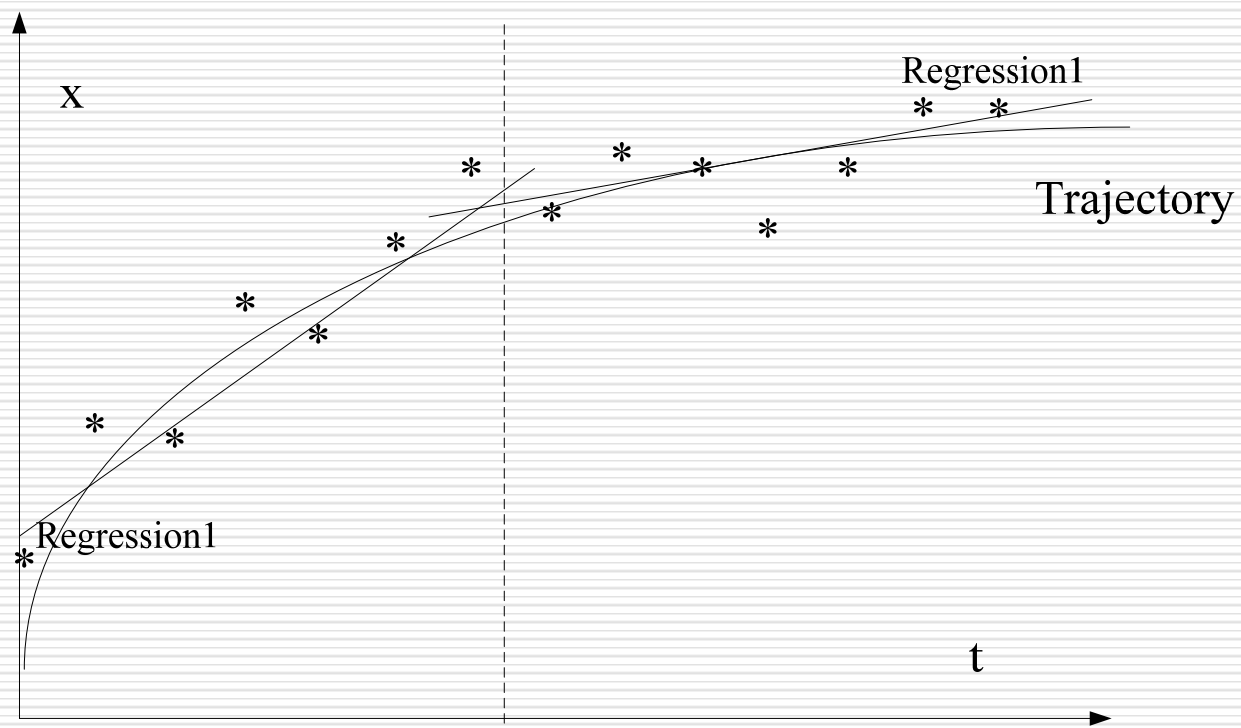
Base Line: A Simple Gaussian Model for the whole data

