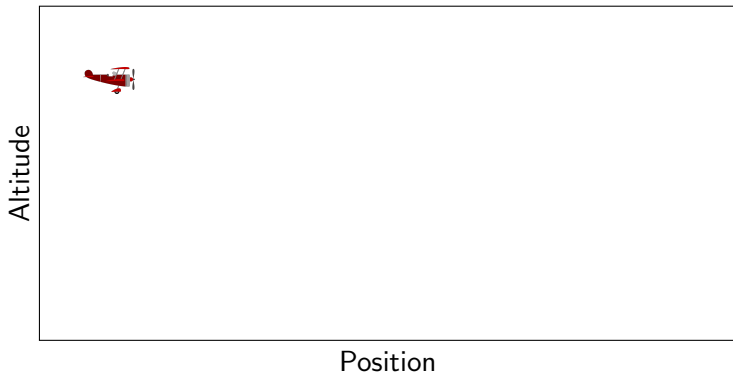


A Sequential Monte Carlo Example

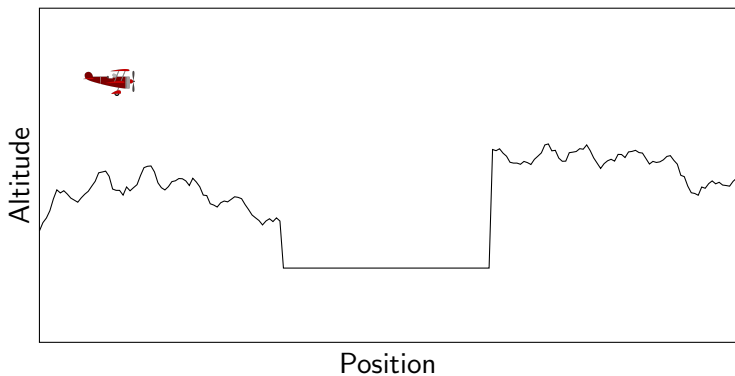
Daniel Lundén

October 11, 2019

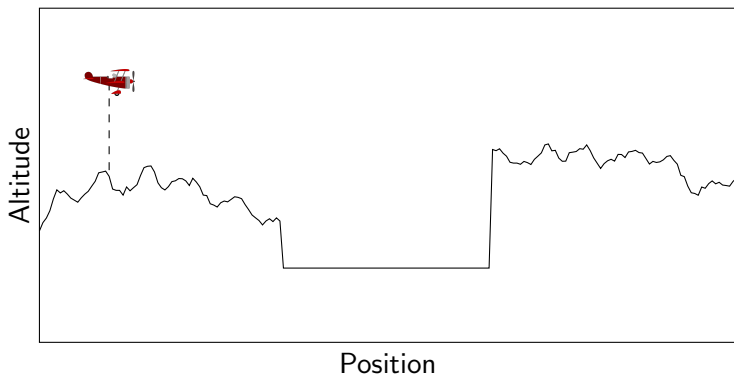
A Model for Aircraft Localization



A Model for Aircraft Localization



A Model for Aircraft Localization



A Model for Aircraft Localization

- ▶ Initial position: $X_0 \sim \mathcal{U}(0, 100)$

A Model for Aircraft Localization

- ▶ Initial position: $X_0 \sim \mathcal{U}(0, 100)$
- ▶ Transition model: $X_t \sim \mathcal{N}(X_{t-1} + 2, 0.5)$

A Model for Aircraft Localization

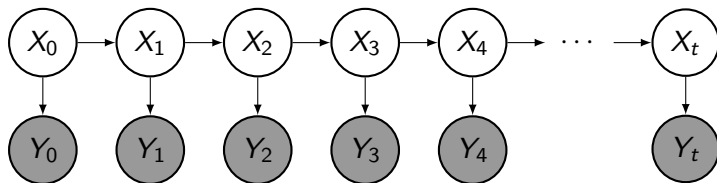
- ▶ Initial position: $X_0 \sim \mathcal{U}(0, 100)$
- ▶ Transition model: $X_t \sim \mathcal{N}(X_{t-1} + 2, 0.5)$
- ▶ Observation model: $Y_t \sim \mathcal{N}(\text{map}(X_t), 5)$

A Model for Aircraft Localization

- ▶ Initial position: $X_0 \sim \mathcal{U}(0, 100)$
- ▶ Transition model: $X_t \sim \mathcal{N}(X_{t-1} + 2, 0.5)$
- ▶ Observation model: $Y_t \sim \mathcal{N}(\text{map}(X_t), 5)$
- ▶ Problem: Find $p(x_t \mid y_{0:t})$

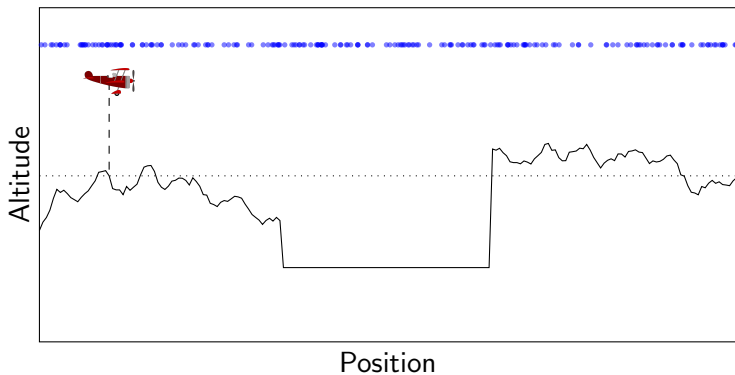
A Model for Aircraft Localization

- ▶ Initial position: $X_0 \sim \mathcal{U}(0, 100)$
- ▶ Transition model: $X_t \sim \mathcal{N}(X_{t-1} + 2, 0.5)$
- ▶ Observation model: $Y_t \sim \mathcal{N}(\text{map}(X_t), 5)$
- ▶ Problem: Find $p(x_t \mid y_{0:t})$