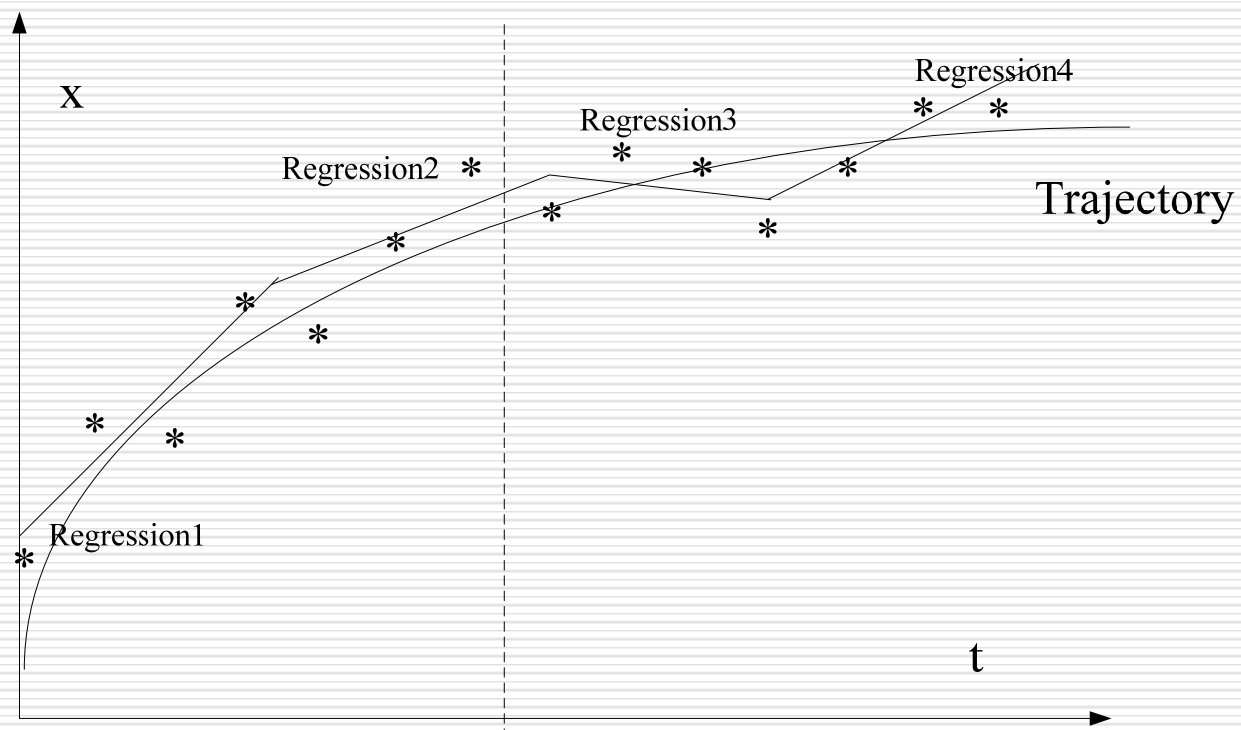
DBN model: Fully Connected between two slices



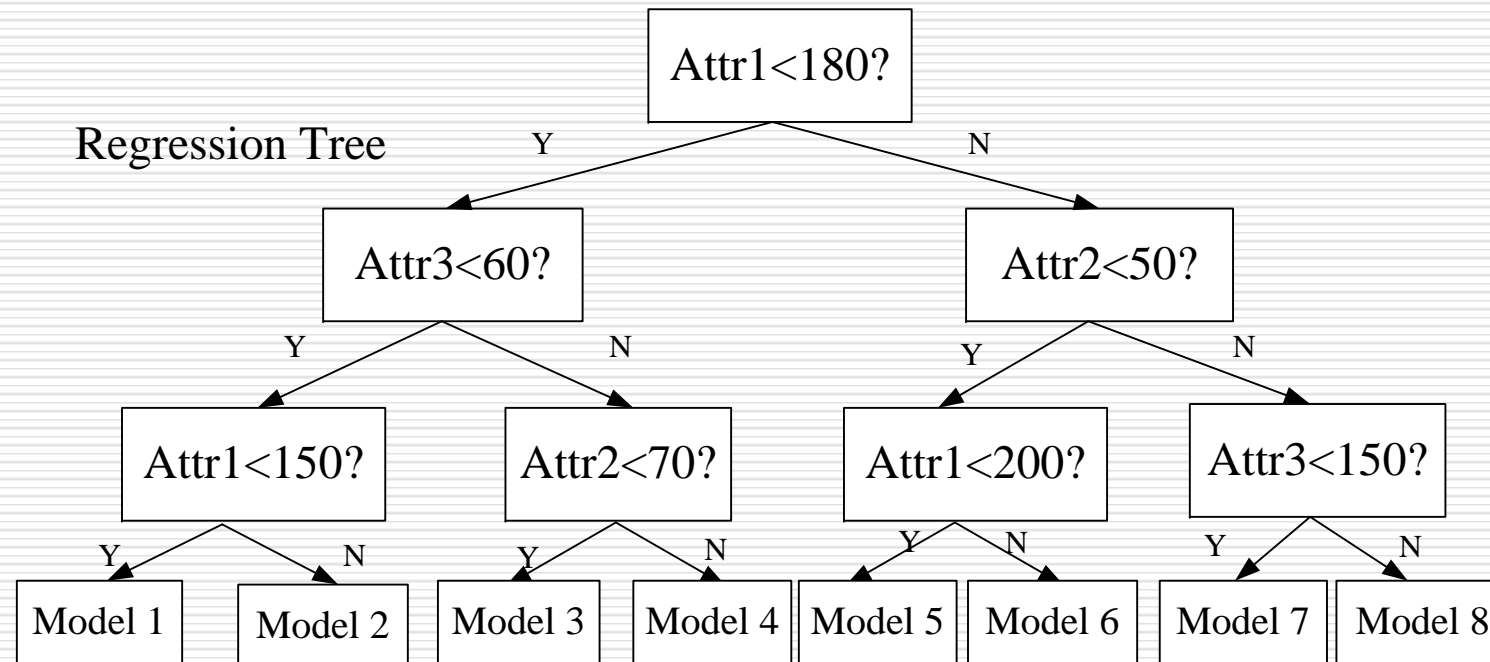
Regression Tree







Regression Tree for Multiple Attribute



Potential Problem: some model may not be well trained.

Regression Tree requires large training data.

Experiment Results

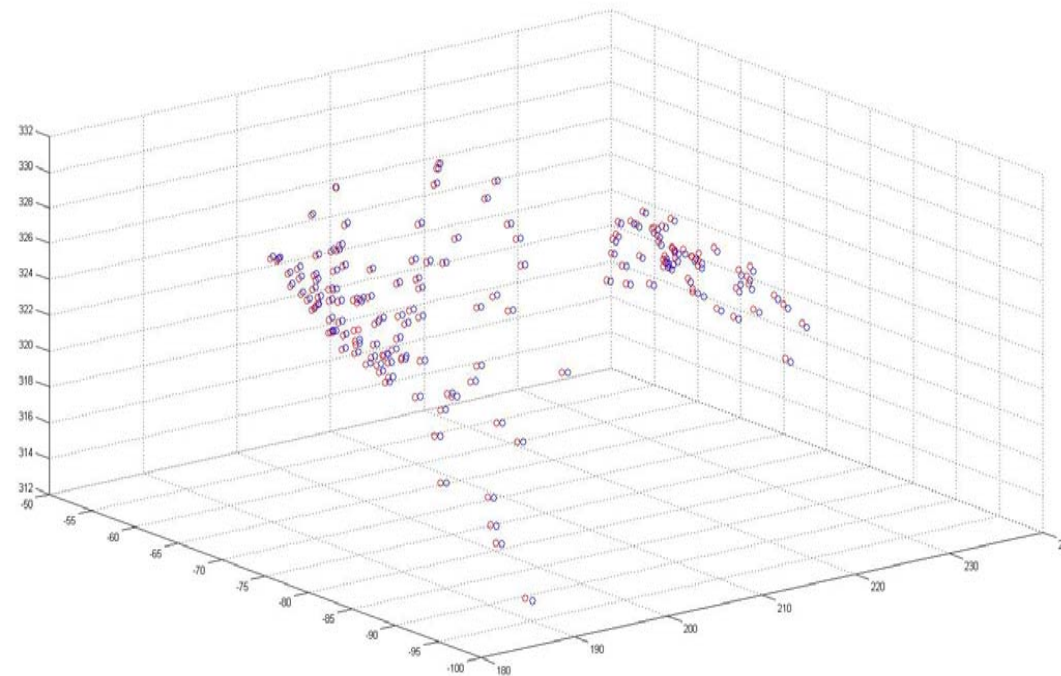
- ❑ Needle Position X, Y, Z
- ❑ Direction of Movement Rx, Ry, Rz
- ❑ DBN: 6 nodes per slice.
- ❑ Prediction: X, Y, Z at time $t + \Delta t$

$\Delta t = 0.1s$

Mean Residual Square	X	Y	Z
DBN	1.7891	7.0827	4.8960
Base Line(Simpe Gaussian)	12.3634	11.1598	20.0257

Tracking

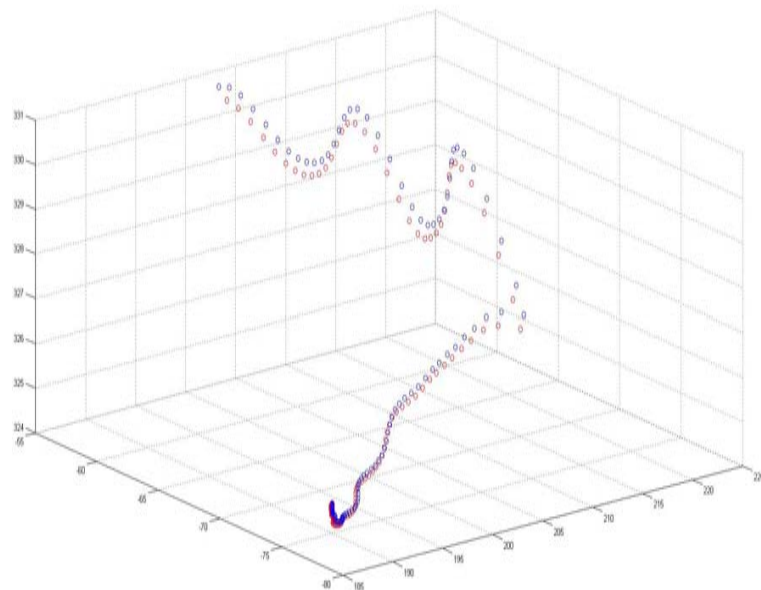
- $\Delta t = 0.1\text{s}$ Training and Testing with noise data