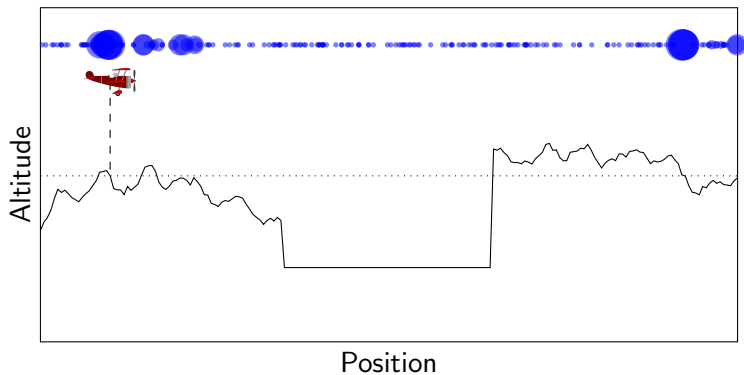
Importance sampling

Initialize 200 samples from X_0



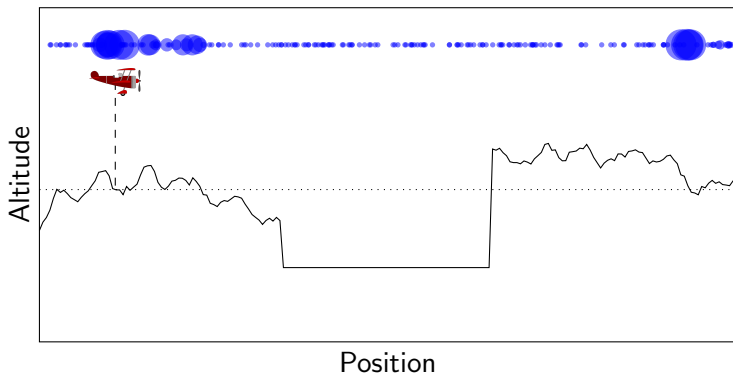
Importance sampling

Weigh samples using observation model



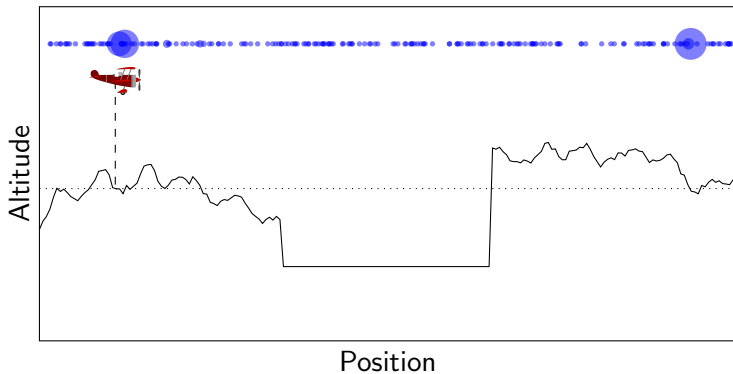
Importance sampling

Propagate samples using transition model



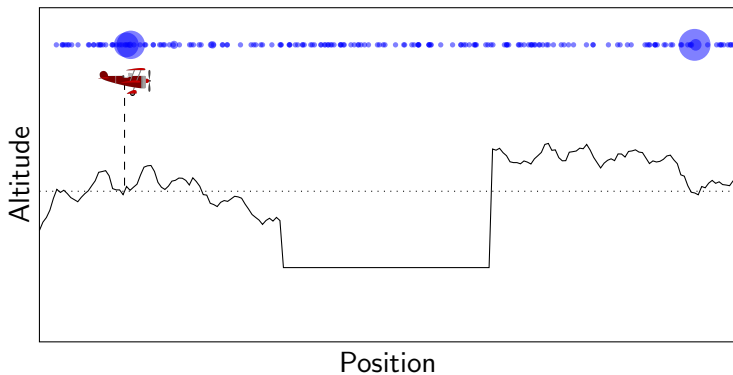
Importance sampling

Weigh samples using observation model



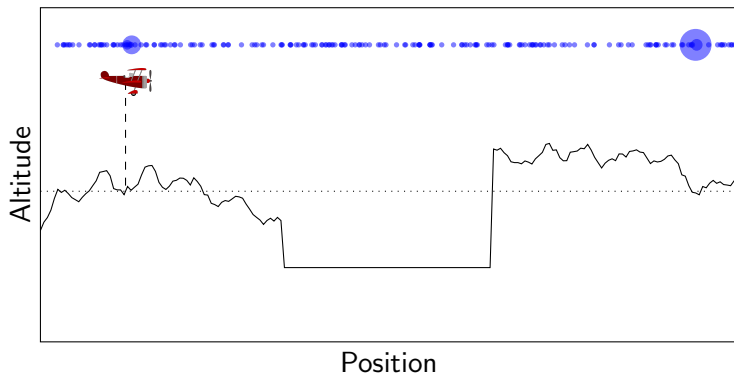
Importance sampling

Propagate samples using transition model



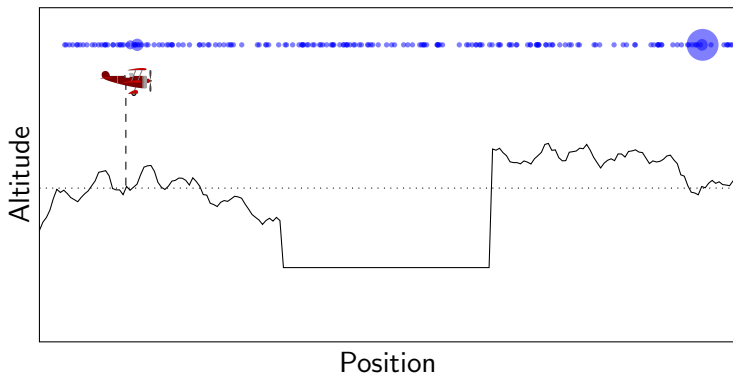
Importance sampling

Weigh samples using observation model



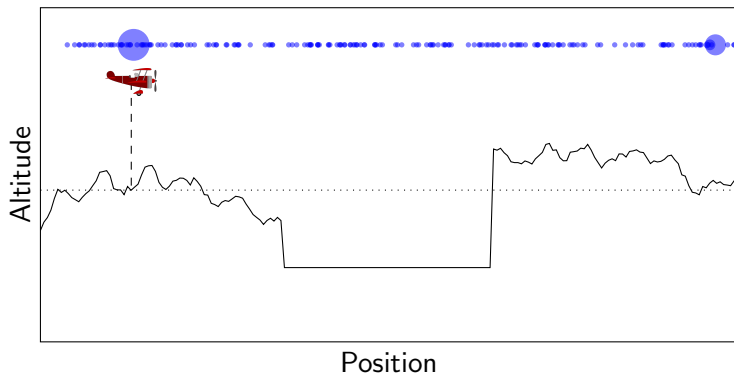
Importance sampling

Propagate, weigh



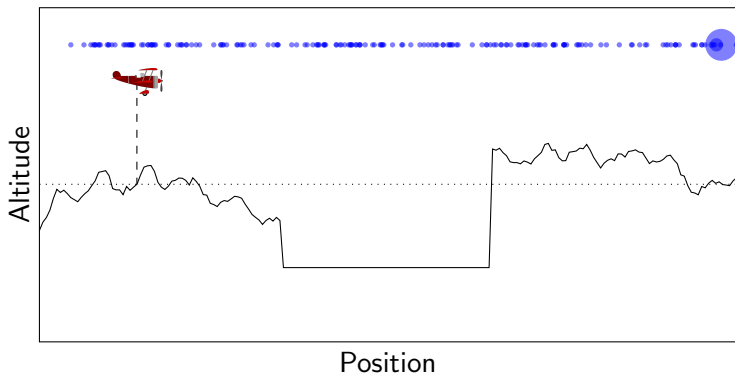
Importance sampling

Propagate, weigh



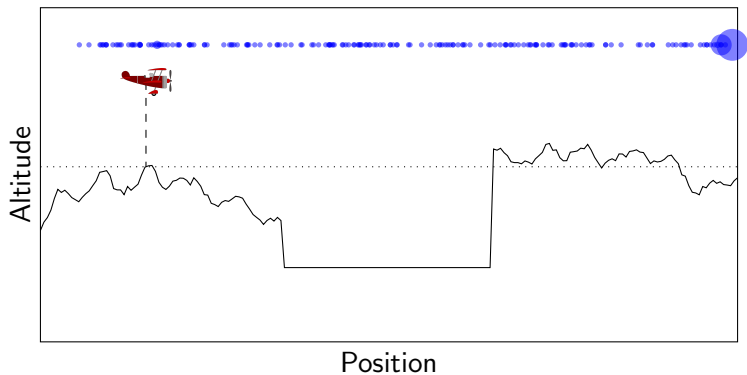
Importance sampling

Propagate, weigh



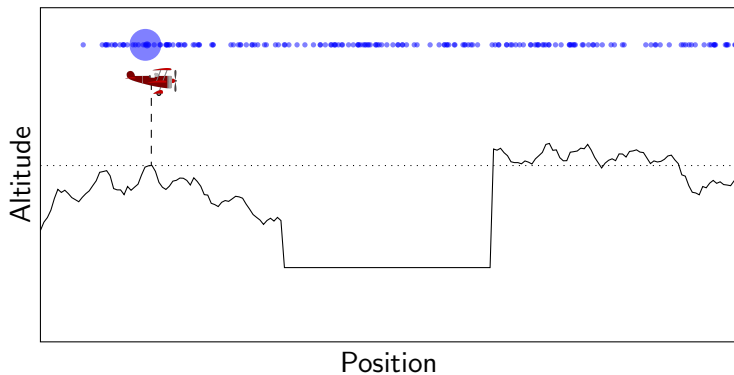
Importance sampling

Propagate, weigh



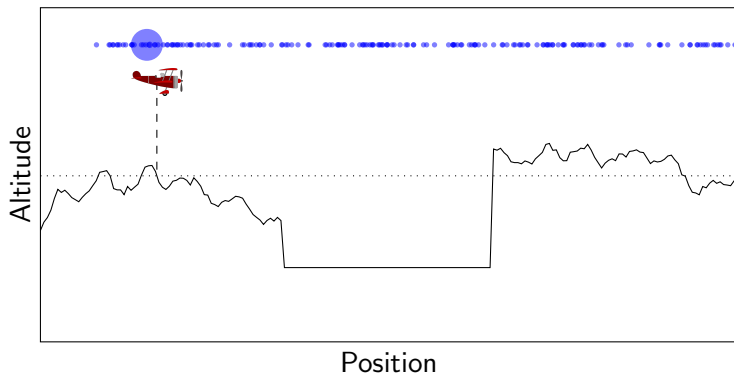
Importance sampling

Propagate, weigh



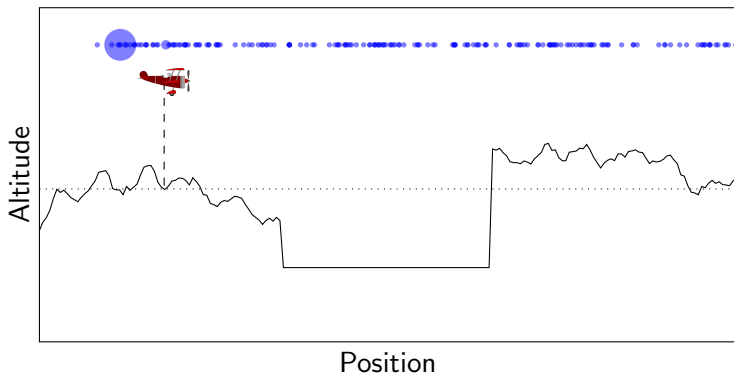
Importance sampling

Propagate, weigh



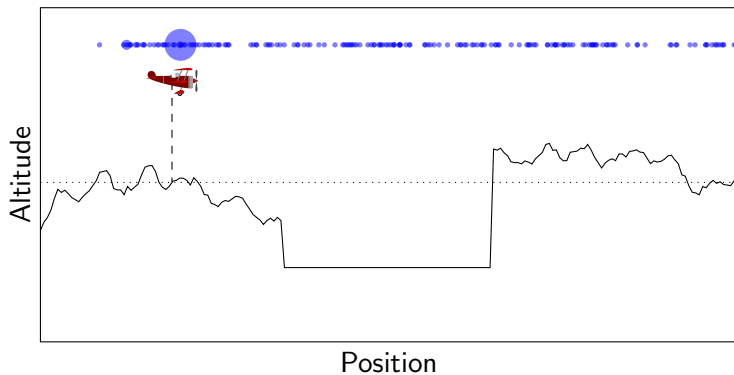
Importance sampling

Propagate, weigh



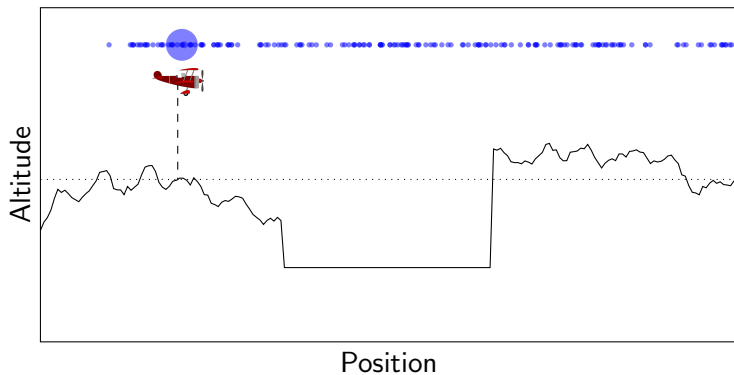
Importance sampling

Propagate, weigh



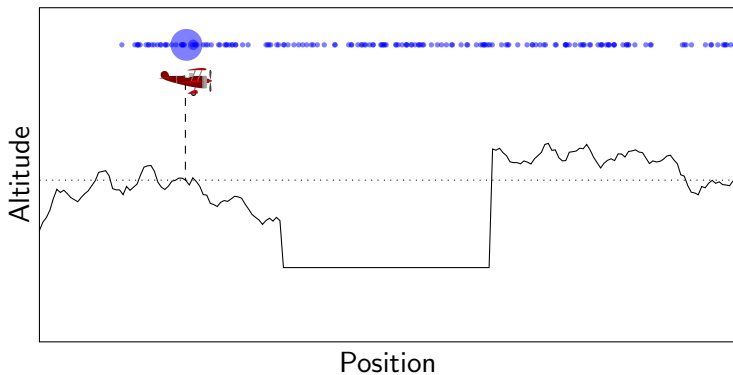
Importance sampling

Propagate, weigh



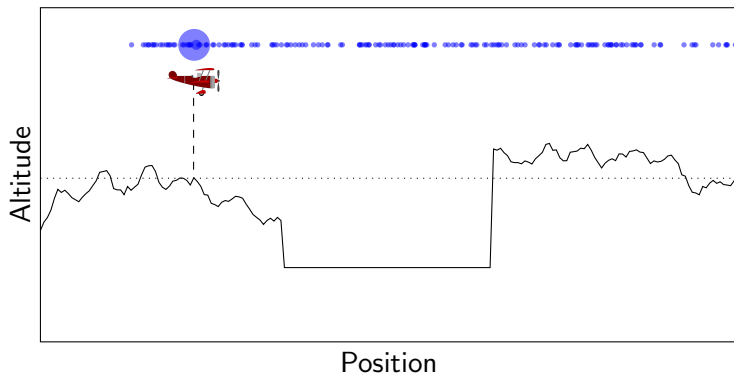
Importance sampling

Propagate, weigh



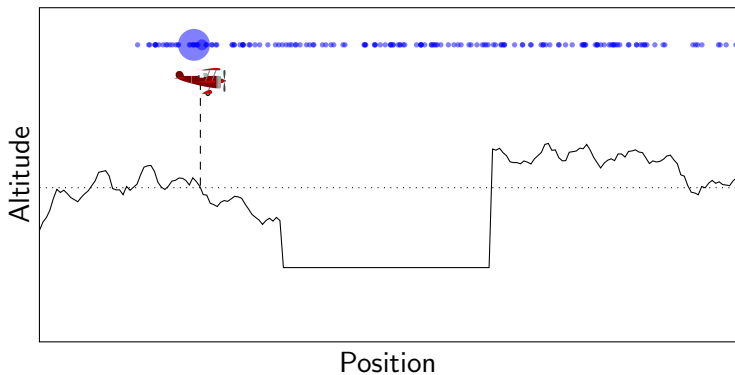
Importance sampling

Propagate, weigh



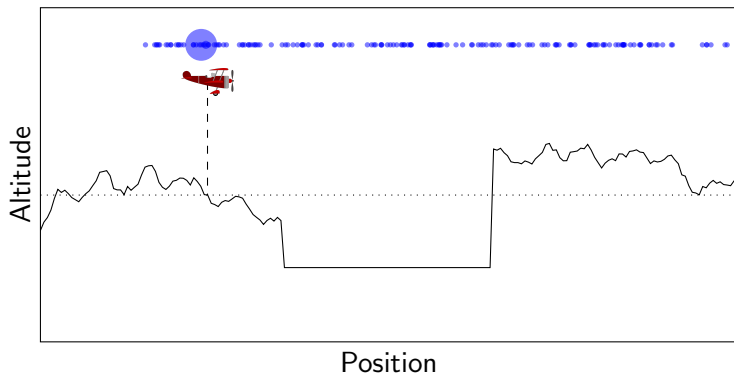
Importance sampling

Propagate, weigh



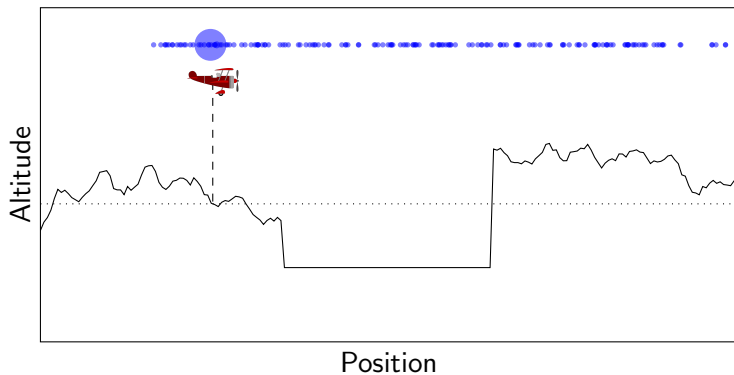
Importance sampling

Propagate, weigh



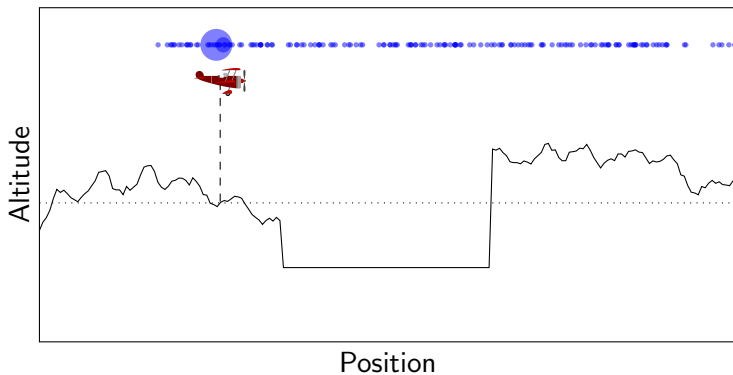
Importance sampling

Propagate, weigh



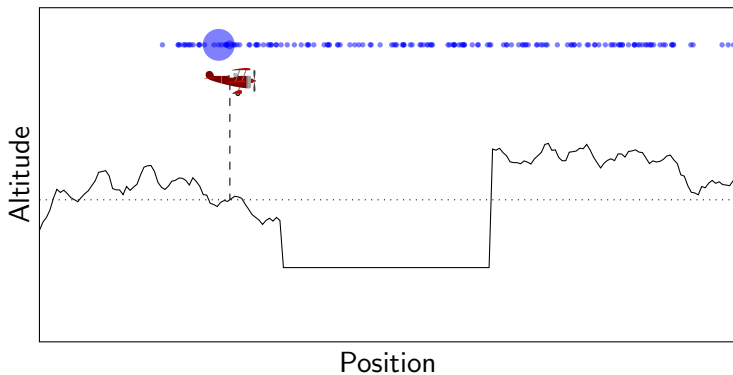
Importance sampling

Propagate, weigh



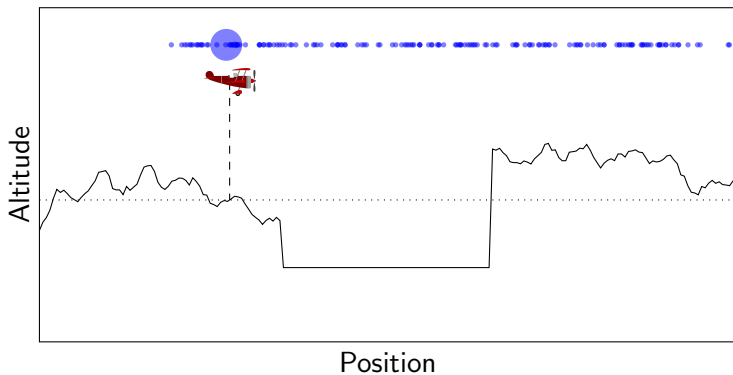
Importance sampling

Propagate, weigh



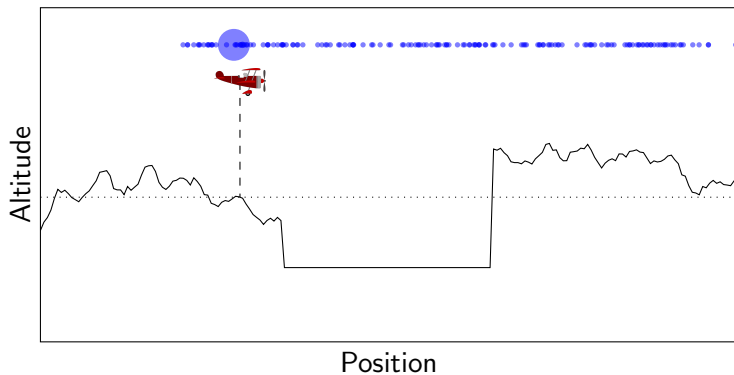
Importance sampling

Propagate, weigh



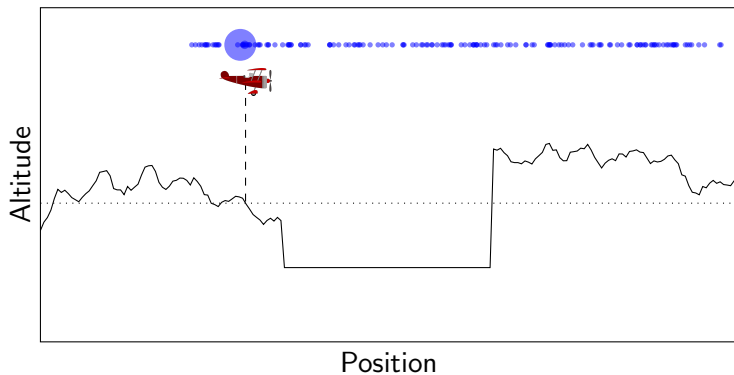
Importance sampling

Propagate, weigh



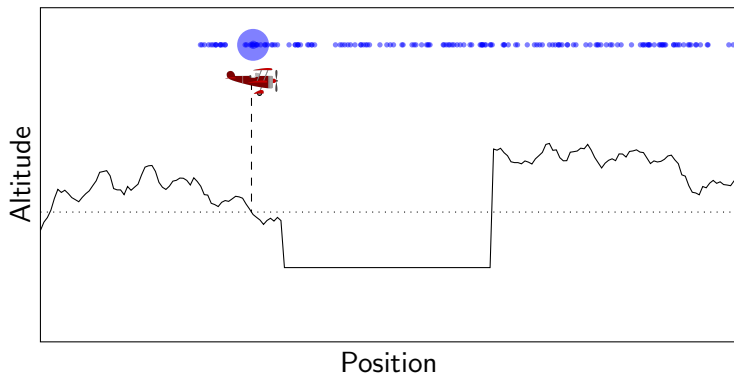
Importance sampling

Propagate, weigh



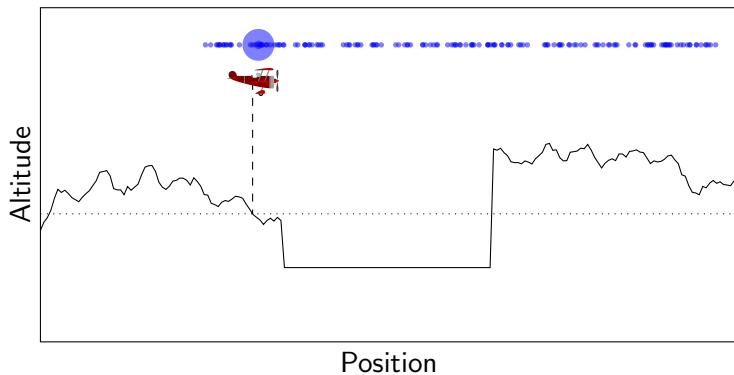
Importance sampling

Propagate, weigh



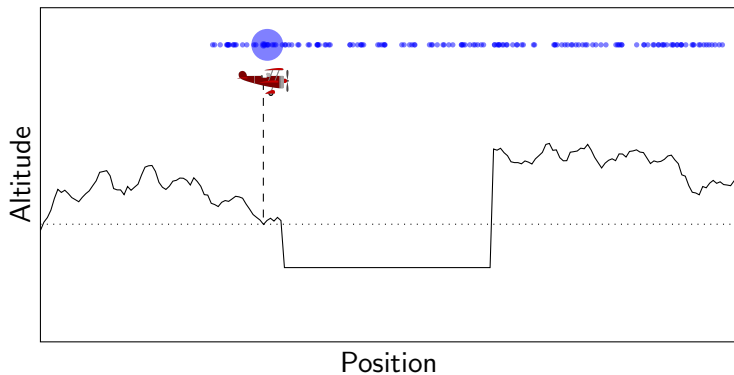
Importance sampling

Propagate, weigh



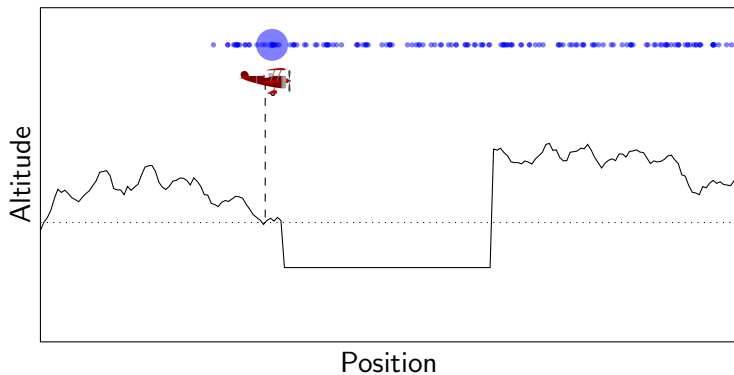
Importance sampling

Propagate, weigh



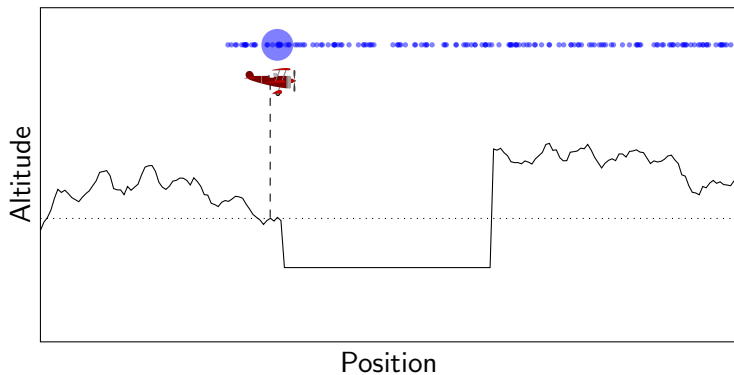
Importance sampling

Propagate, weigh



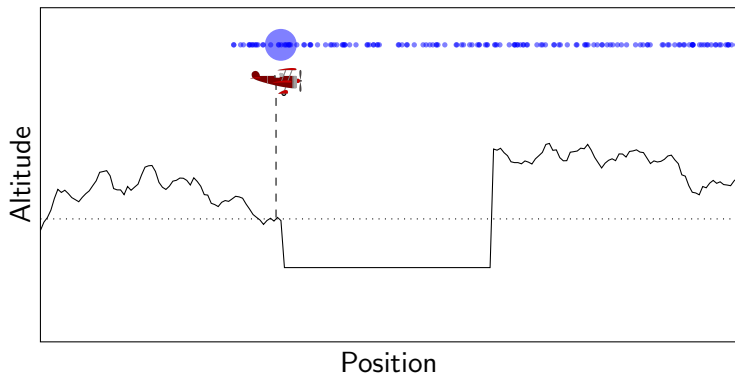
Importance sampling

Propagate, weigh



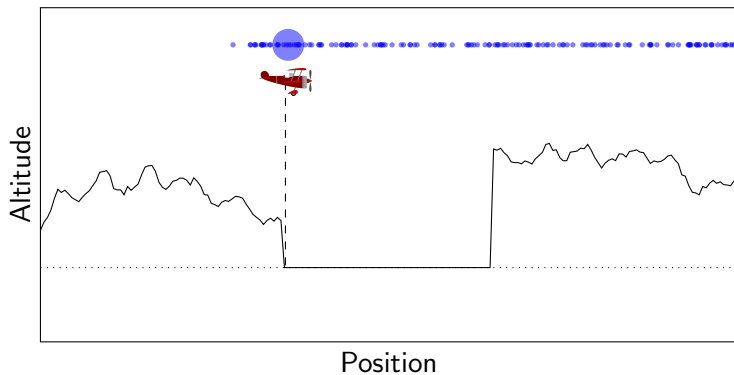
Importance sampling

Propagate, weigh



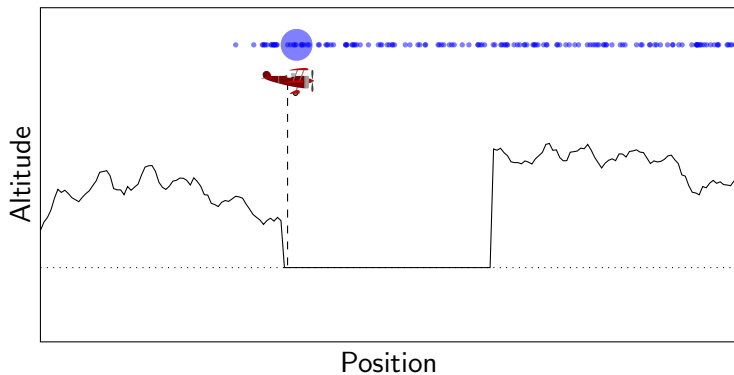
Importance sampling

Propagate, weigh



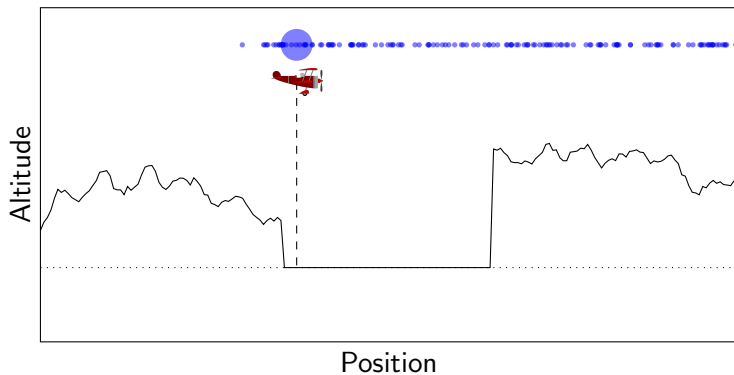
Importance sampling

Propagate, weigh



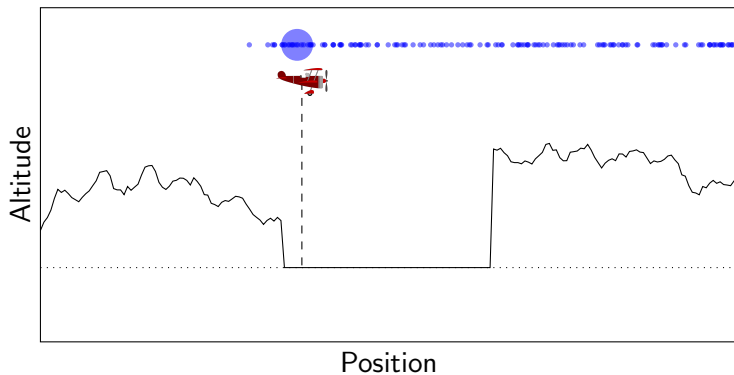
Importance sampling

Propagate, weigh



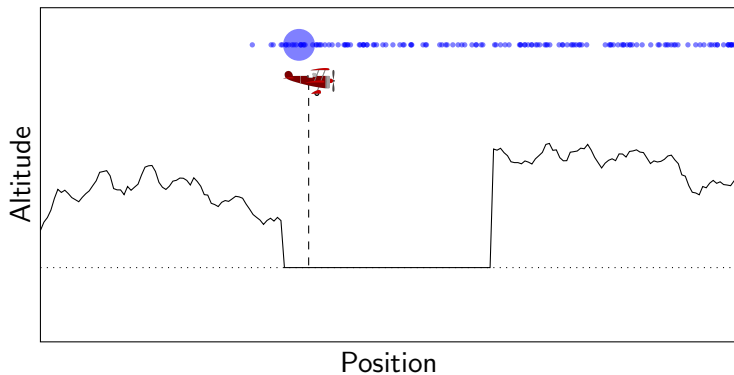
Importance sampling

Propagate, weigh



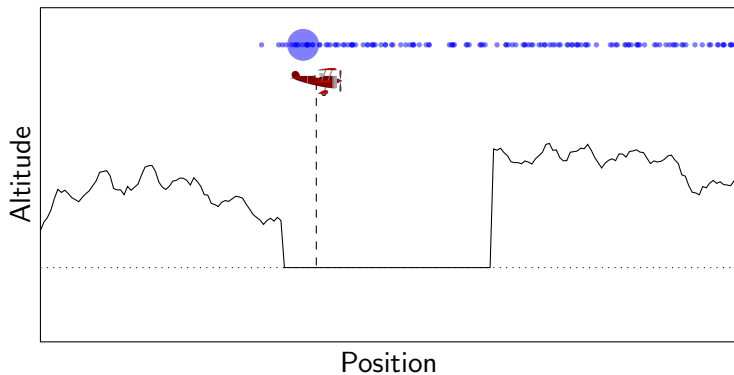
Importance sampling

Propagate, weigh



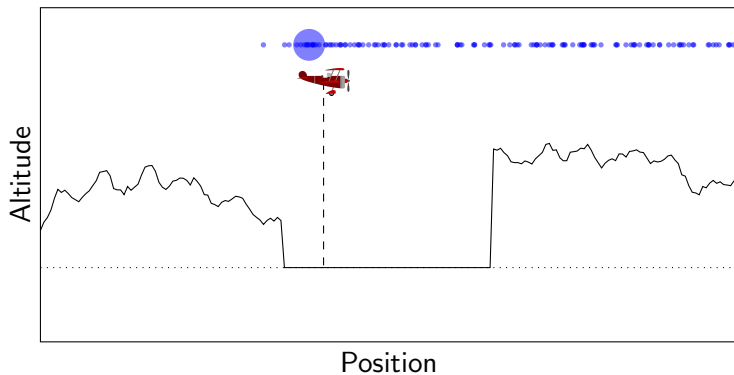
Importance sampling

Propagate, weigh



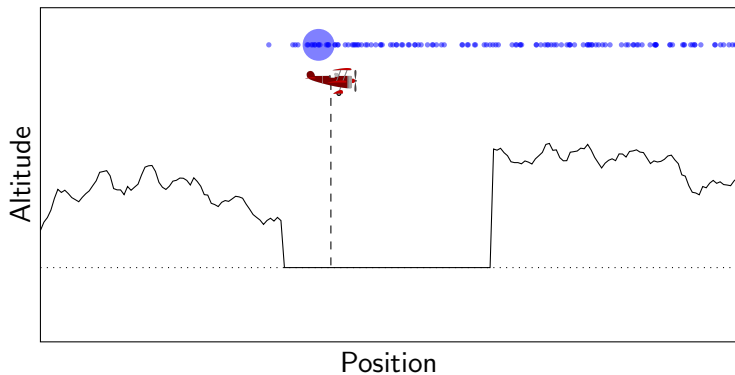
Importance sampling

Propagate, weigh



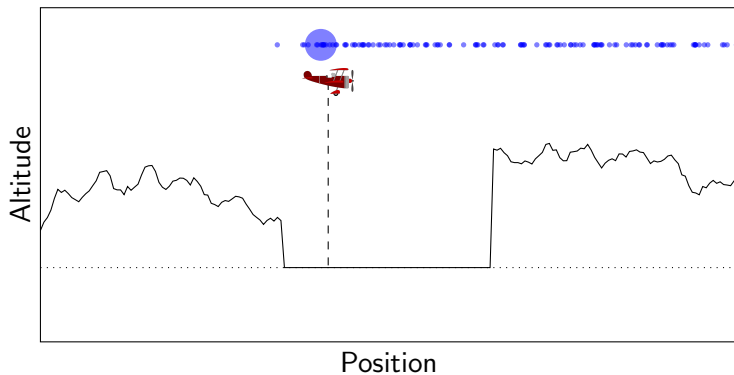
Importance sampling

Propagate, weigh



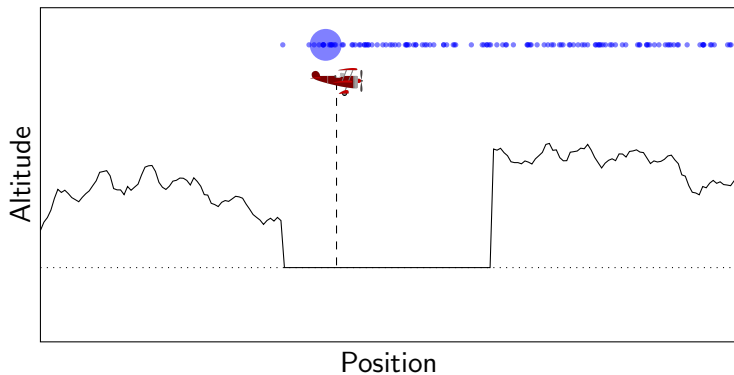
Importance sampling

Propagate, weigh



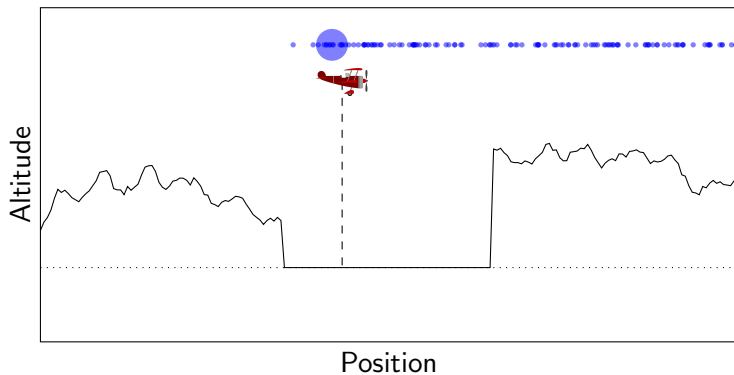
Importance sampling

Propagate, weigh



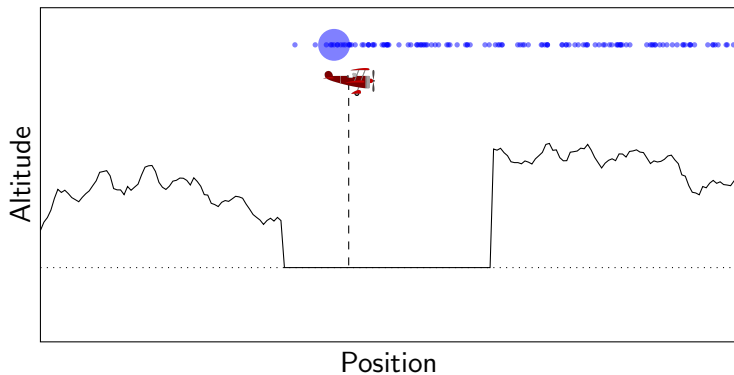
Importance sampling

Propagate, weigh



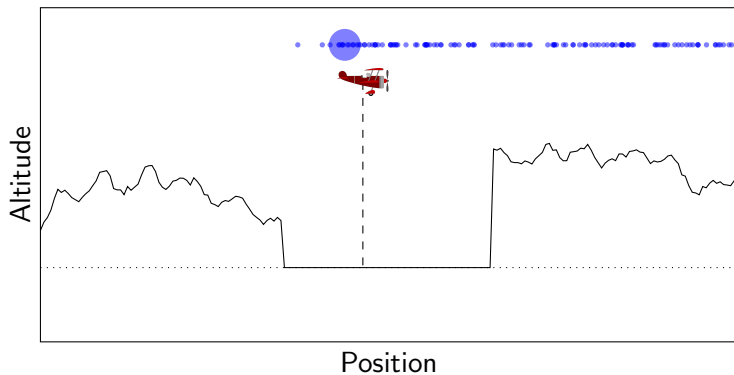
Importance sampling

Propagate, weigh



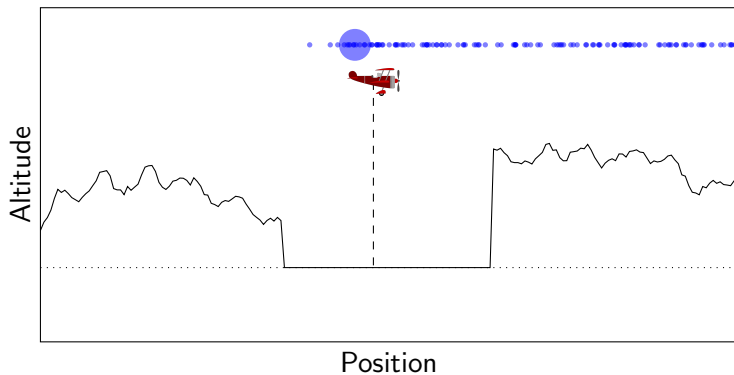
Importance sampling

Propagate, weigh



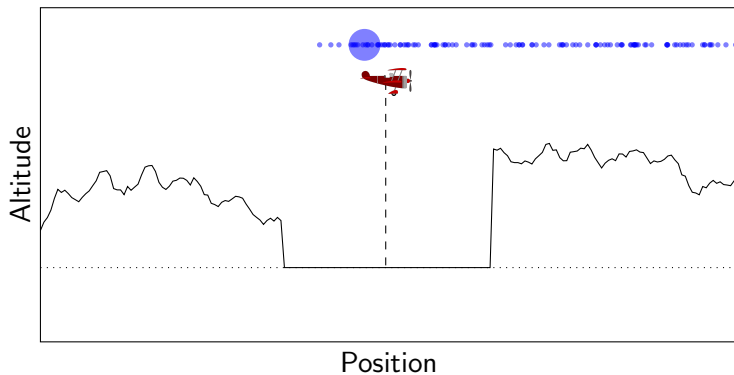
Importance sampling

Propagate, weigh



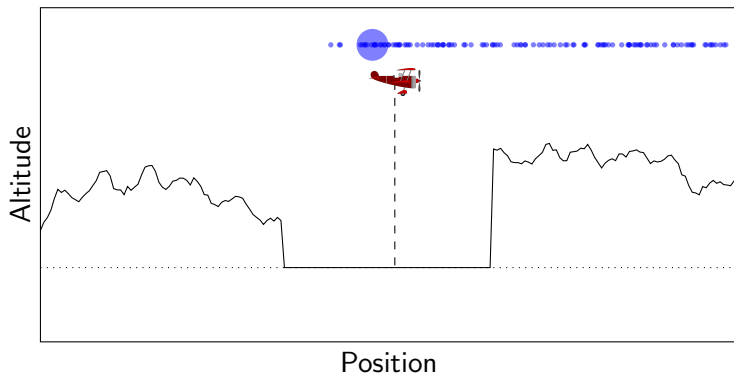
Importance sampling

Propagate, weigh



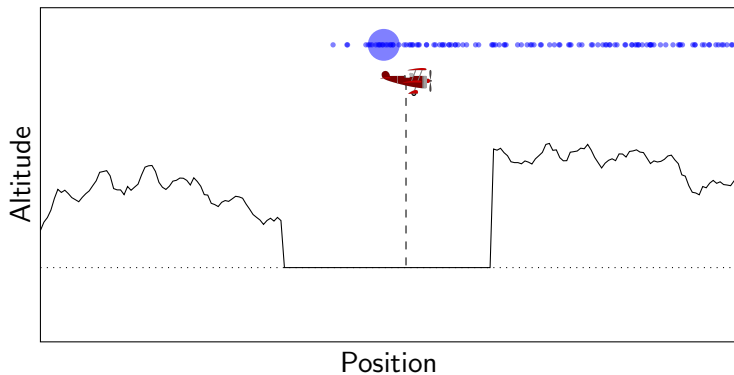
Importance sampling

Propagate, weigh



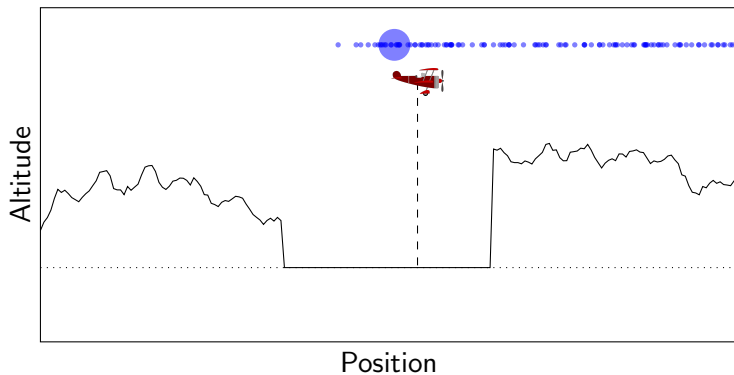
Importance sampling

Propagate, weigh



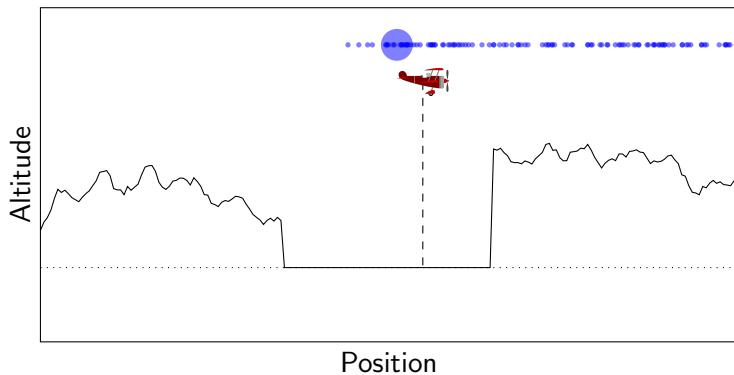
Importance sampling

Propagate, weigh



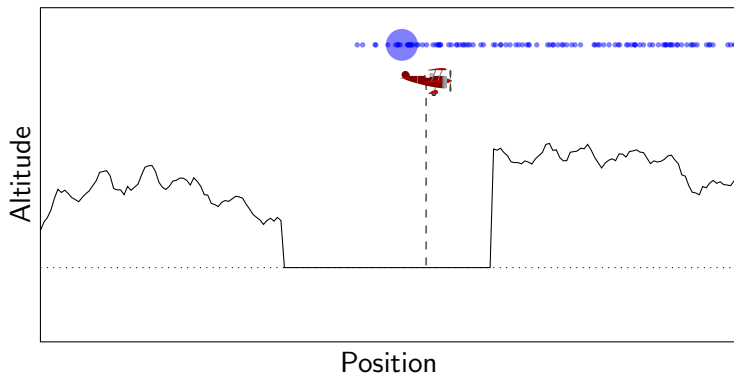
Importance sampling

Propagate, weigh



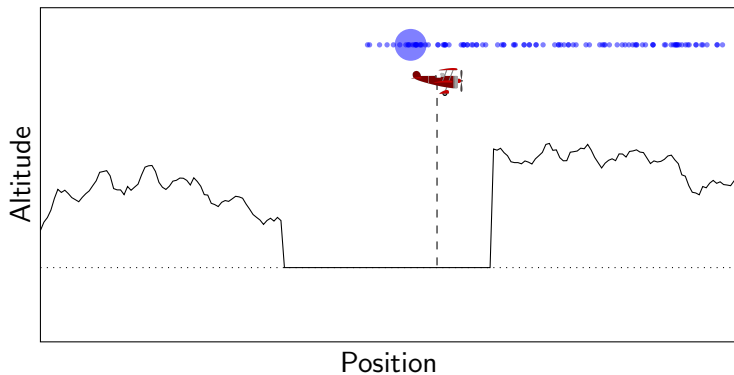
Importance sampling

Propagate, weigh



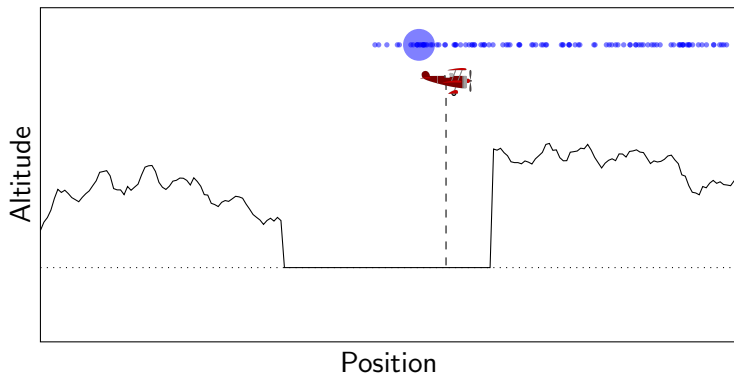
Importance sampling

Propagate, weigh



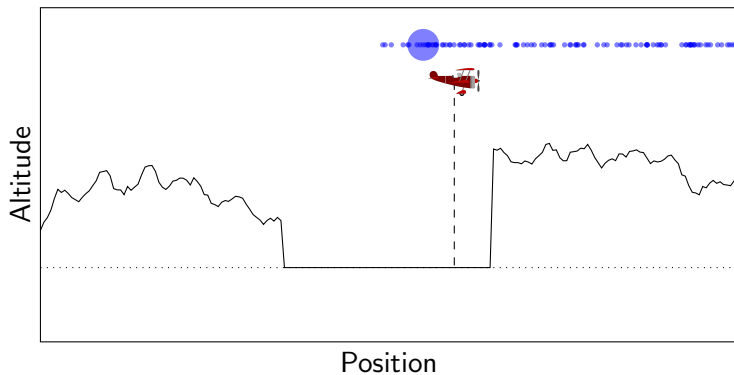
Importance sampling

Propagate, weigh



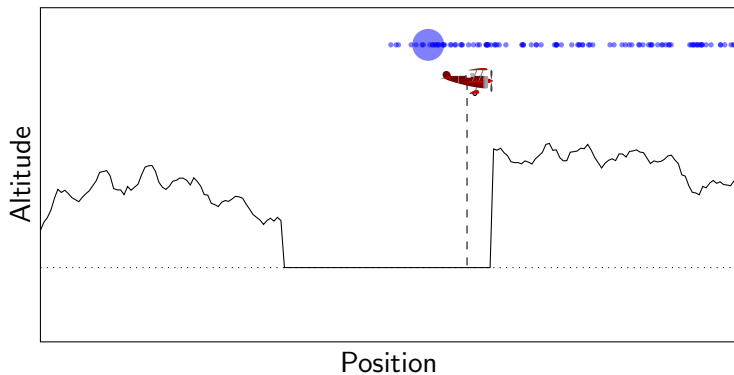
Importance sampling

Propagate, weigh



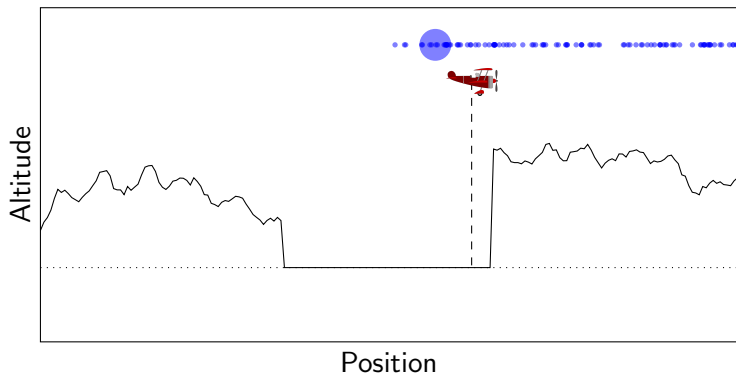
Importance sampling

Propagate, weigh



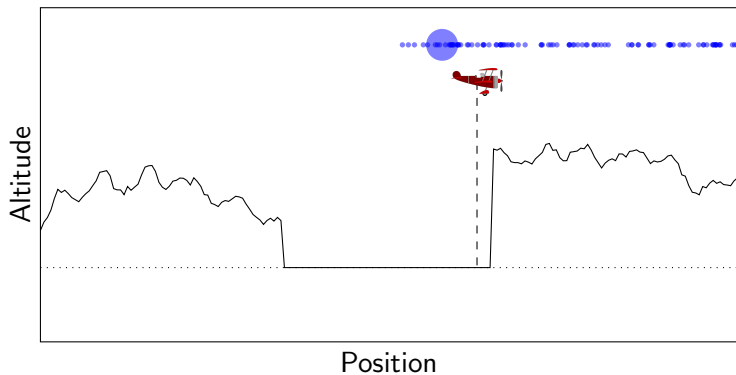
Importance sampling

Propagate, weigh



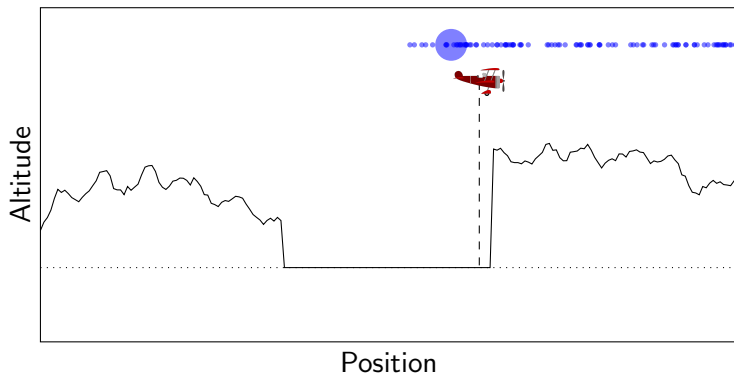
Importance sampling

Propagate, weigh



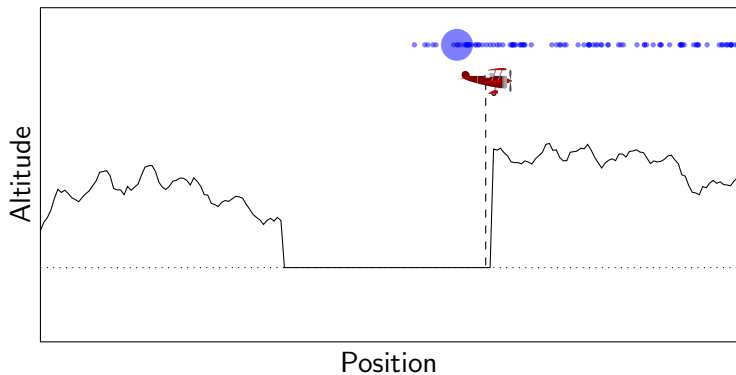