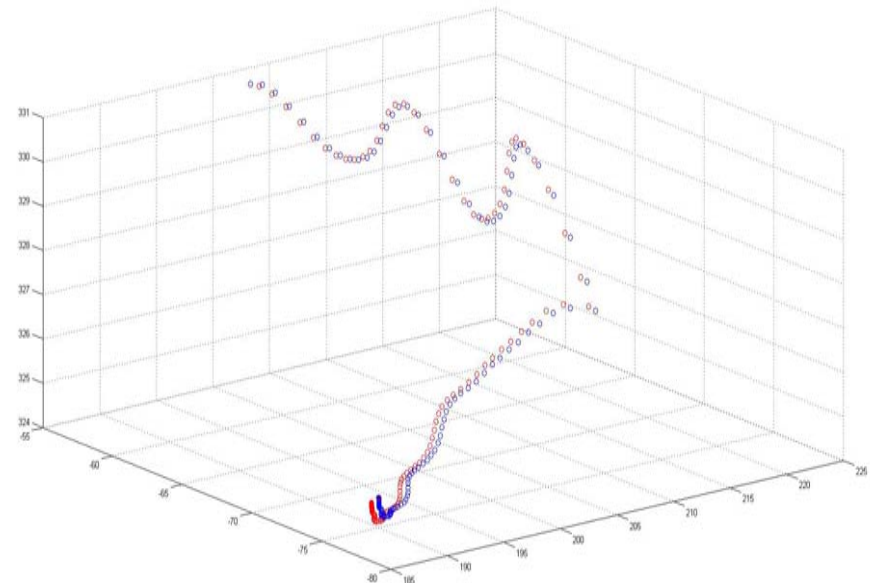
Tracking

$\Delta t = 0.01s$ Training with noise data Testing with noise free data

Base Line



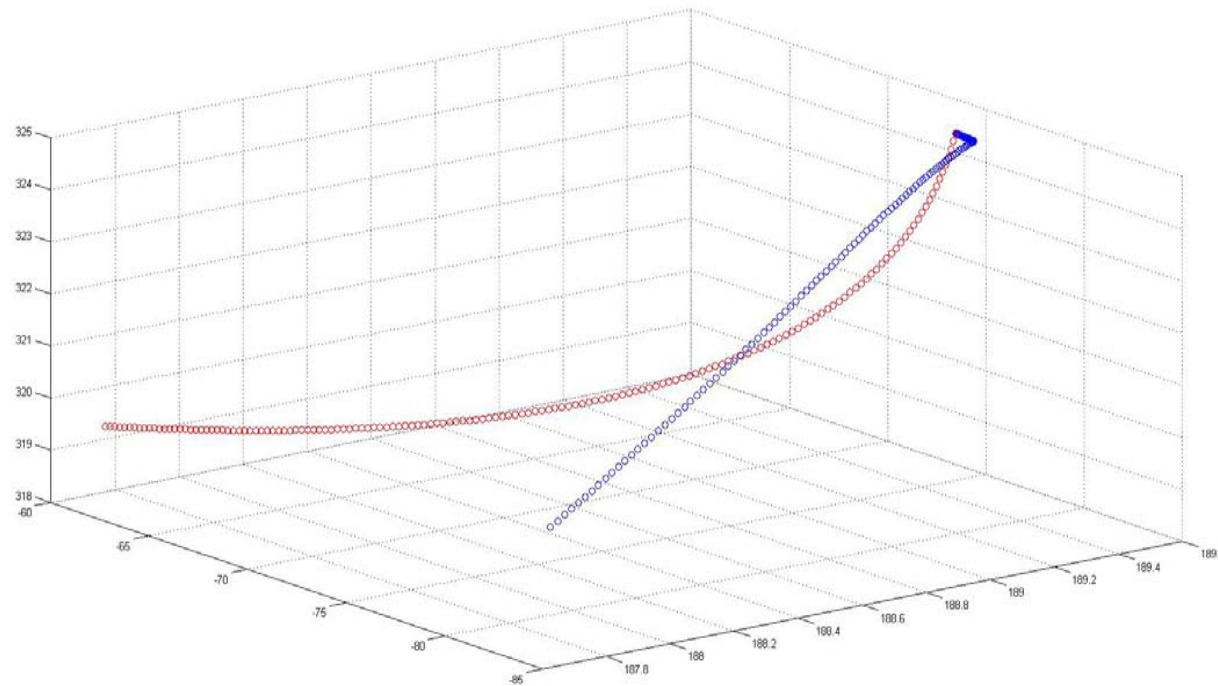
DBN



Generating Trajectory Automatically

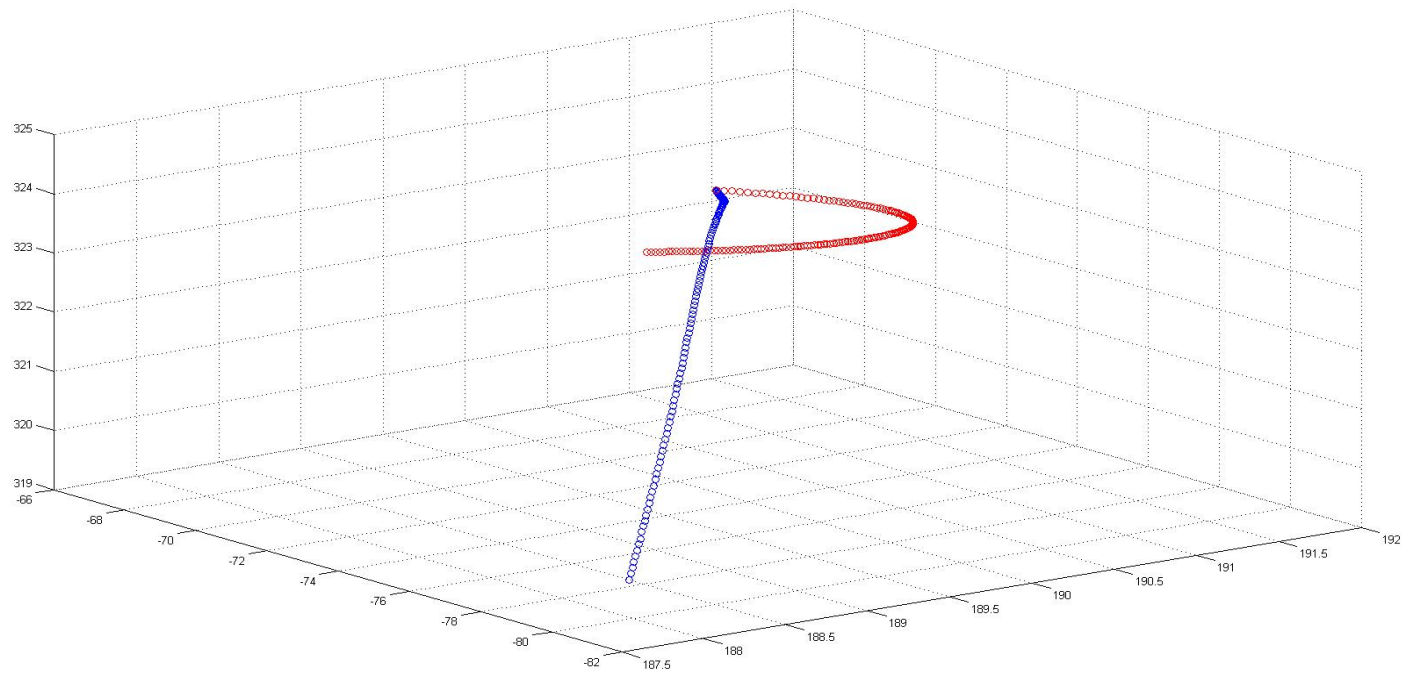
□ $\Delta t = 0.01s$

DBN



□ $\Delta t = 0.01s$

Base Line



-
- ❑ Build a 3 level Regression Tree with 34 attributes to estimate the X value of Needle Position.
 - ❑ X value's range is [130 260]
 - ❑ Result: Mean Residual Square= 46.5910
 - ❑ The mean value of estimation error is about 7.
 - ❑ A 3 level tree is not enough for well estimating a state with 34 attributes. More training is necessary.
-



Thank you

Questions?