Importance sampling

Propagate, weigh



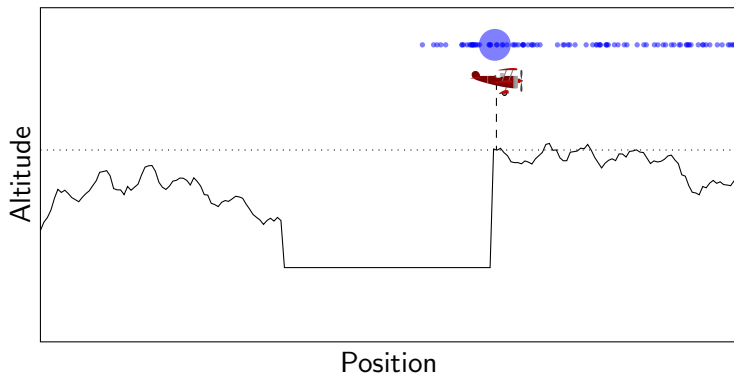
Importance sampling

Propagate, weigh



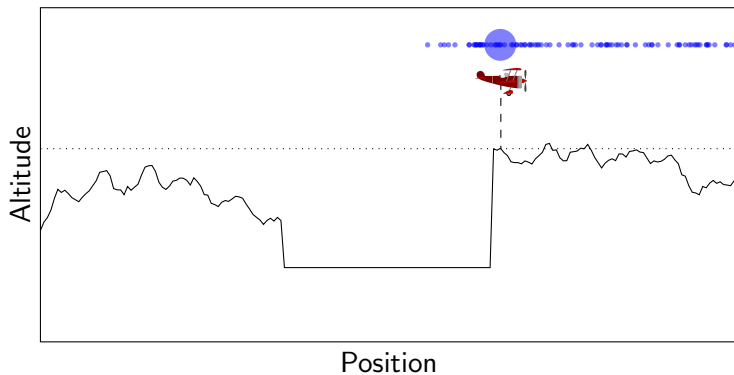
Importance sampling

Propagate, weigh



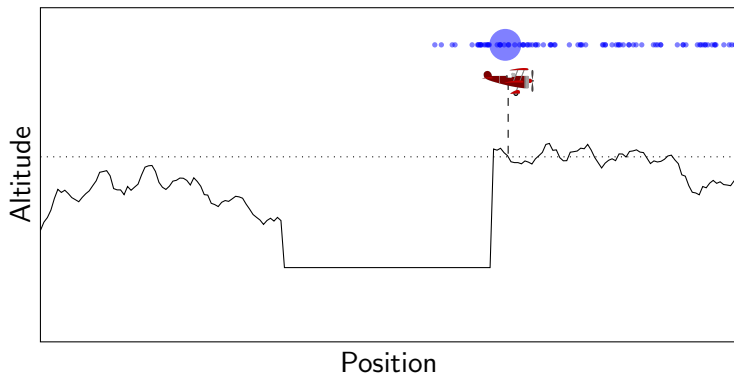
Importance sampling

Propagate, weigh



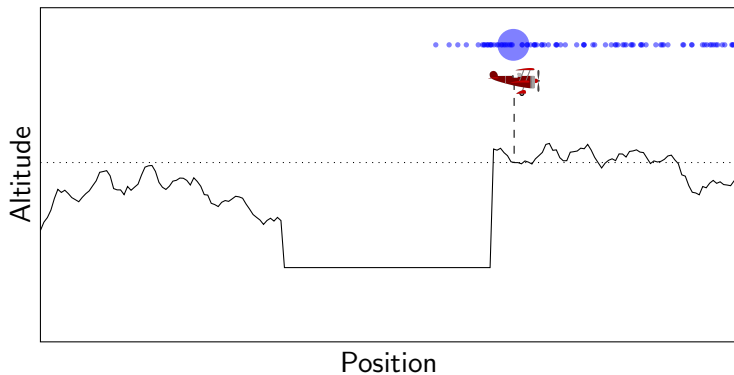
Importance sampling

Propagate, weigh



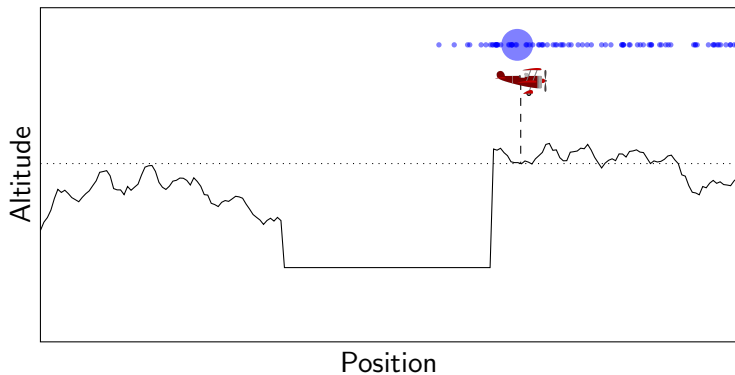
Importance sampling

Propagate, weigh



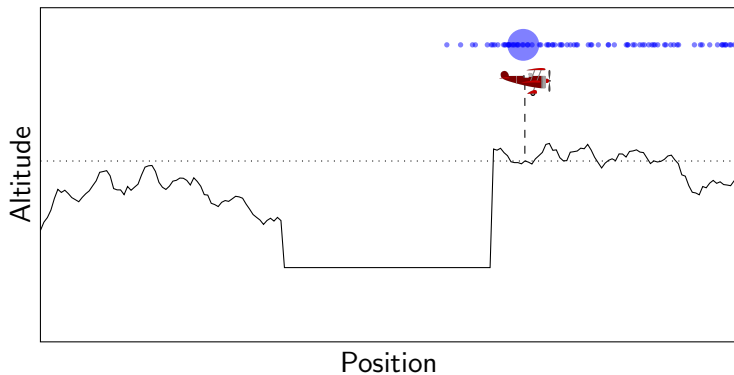
Importance sampling

Propagate, weigh



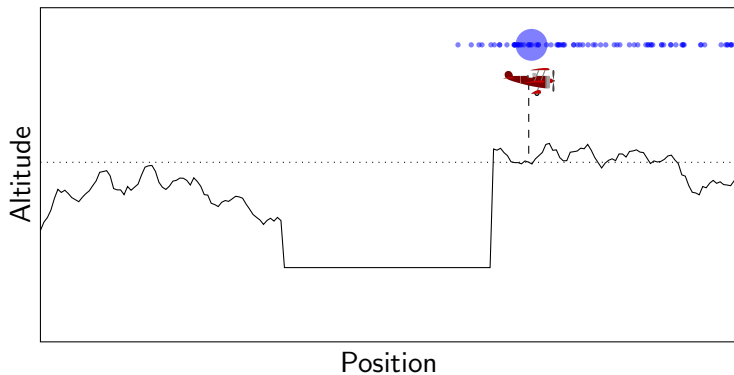
Importance sampling

Propagate, weigh



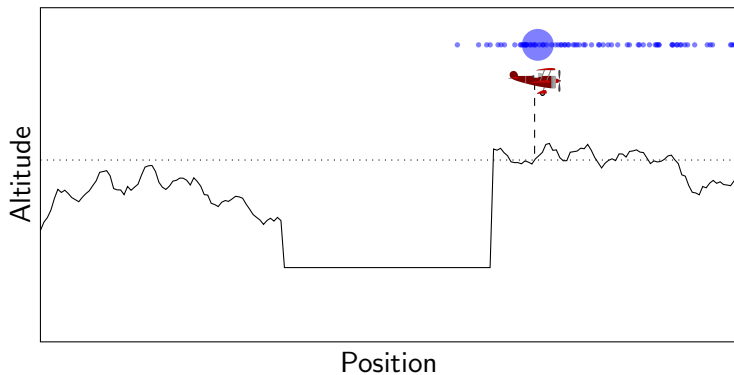
Importance sampling

Propagate, weigh



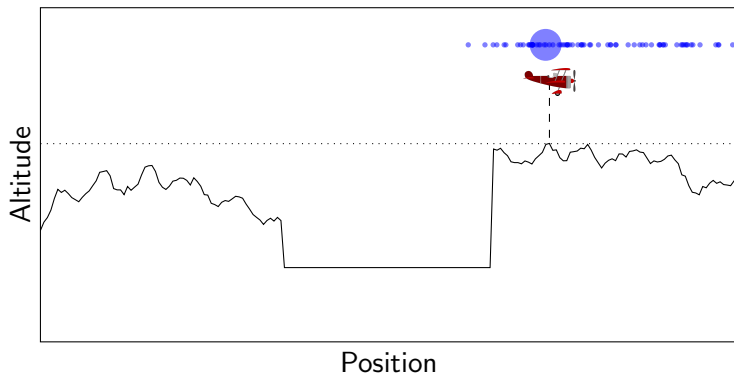
Importance sampling

Propagate, weigh



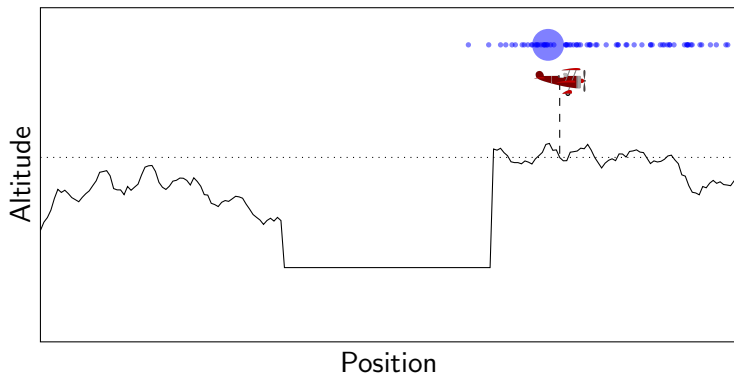
Importance sampling

Propagate, weigh



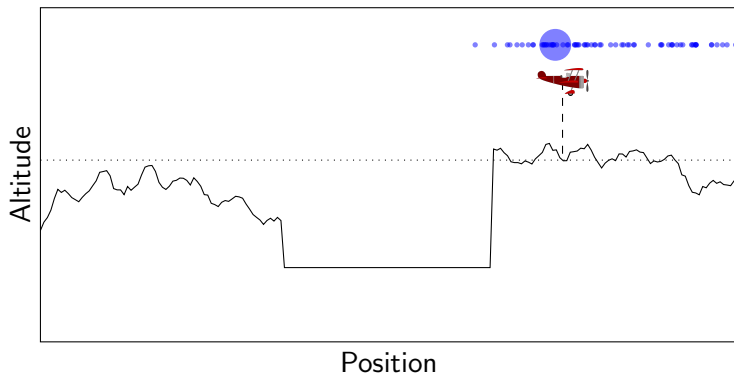
Importance sampling

Propagate, weigh



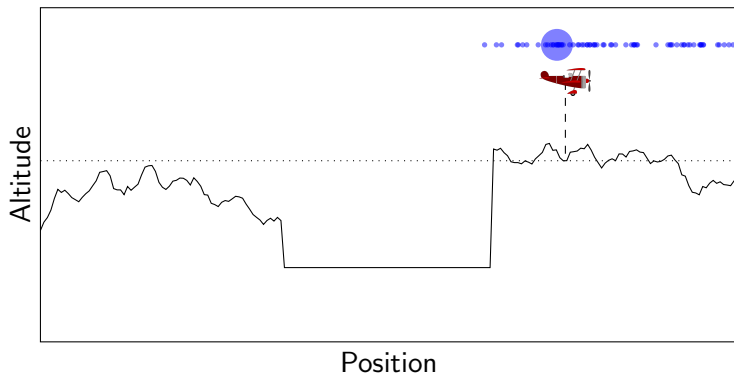
Importance sampling

Propagate, weigh



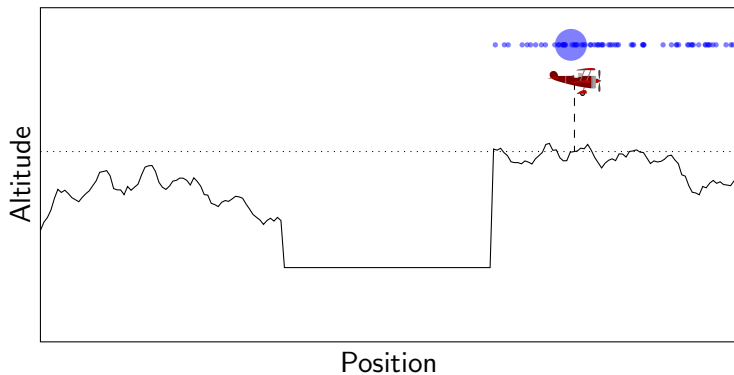
Importance sampling

Propagate, weigh



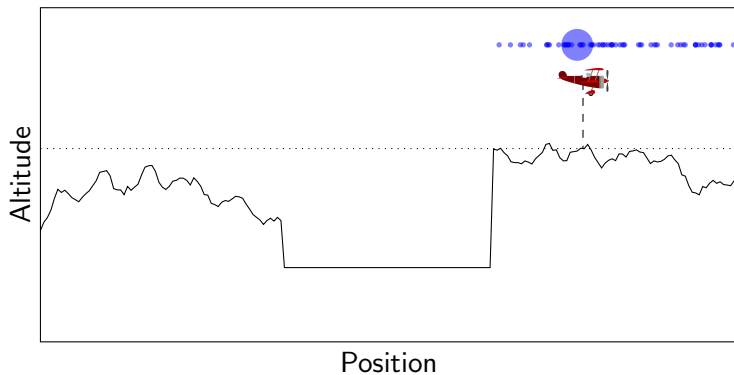
Importance sampling

Propagate, weigh



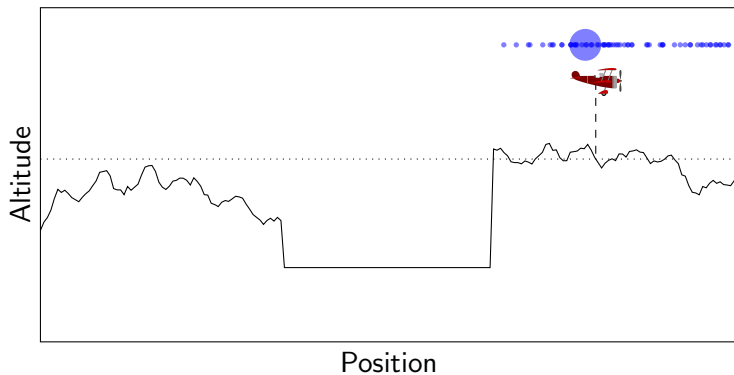
Importance sampling

Propagate, weigh



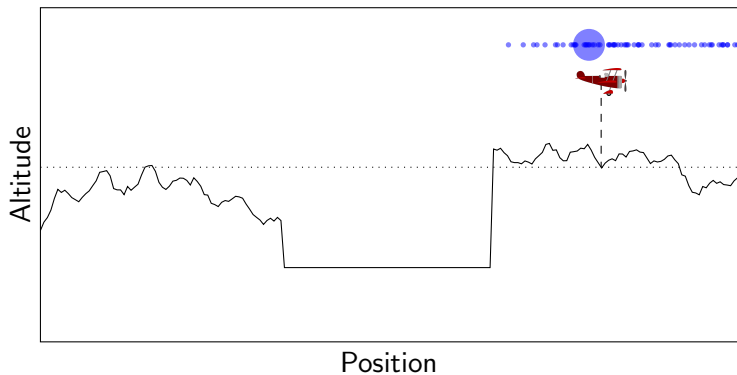
Importance sampling

Propagate, weigh



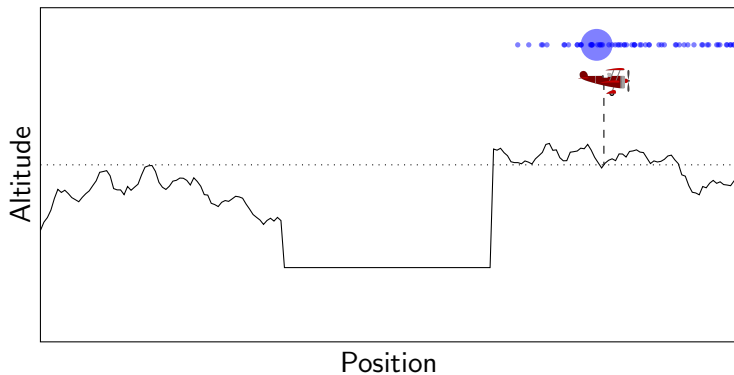
Importance sampling

Propagate, weigh



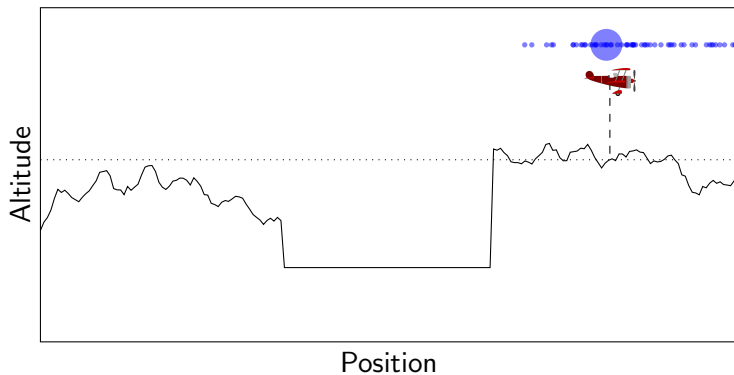
Importance sampling

Propagate, weigh



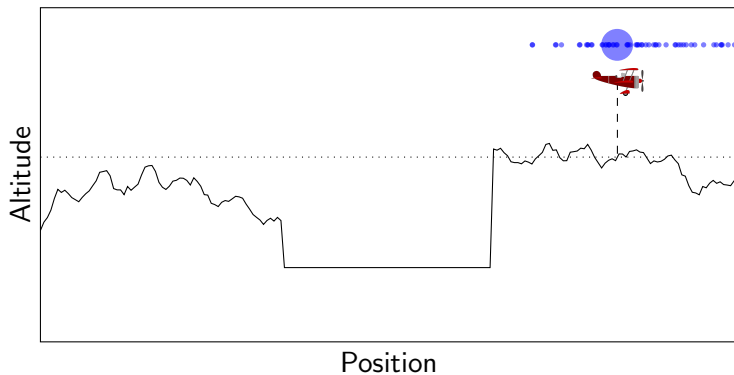
Importance sampling

Propagate, weigh



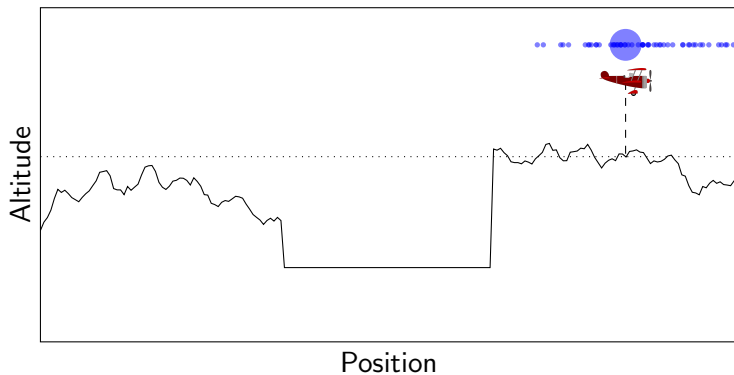
Importance sampling

Propagate, weigh



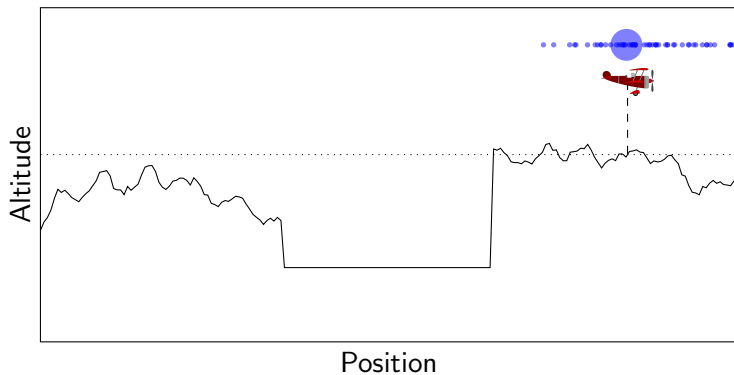
Importance sampling

Propagate, weigh



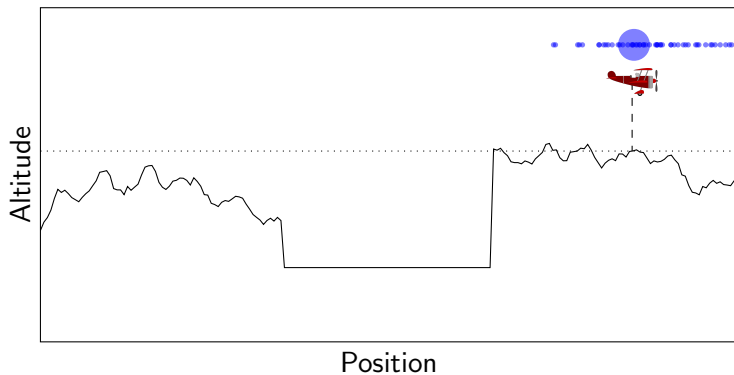
Importance sampling

Propagate, weigh



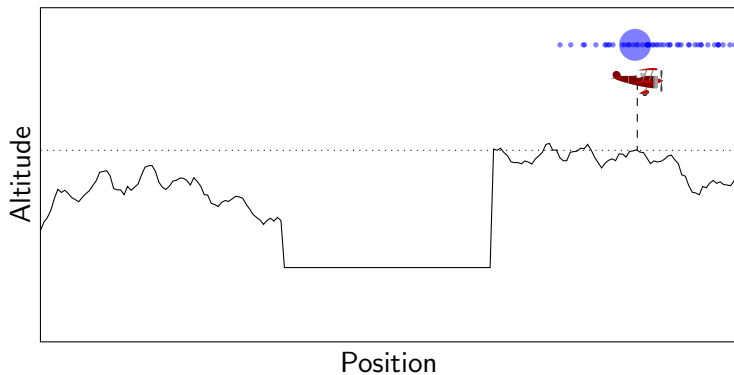
Importance sampling

Propagate, weigh



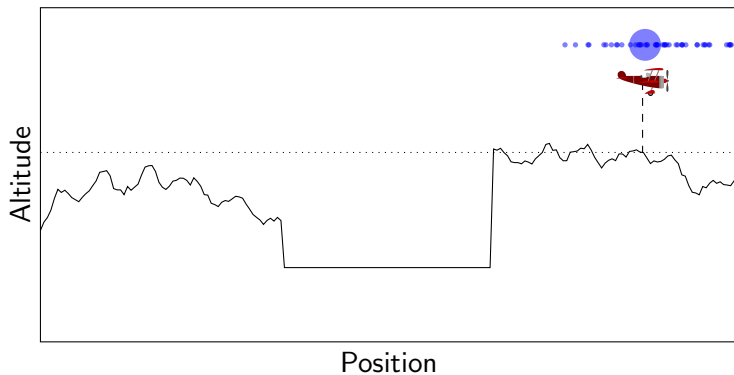
Importance sampling

Propagate, weigh



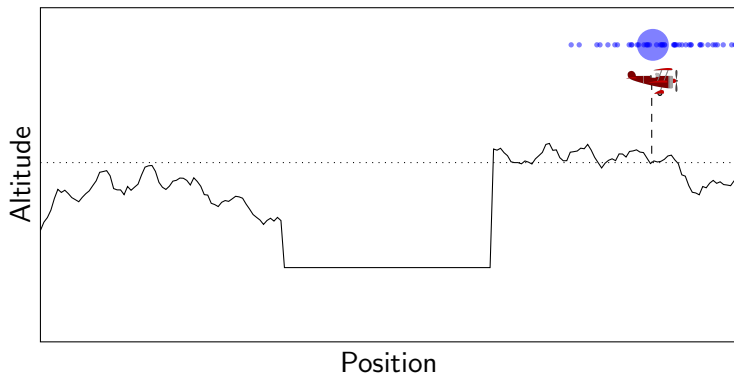
Importance sampling

Propagate, weigh



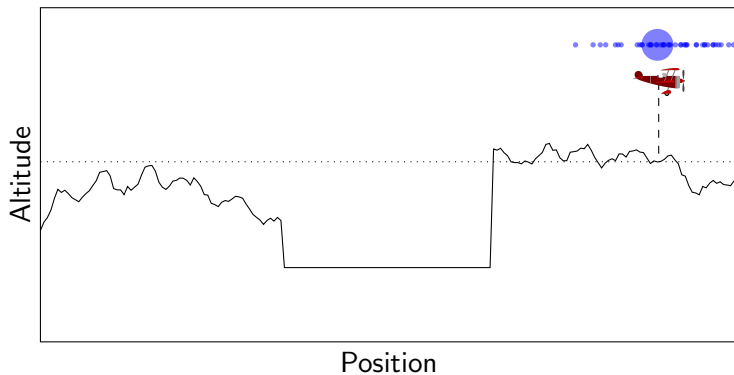
Importance sampling

Propagate, weigh



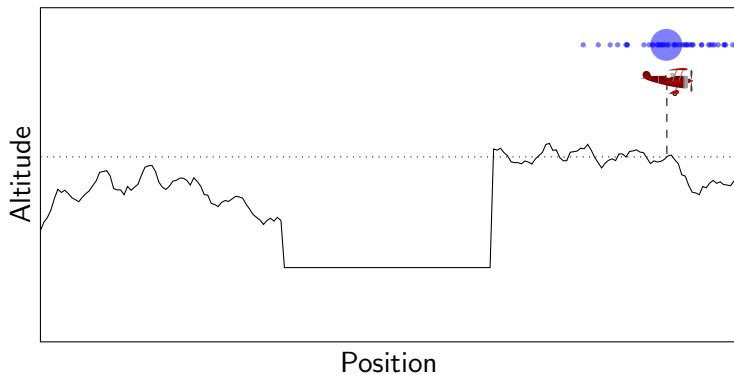
Importance sampling

Propagate, weigh



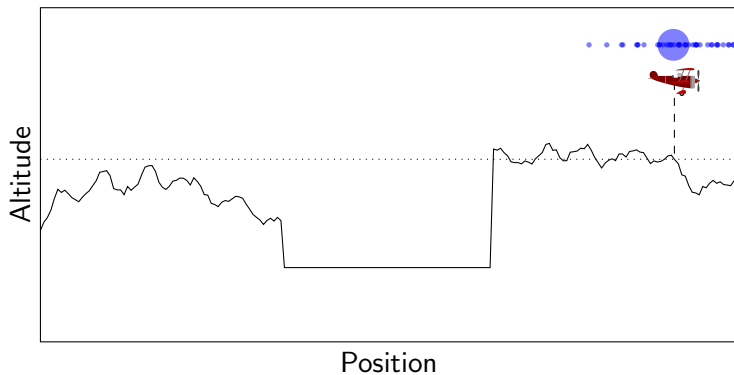
Importance sampling

Propagate, weigh



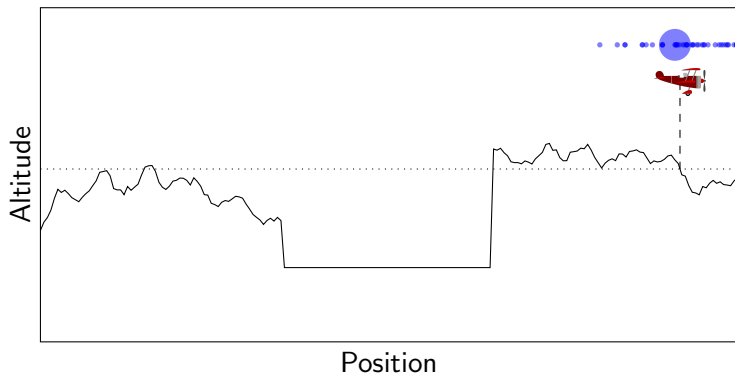
Importance sampling

Propagate, weigh



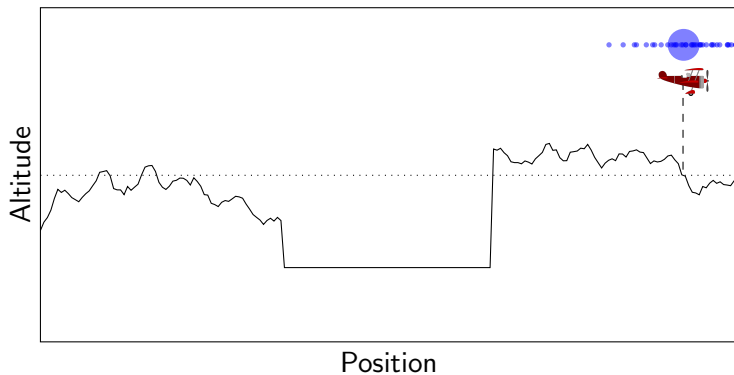
Importance sampling

Propagate, weigh



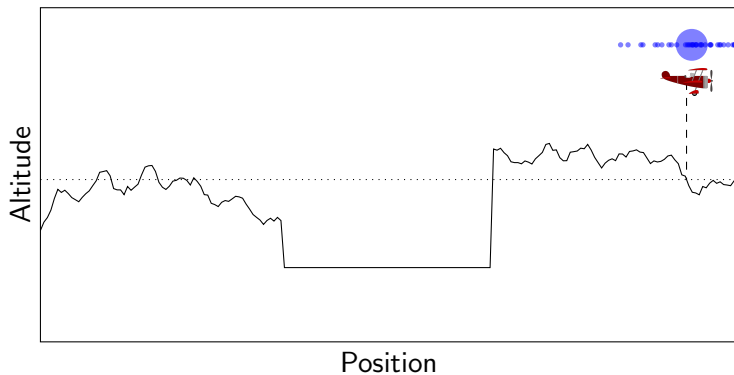
Importance sampling

Propagate, weigh



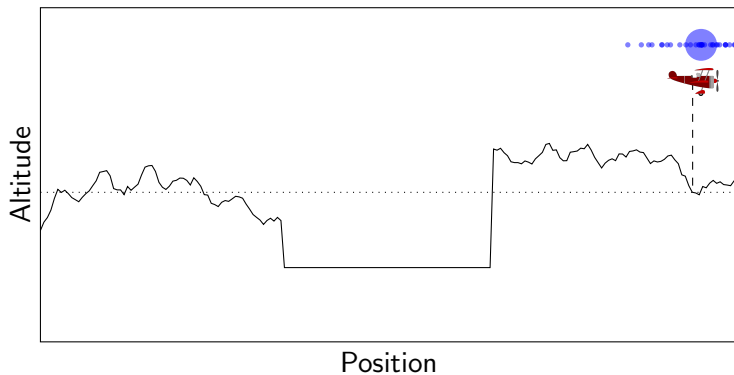
Importance sampling

Propagate, weigh



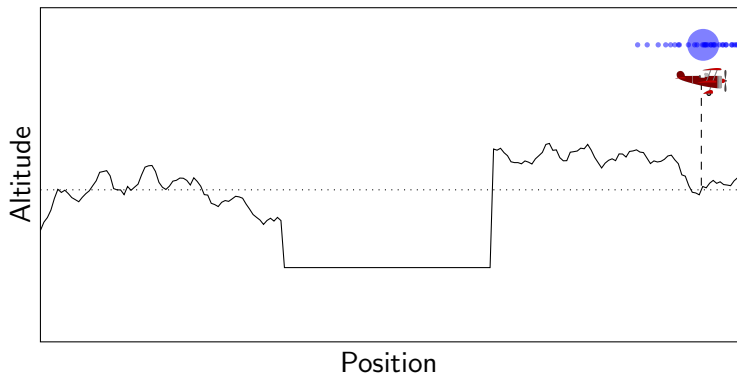
Importance sampling

Propagate, weigh



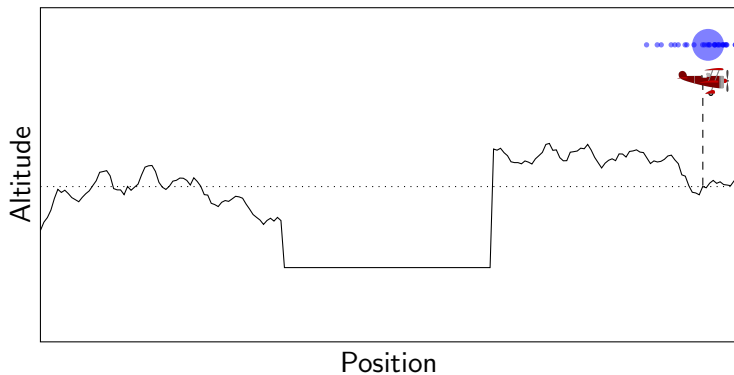
Importance sampling

Propagate, weigh



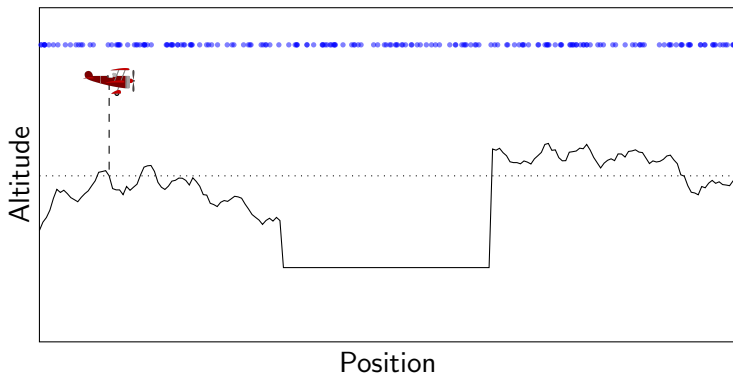
Importance sampling

Propagate, weigh



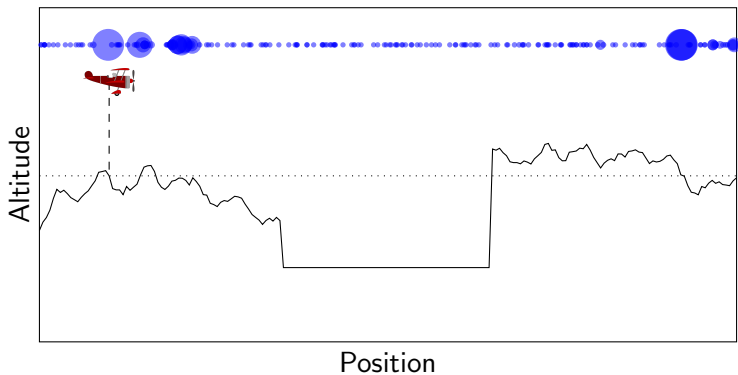
Sequential Monte Carlo inference

Initialize 200 samples from X_0



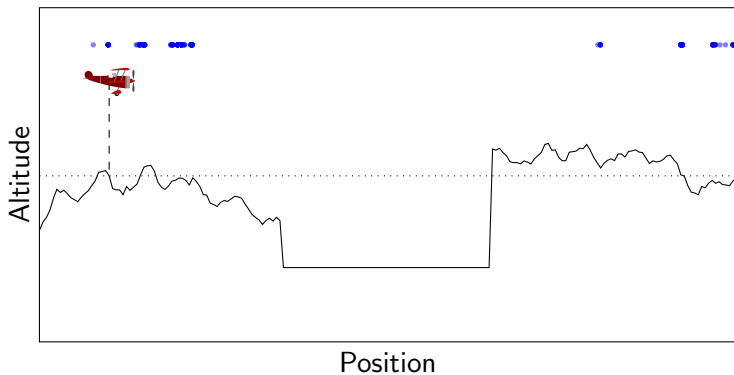
Sequential Monte Carlo inference

Weigh samples using observation model



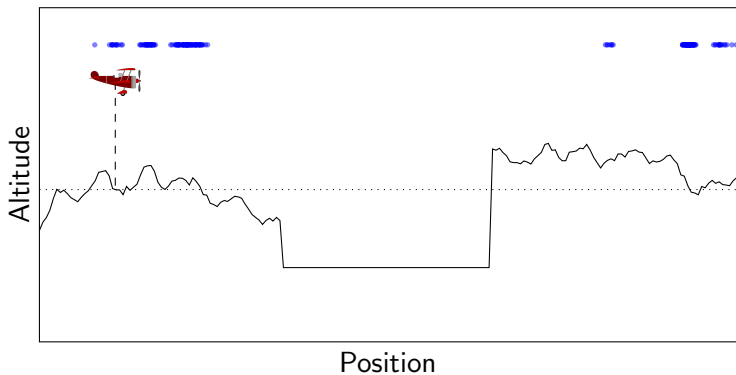
Sequential Monte Carlo inference

Resample



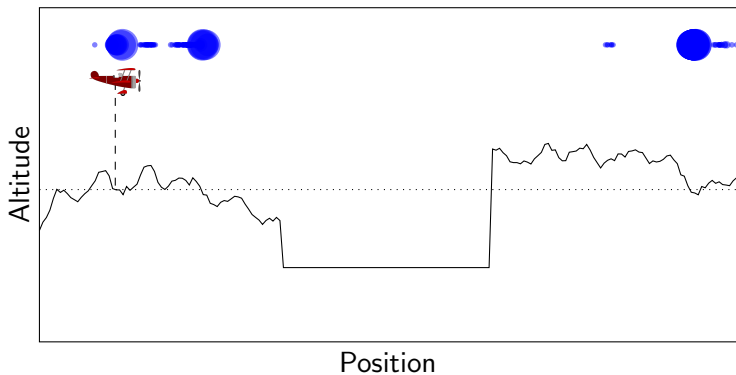
Sequential Monte Carlo inference

Propagate samples using transition model



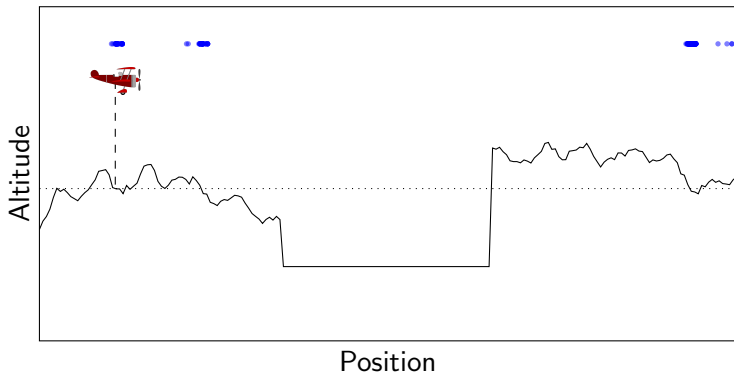
Sequential Monte Carlo inference

Weigh samples using observation model



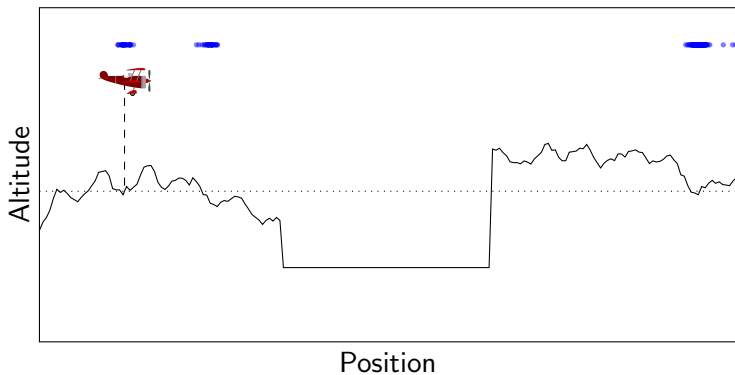
Sequential Monte Carlo inference

Resample



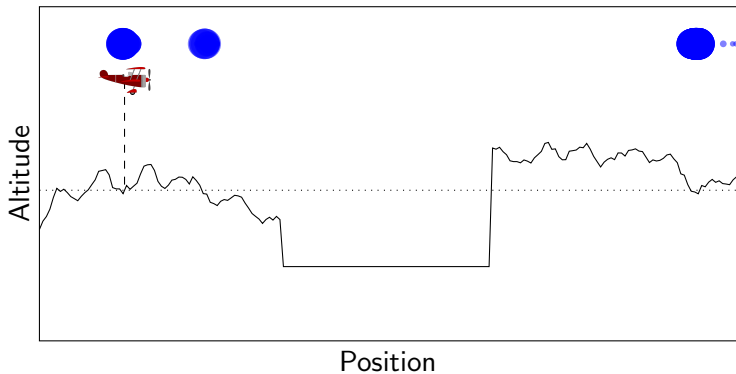
Sequential Monte Carlo inference

Propagate samples using transition model



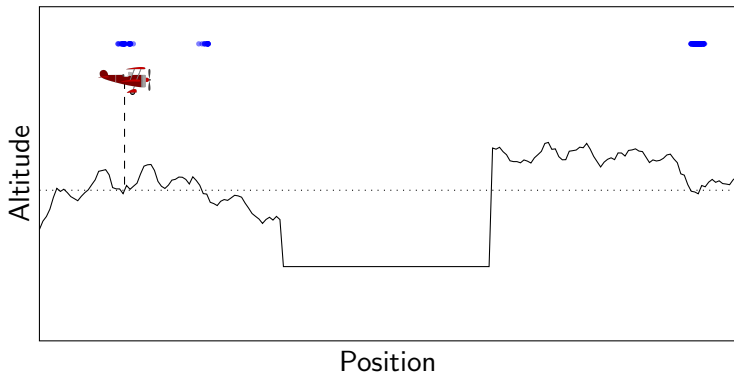
Sequential Monte Carlo inference

Weigh samples using observation model



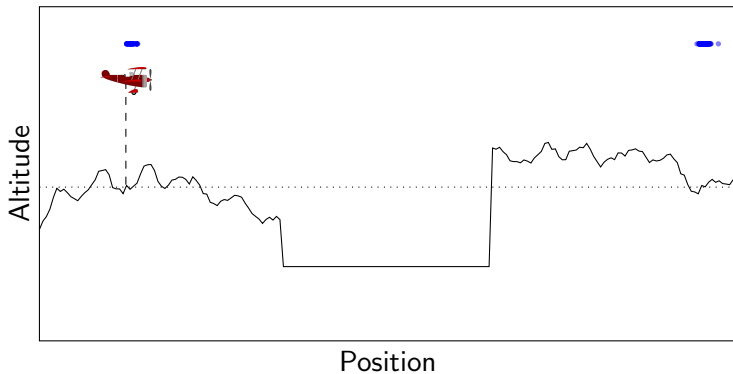
Sequential Monte Carlo inference

Resample



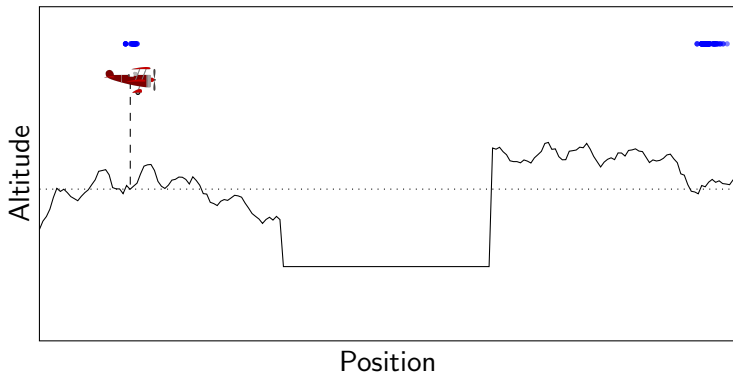
Sequential Monte Carlo inference

Propagate, weigh, resample



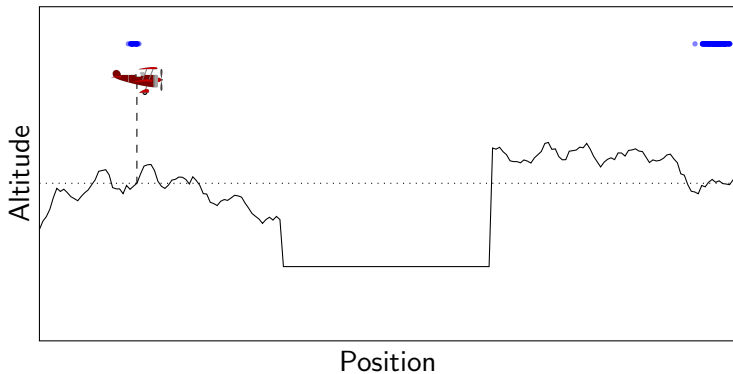
Sequential Monte Carlo inference

Propagate, weigh, resample



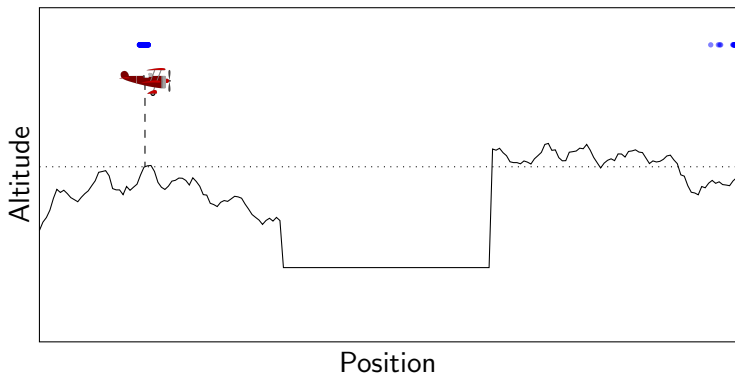
Sequential Monte Carlo inference

Propagate, weigh, resample



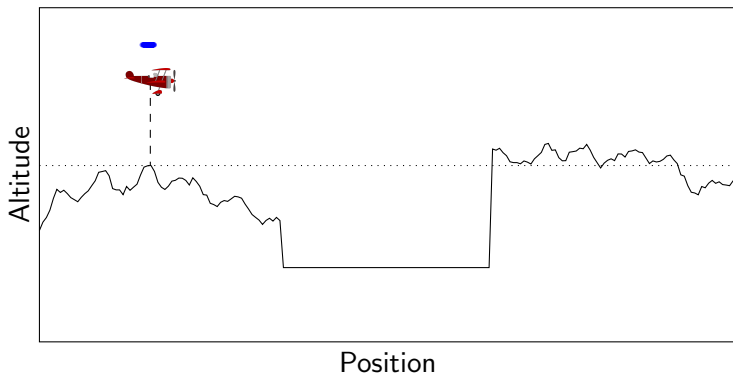
Sequential Monte Carlo inference

Propagate, weigh, resample



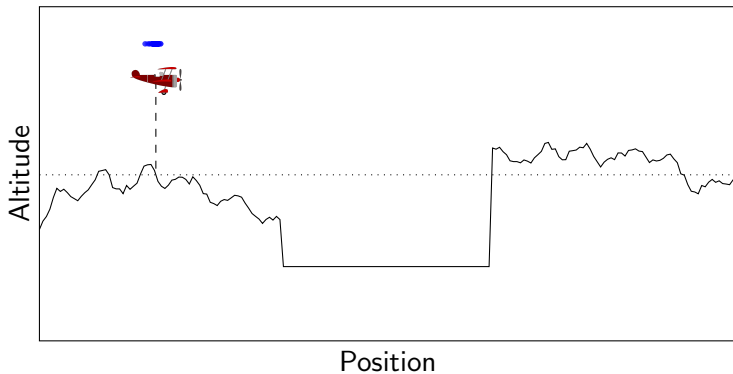
Sequential Monte Carlo inference

Propagate, weigh, resample



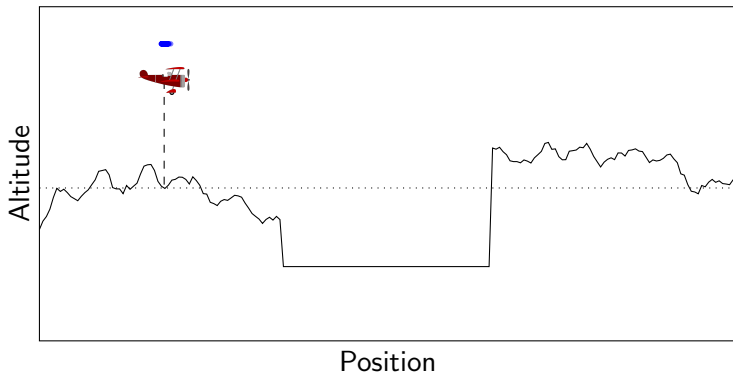
Sequential Monte Carlo inference

Propagate, weigh, resample



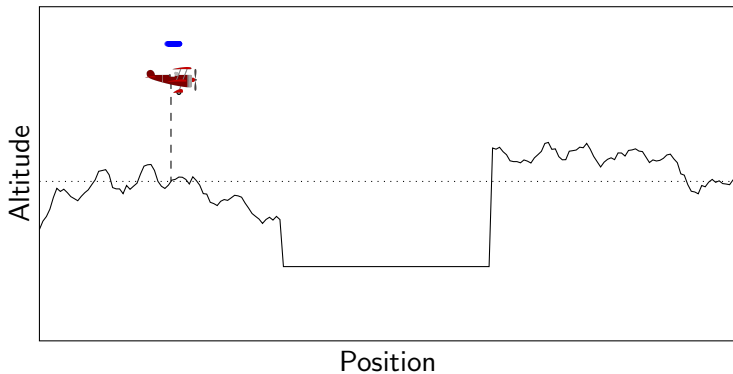
Sequential Monte Carlo inference

Propagate, weigh, resample



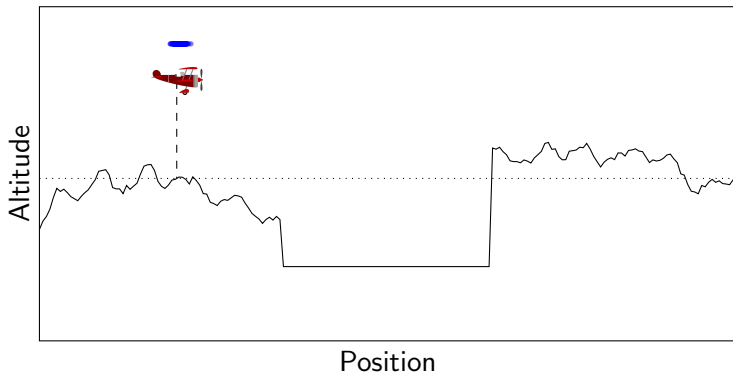
Sequential Monte Carlo inference

Propagate, weigh, resample



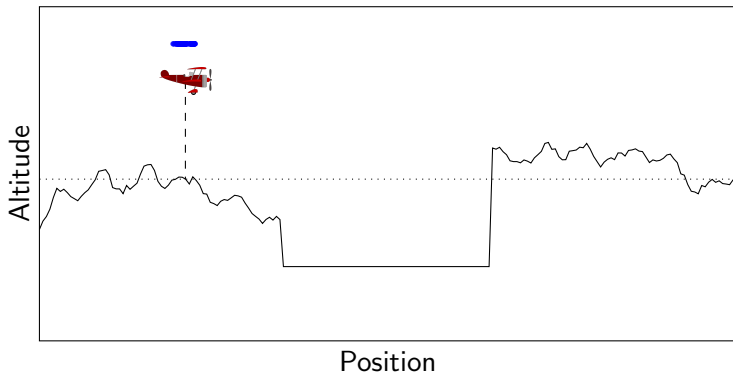
Sequential Monte Carlo inference

Propagate, weigh, resample



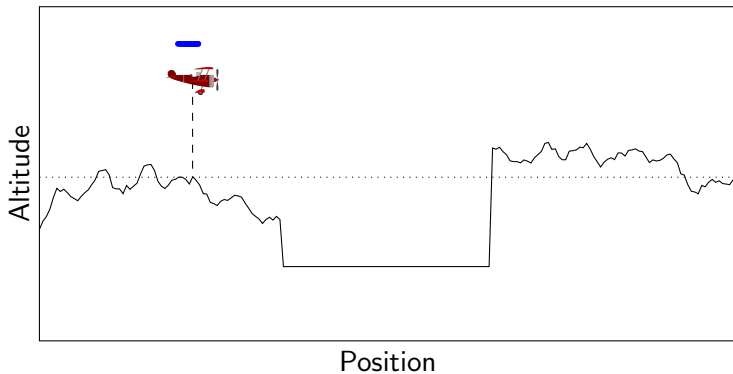
Sequential Monte Carlo inference

Propagate, weigh, resample



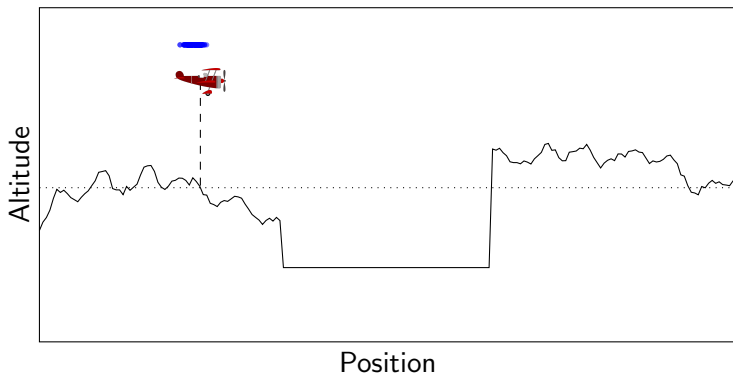
Sequential Monte Carlo inference

Propagate, weigh, resample



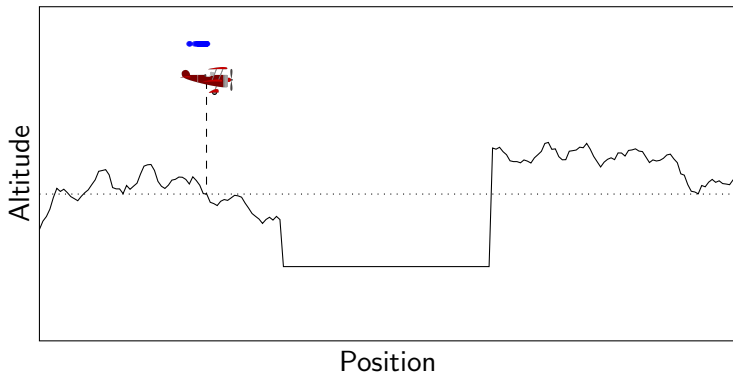
Sequential Monte Carlo inference

Propagate, weigh, resample



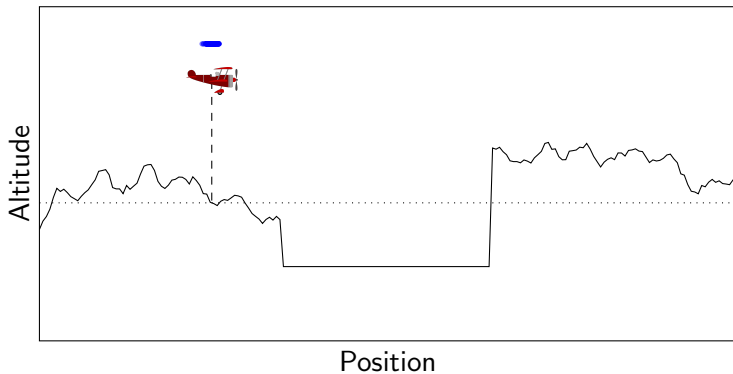
Sequential Monte Carlo inference

Propagate, weigh, resample



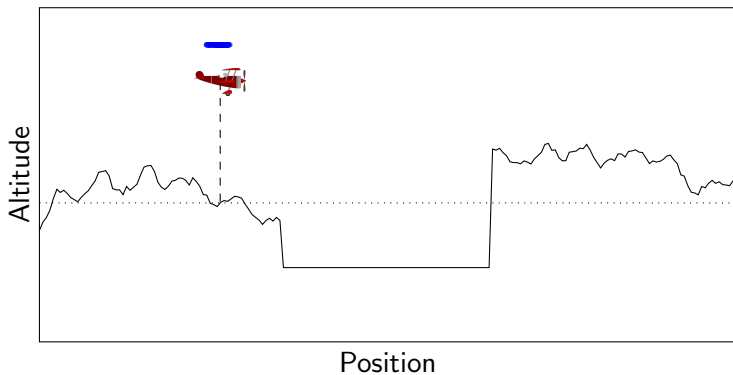
Sequential Monte Carlo inference

Propagate, weigh, resample



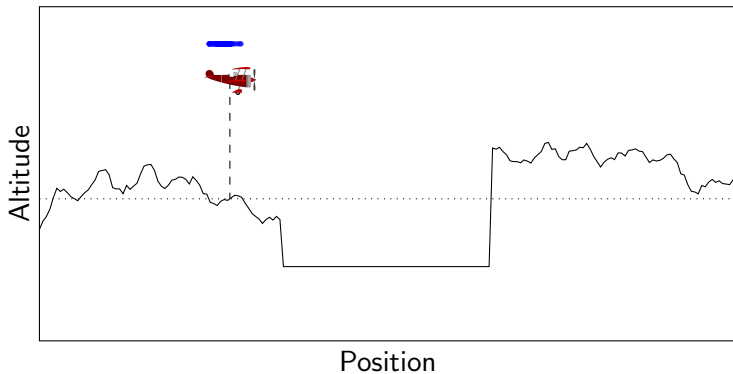
Sequential Monte Carlo inference

Propagate, weigh, resample



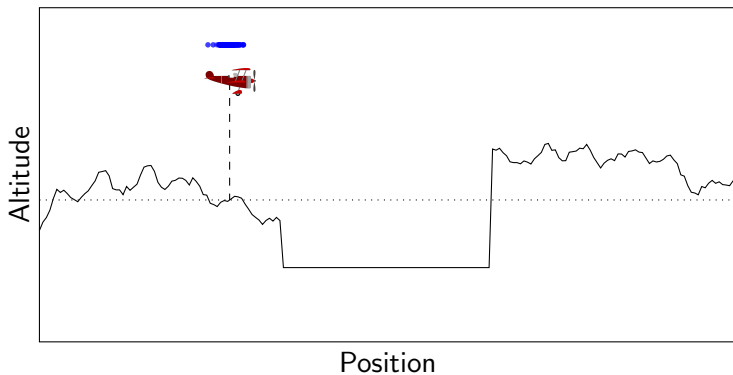
Sequential Monte Carlo inference

Propagate, weigh, resample



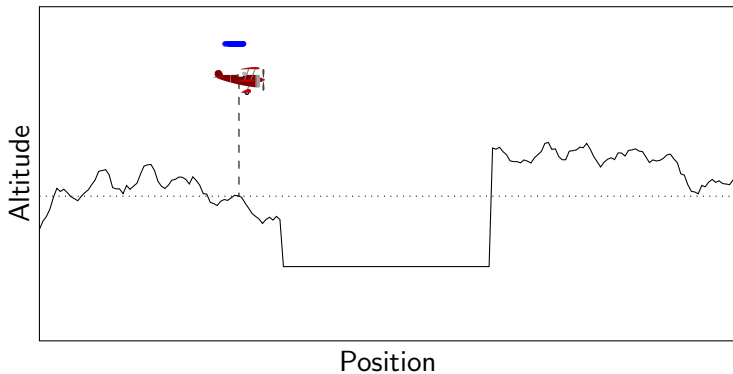
Sequential Monte Carlo inference

Propagate, weigh, resample



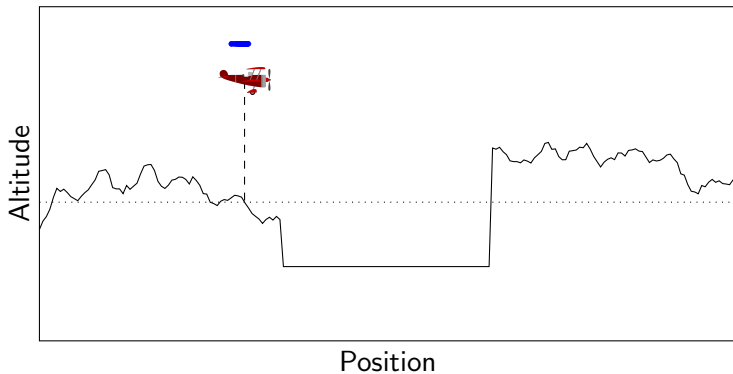
Sequential Monte Carlo inference

Propagate, weigh, resample



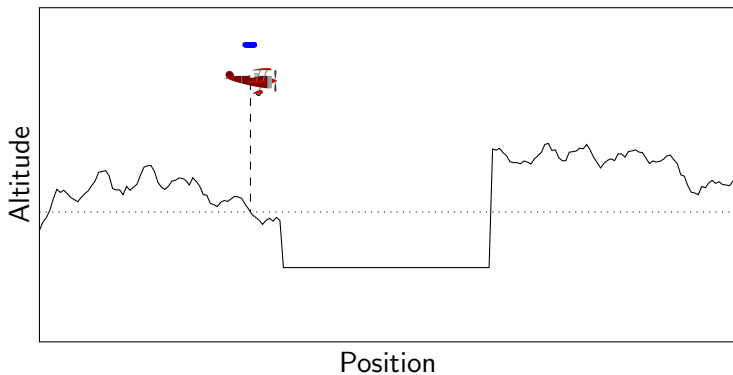
Sequential Monte Carlo inference

Propagate, weigh, resample



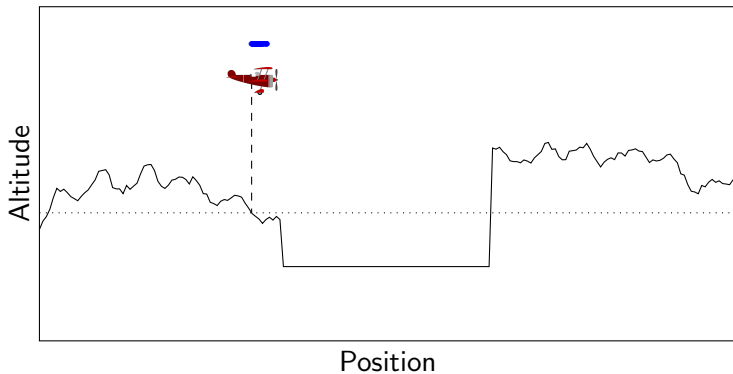
Sequential Monte Carlo inference

Propagate, weigh, resample



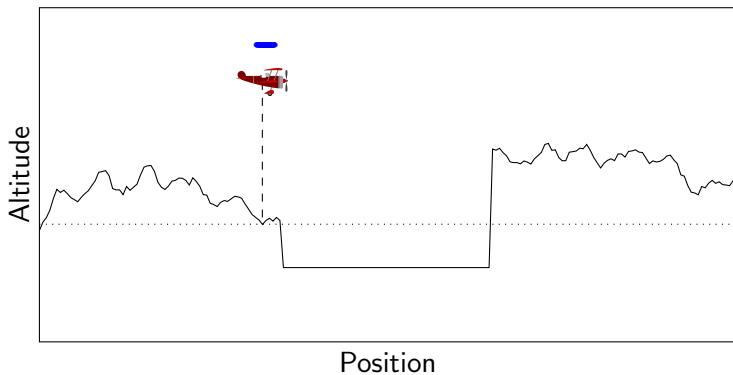
Sequential Monte Carlo inference

Propagate, weigh, resample



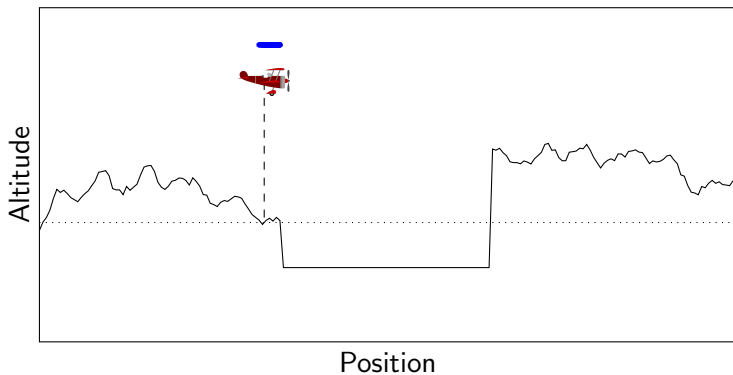
Sequential Monte Carlo inference

Propagate, weigh, resample



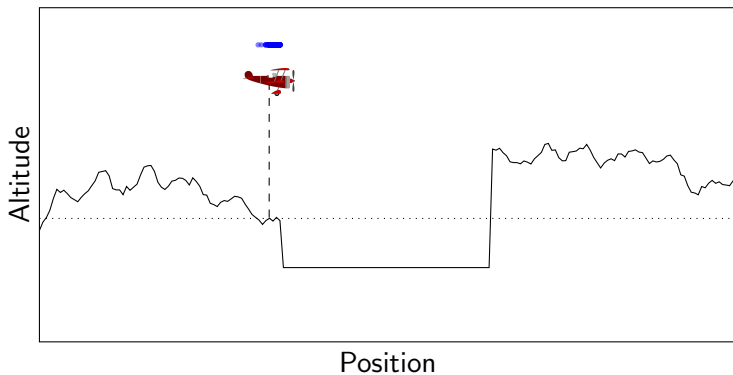
Sequential Monte Carlo inference

Propagate, weigh, resample



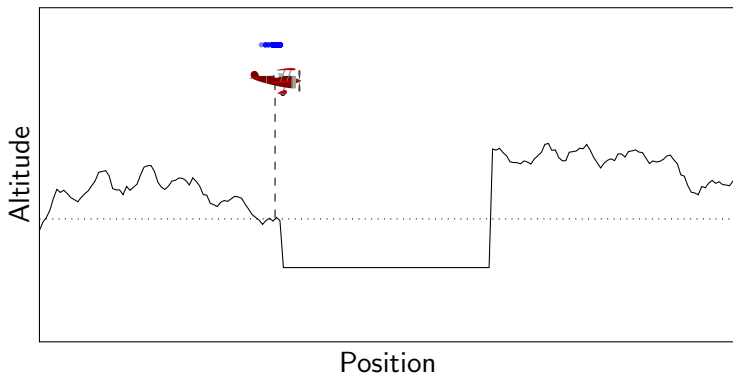
Sequential Monte Carlo inference

Propagate, weigh, resample



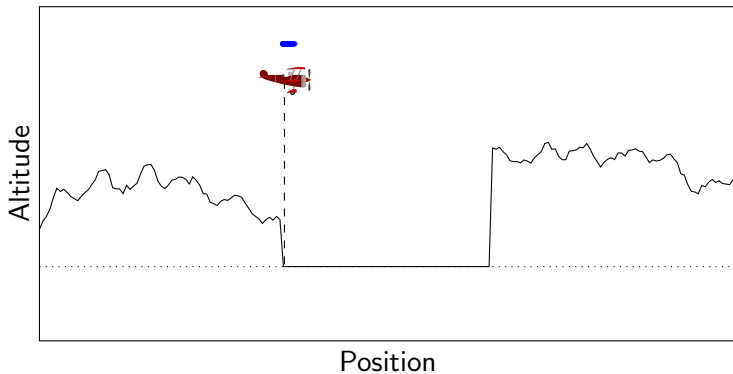
Sequential Monte Carlo inference

Propagate, weigh, resample



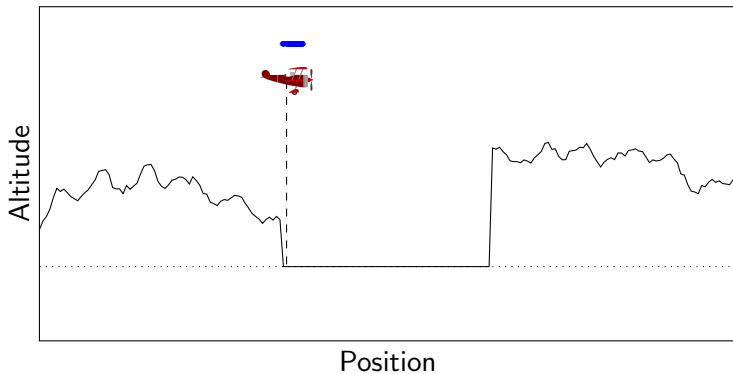
Sequential Monte Carlo inference

Propagate, weigh, resample



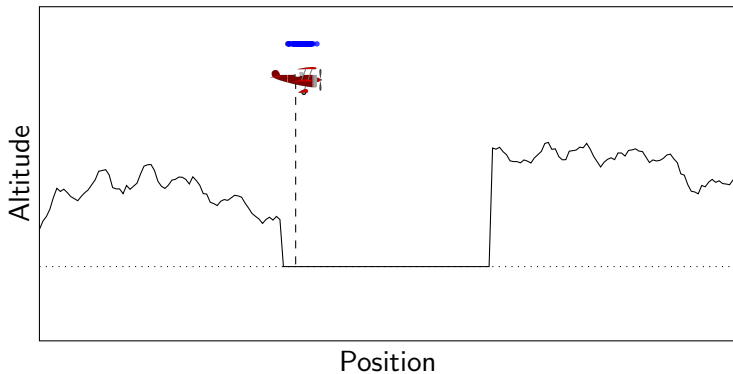
Sequential Monte Carlo inference

Propagate, weigh, resample



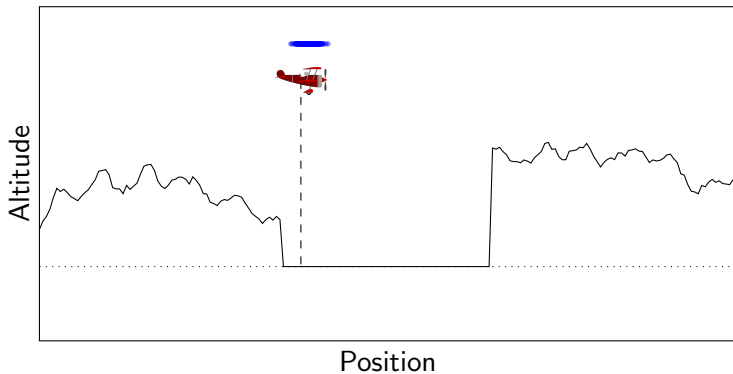
Sequential Monte Carlo inference

Propagate, weigh, resample



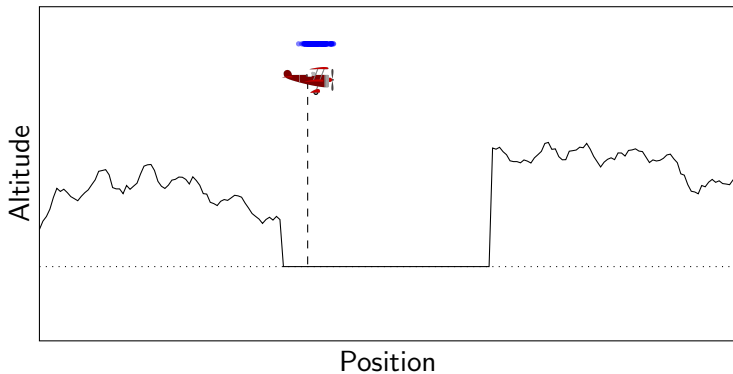
Sequential Monte Carlo inference

Propagate, weigh, resample



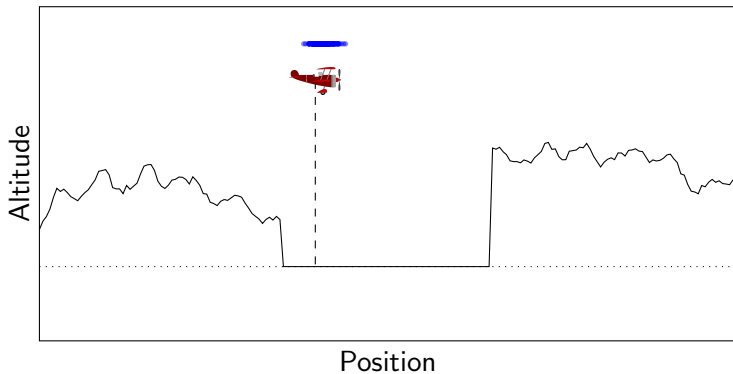
Sequential Monte Carlo inference

Propagate, weigh, resample



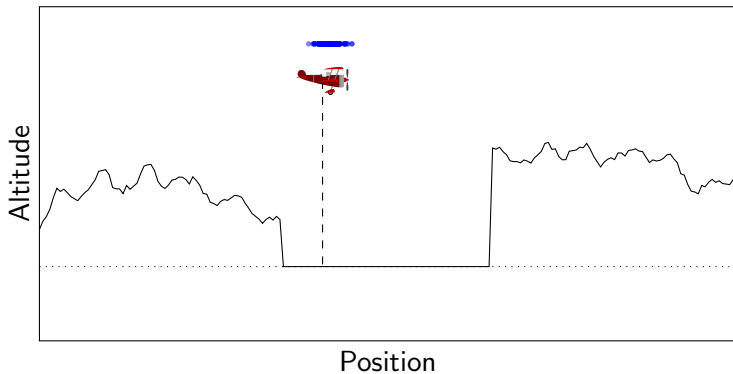
Sequential Monte Carlo inference

Propagate, weigh, resample



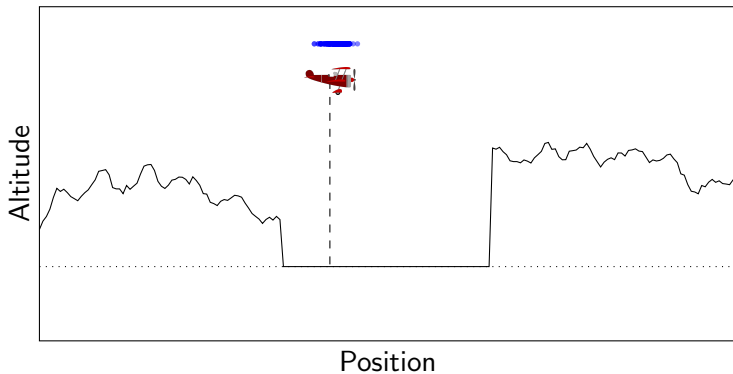
Sequential Monte Carlo inference

Propagate, weigh, resample



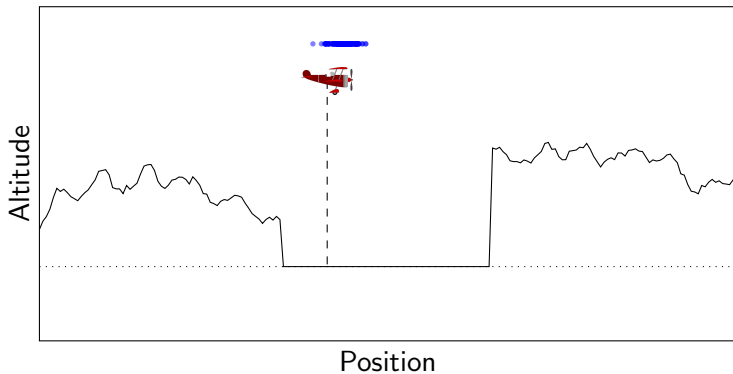
Sequential Monte Carlo inference

Propagate, weigh, resample



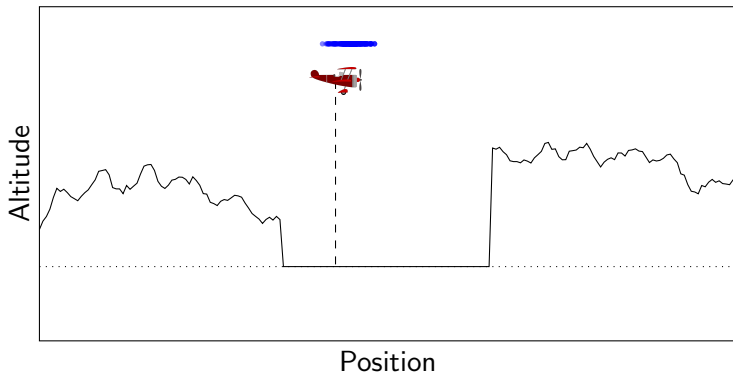
Sequential Monte Carlo inference

Propagate, weigh, resample



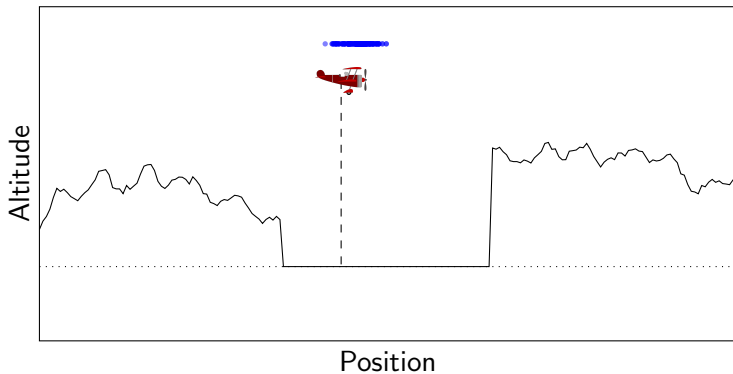
Sequential Monte Carlo inference

Propagate, weigh, resample



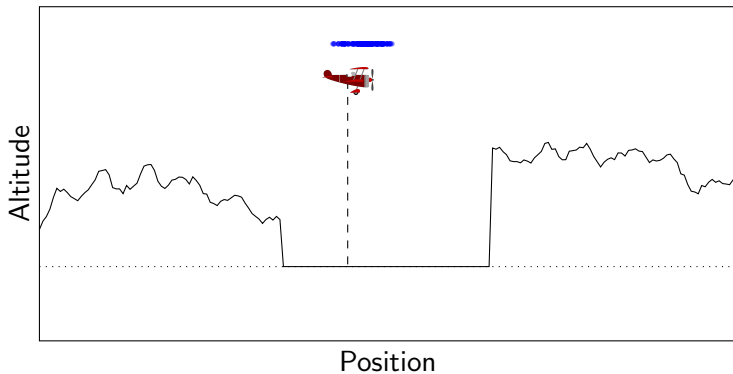
Sequential Monte Carlo inference

Propagate, weigh, resample



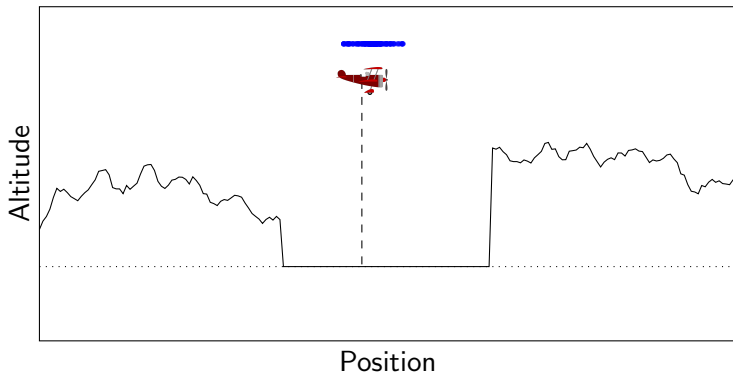
Sequential Monte Carlo inference

Propagate, weigh, resample



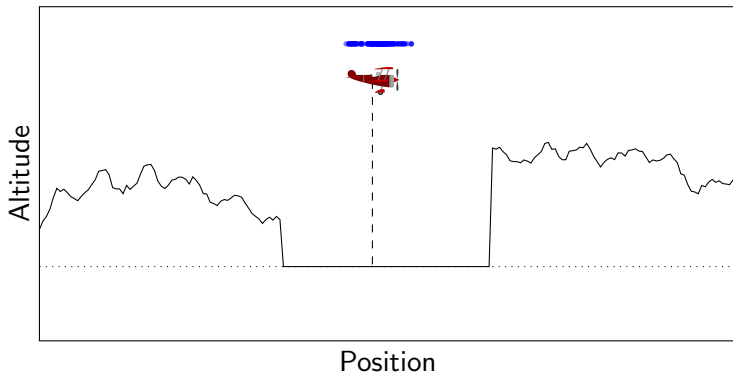
Sequential Monte Carlo inference

Propagate, weigh, resample



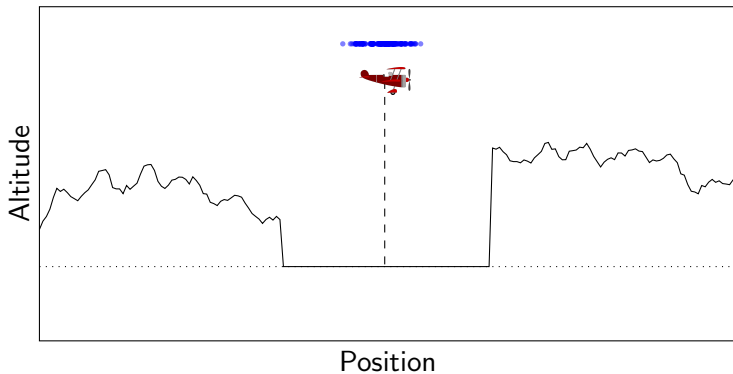
Sequential Monte Carlo inference

Propagate, weigh, resample



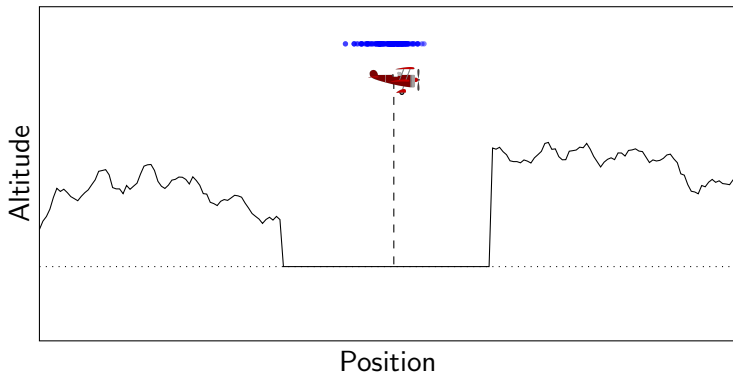
Sequential Monte Carlo inference

Propagate, weigh, resample



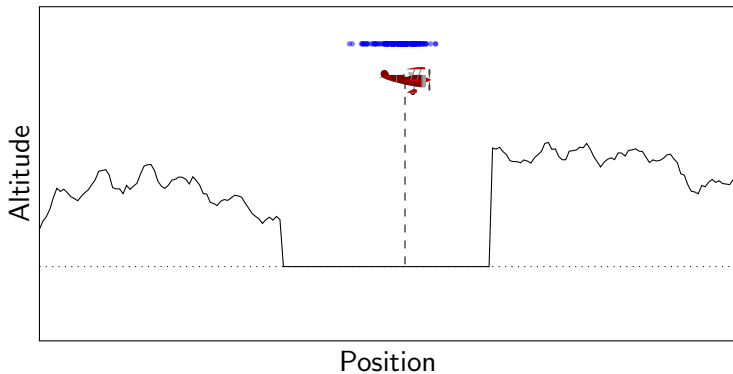
Sequential Monte Carlo inference

Propagate, weigh, resample



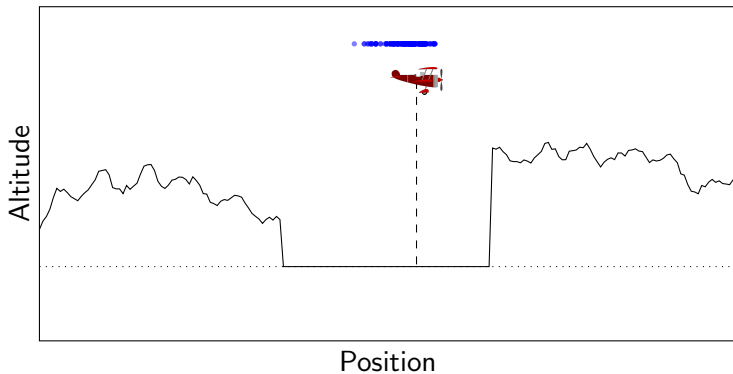
Sequential Monte Carlo inference

Propagate, weigh, resample



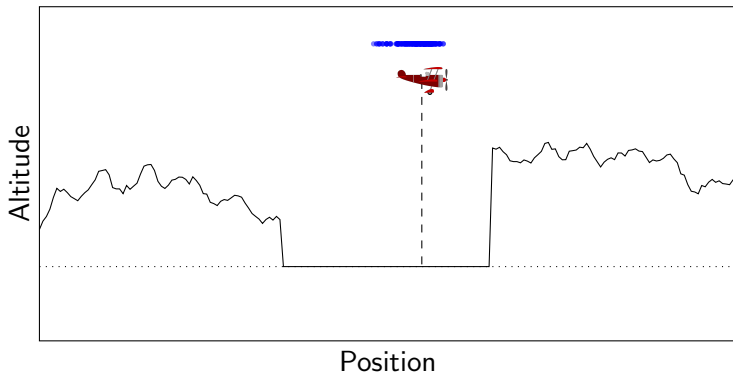
Sequential Monte Carlo inference

Propagate, weigh, resample



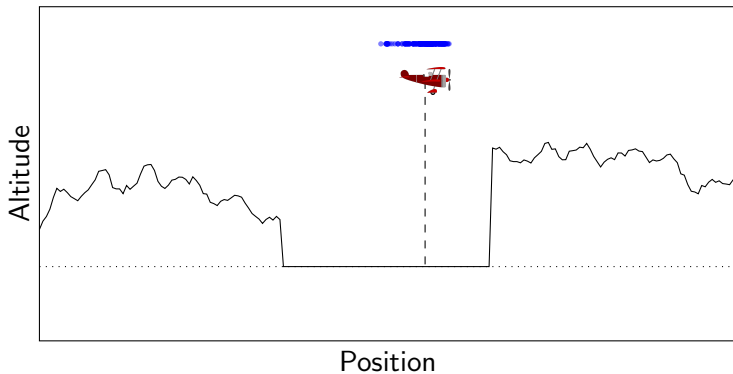
Sequential Monte Carlo inference

Propagate, weigh, resample



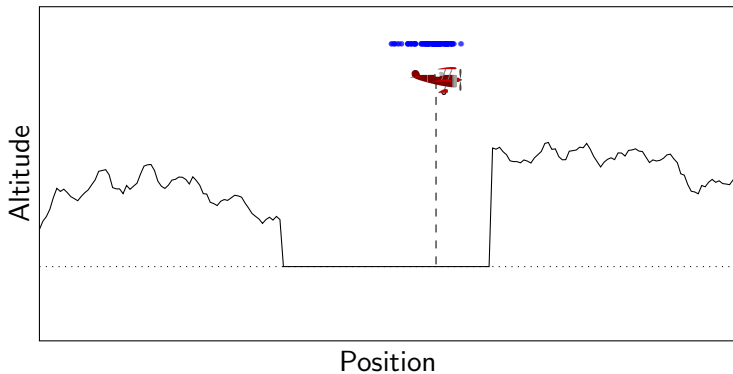
Sequential Monte Carlo inference

Propagate, weigh, resample



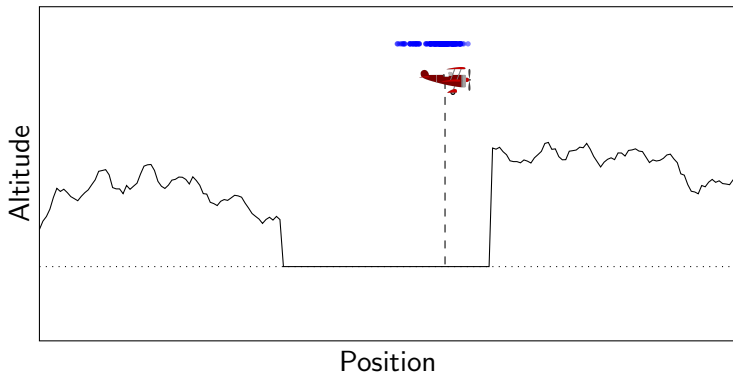
Sequential Monte Carlo inference

Propagate, weigh, resample



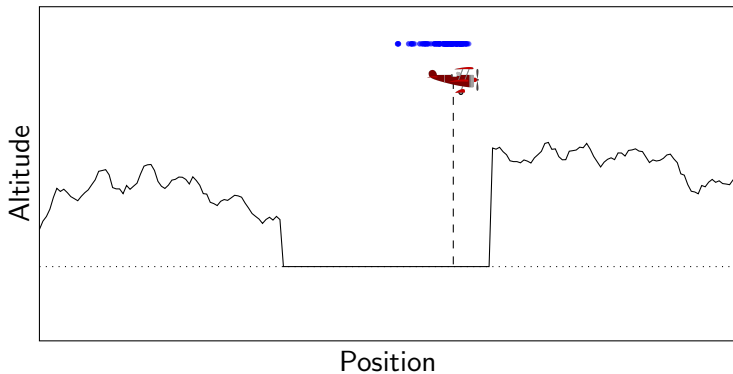
Sequential Monte Carlo inference

Propagate, weigh, resample



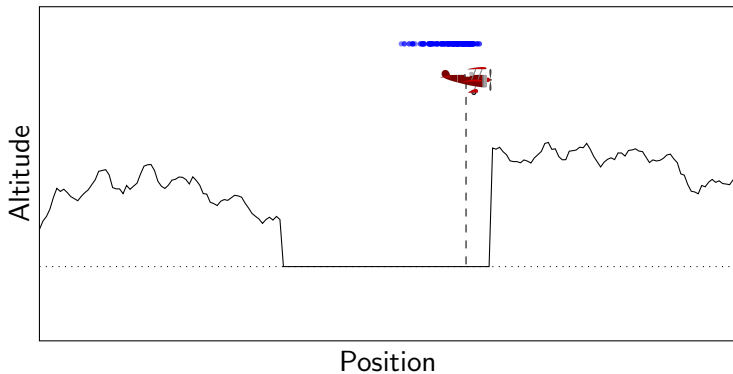
Sequential Monte Carlo inference

Propagate, weigh, resample



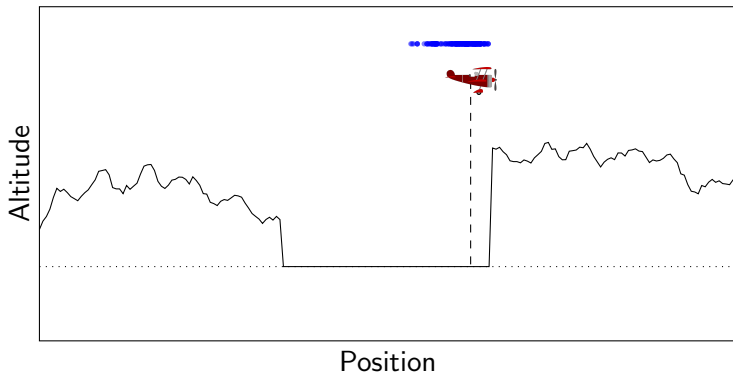
Sequential Monte Carlo inference

Propagate, weigh, resample



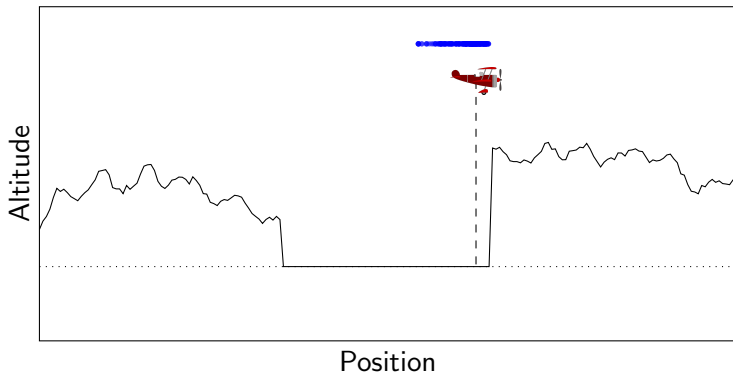
Sequential Monte Carlo inference

Propagate, weigh, resample



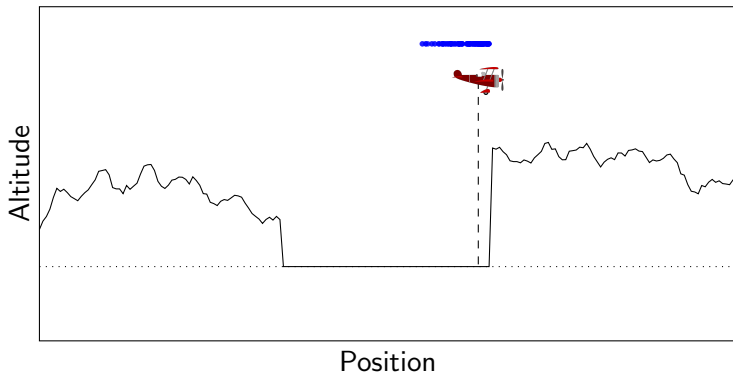
Sequential Monte Carlo inference

Propagate, weigh, resample



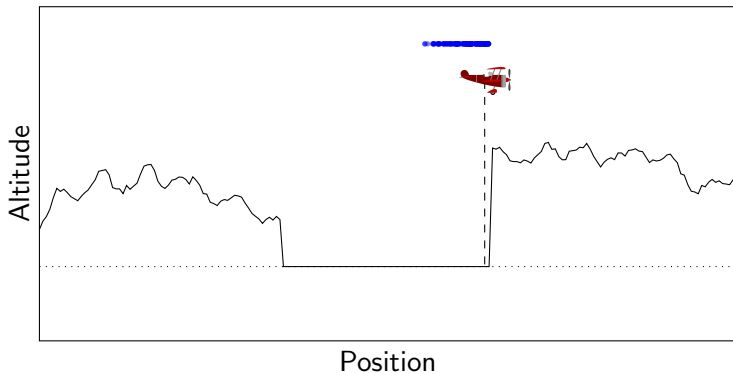
Sequential Monte Carlo inference

Propagate, weigh, resample



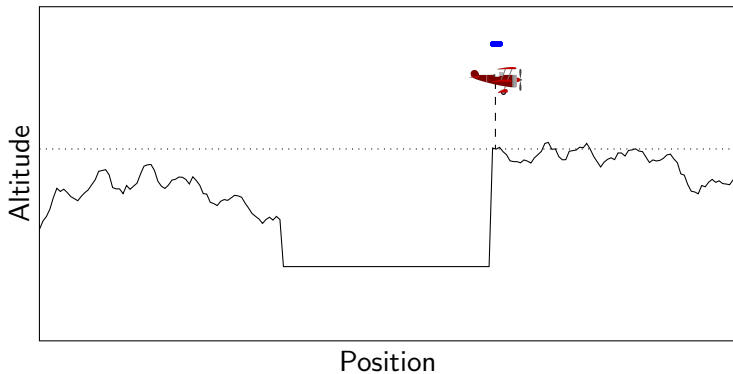
Sequential Monte Carlo inference

Propagate, weigh, resample



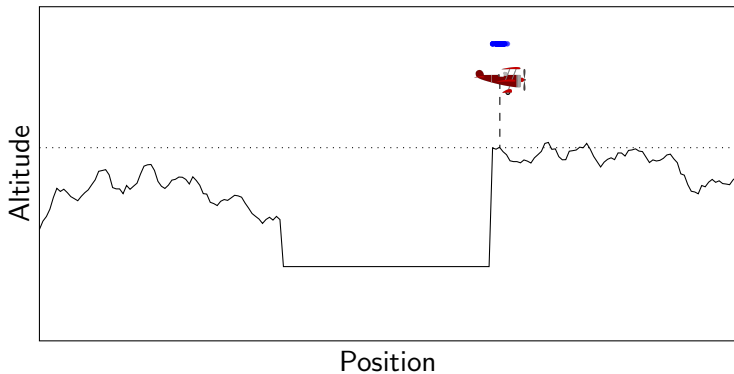
Sequential Monte Carlo inference

Propagate, weigh, resample



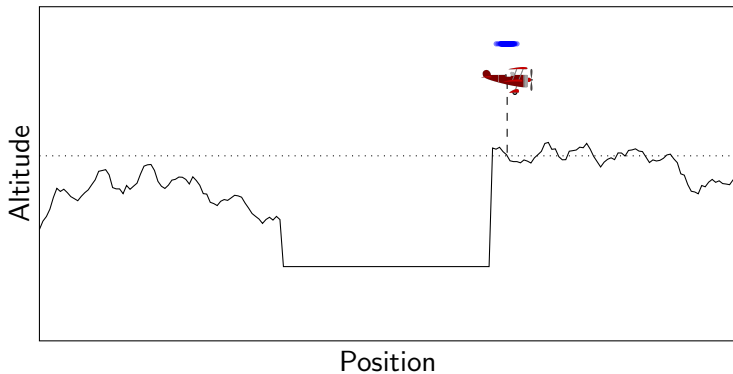
Sequential Monte Carlo inference

Propagate, weigh, resample



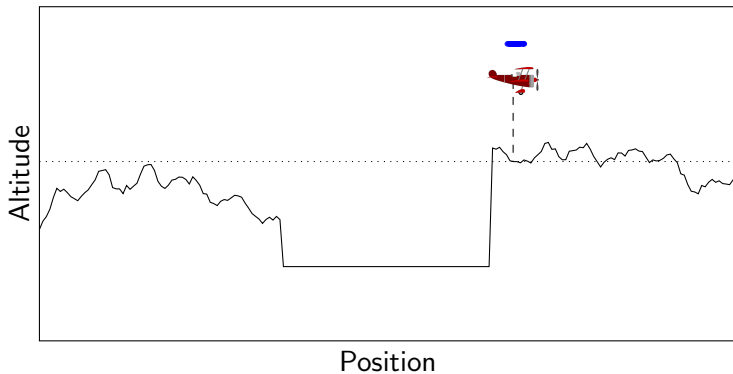
Sequential Monte Carlo inference

Propagate, weigh, resample



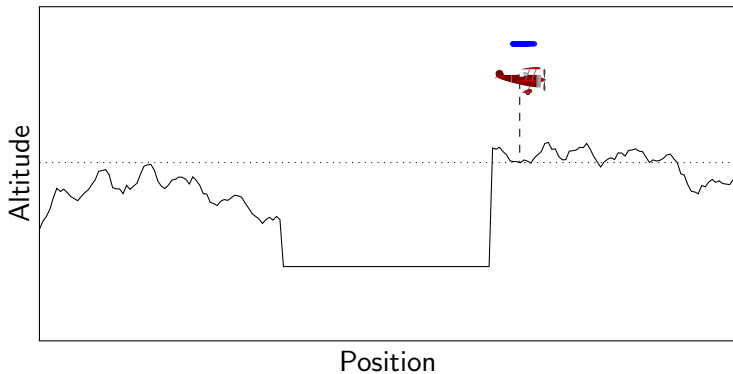
Sequential Monte Carlo inference

Propagate, weigh, resample



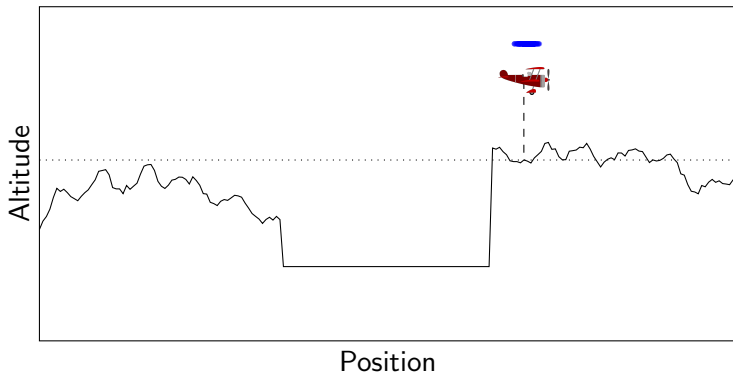
Sequential Monte Carlo inference

Propagate, weigh, resample



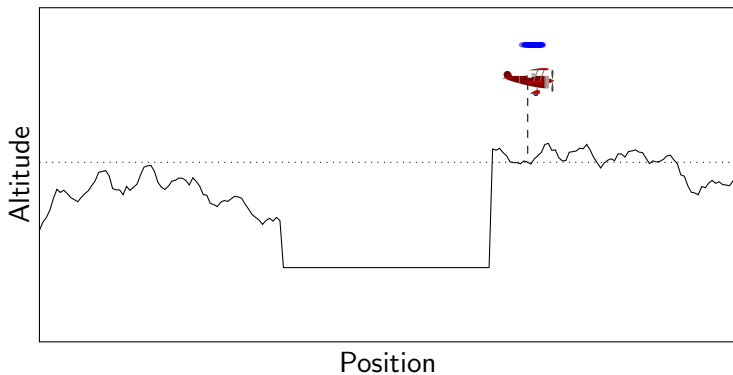
Sequential Monte Carlo inference

Propagate, weigh, resample



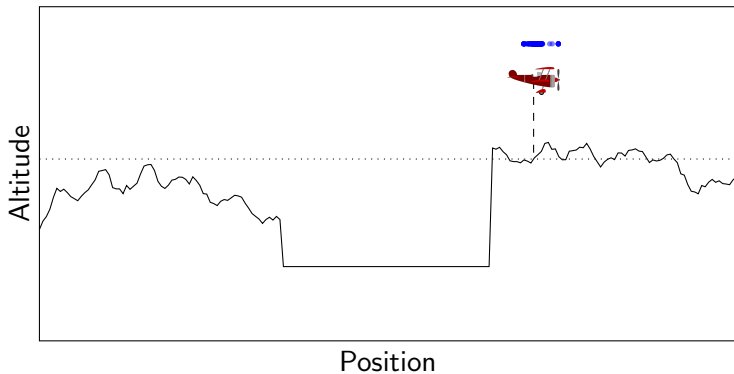
Sequential Monte Carlo inference

Propagate, weigh, resample



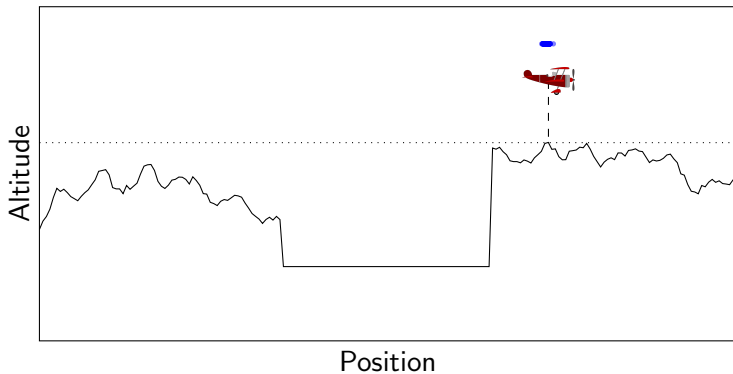
Sequential Monte Carlo inference

Propagate, weigh, resample



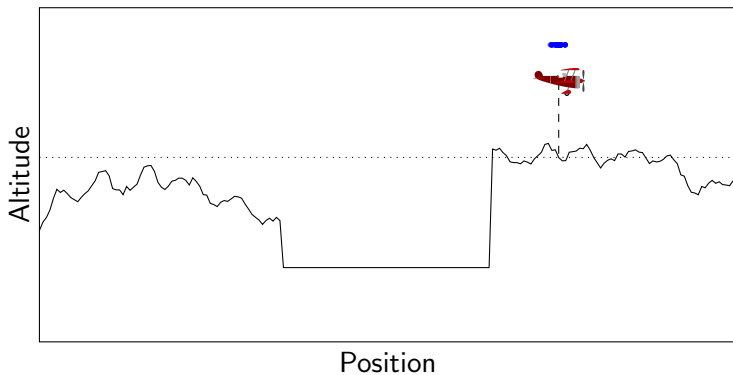
Sequential Monte Carlo inference

Propagate, weigh, resample



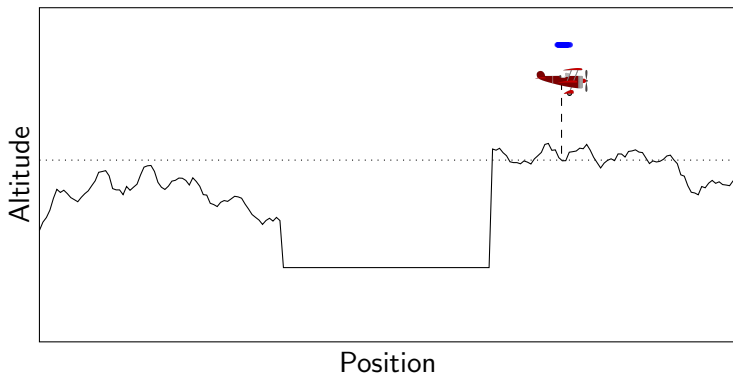
Sequential Monte Carlo inference

Propagate, weigh, resample



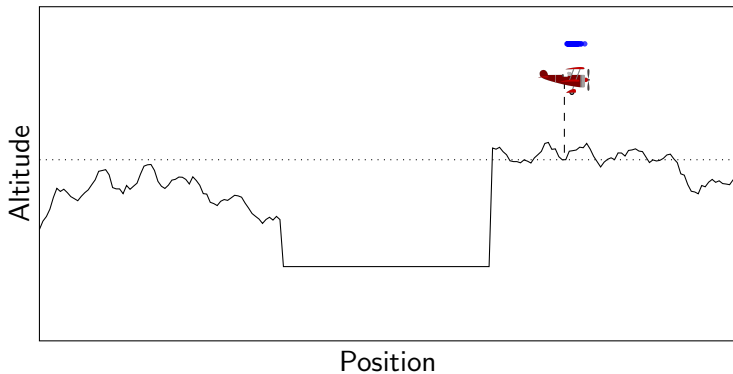
Sequential Monte Carlo inference

Propagate, weigh, resample



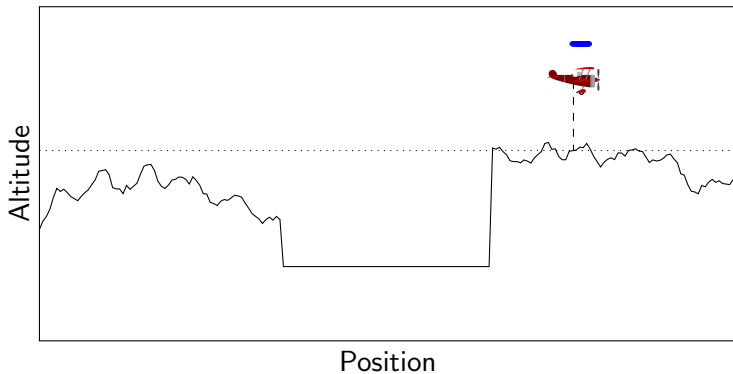
Sequential Monte Carlo inference

Propagate, weigh, resample



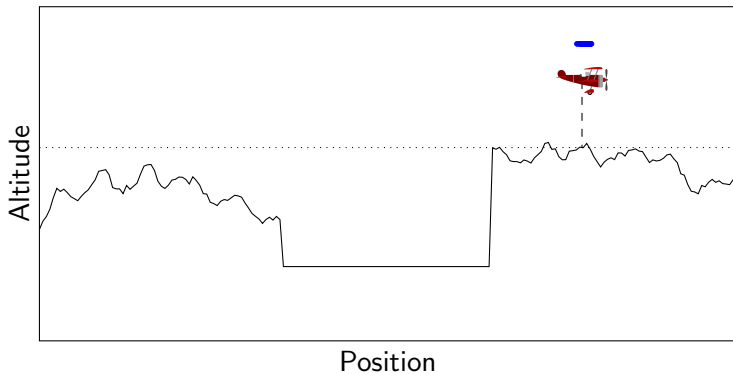
Sequential Monte Carlo inference

Propagate, weigh, resample



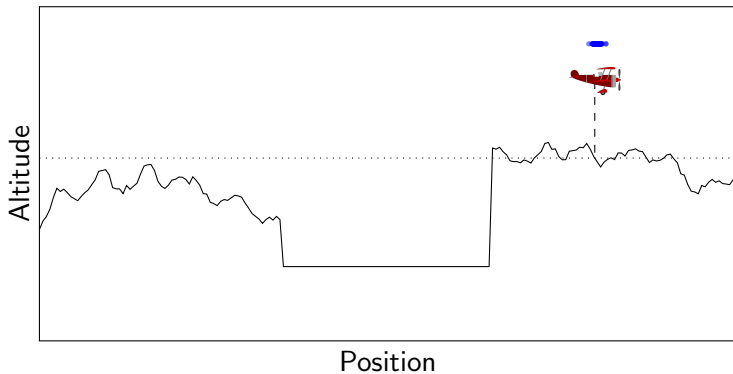
Sequential Monte Carlo inference

Propagate, weigh, resample



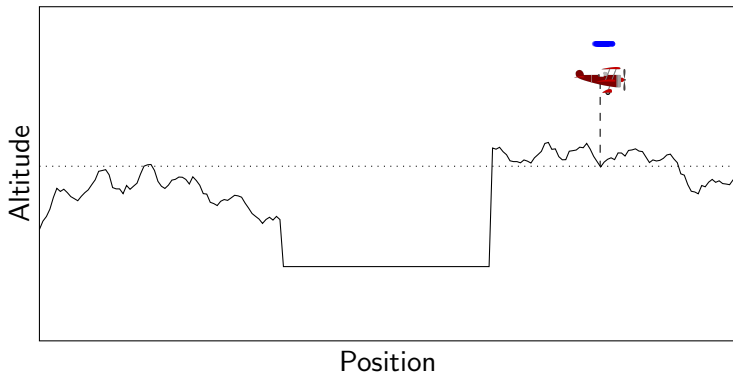
Sequential Monte Carlo inference

Propagate, weigh, resample



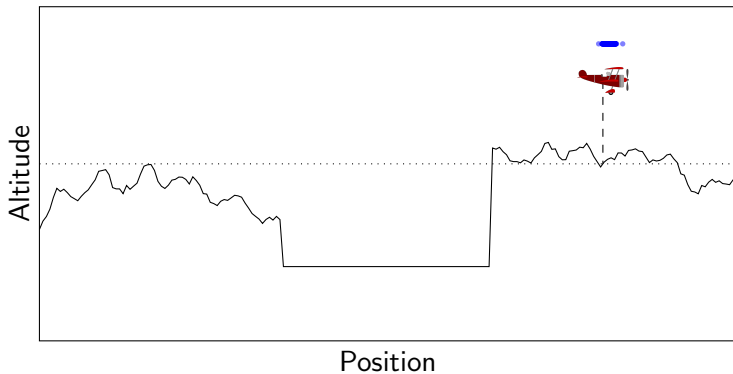
Sequential Monte Carlo inference

Propagate, weigh, resample



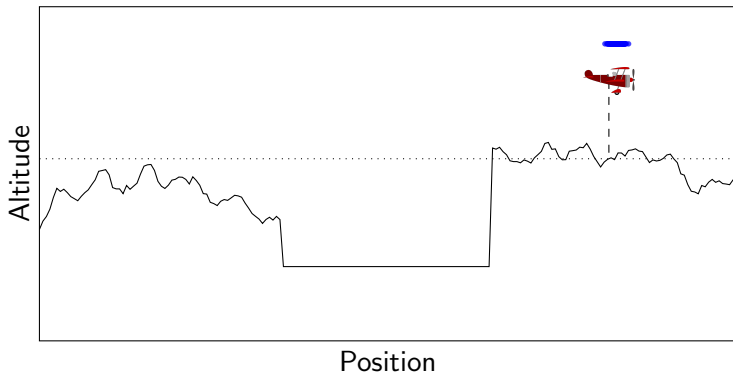
Sequential Monte Carlo inference

Propagate, weigh, resample



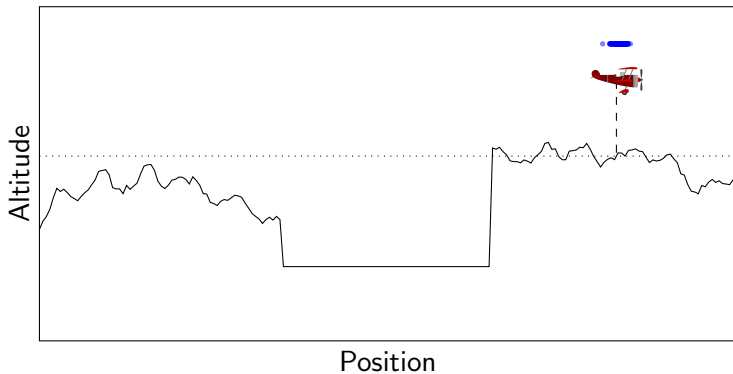
Sequential Monte Carlo inference

Propagate, weigh, resample



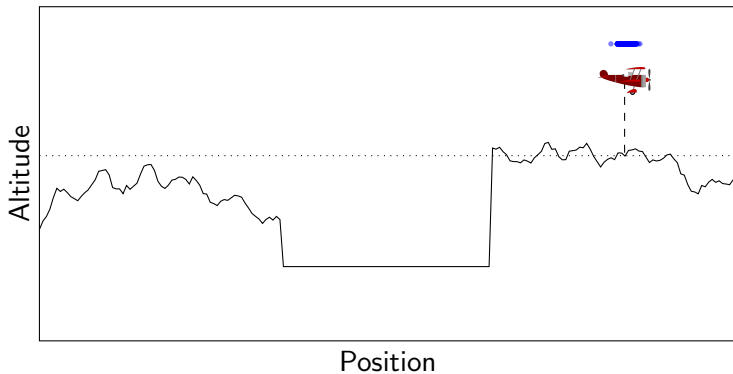
Sequential Monte Carlo inference

Propagate, weigh, resample



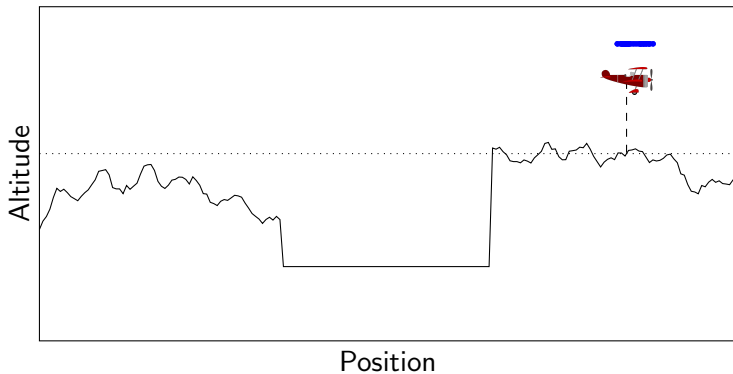
Sequential Monte Carlo inference

Propagate, weigh, resample



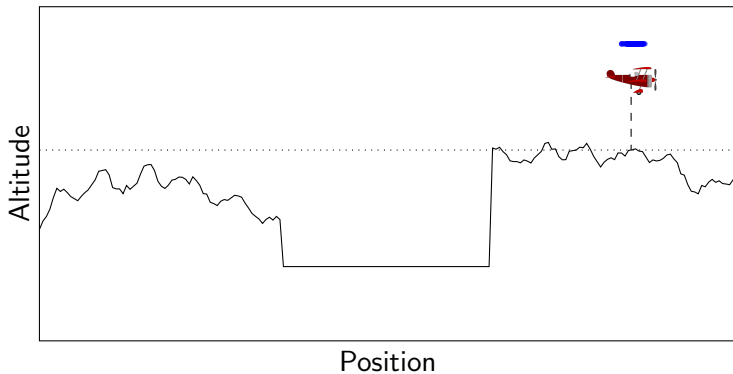
Sequential Monte Carlo inference

Propagate, weigh, resample



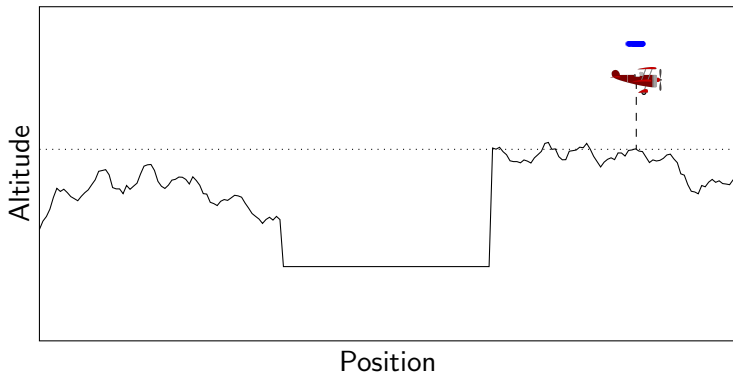
Sequential Monte Carlo inference

Propagate, weigh, resample



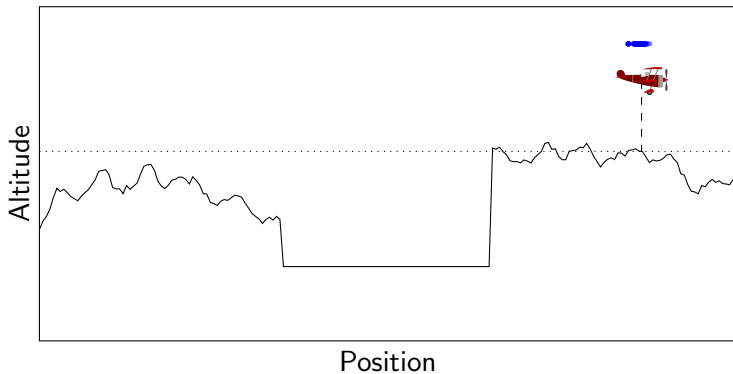
Sequential Monte Carlo inference

Propagate, weigh, resample



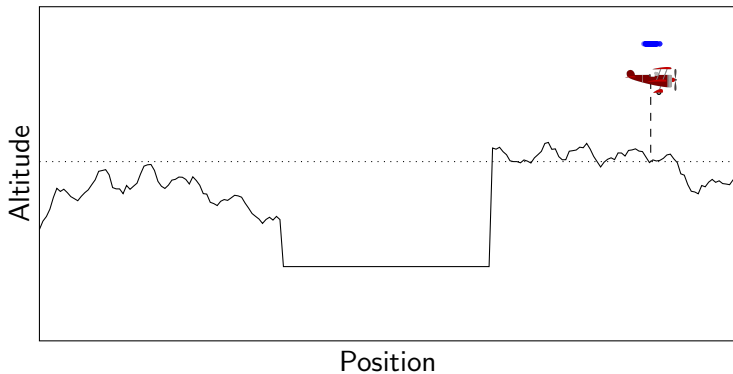
Sequential Monte Carlo inference

Propagate, weigh, resample



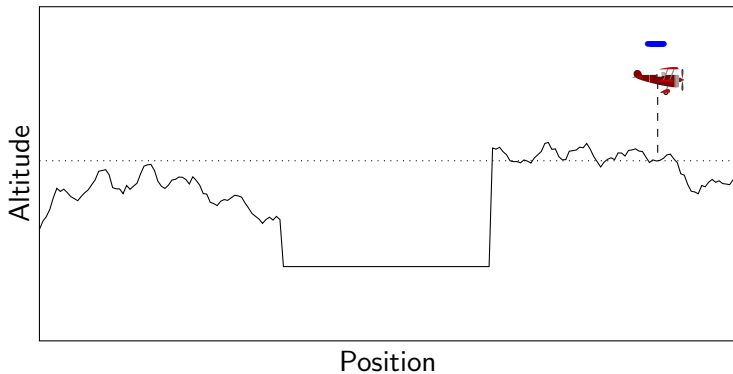
Sequential Monte Carlo inference

Propagate, weigh, resample



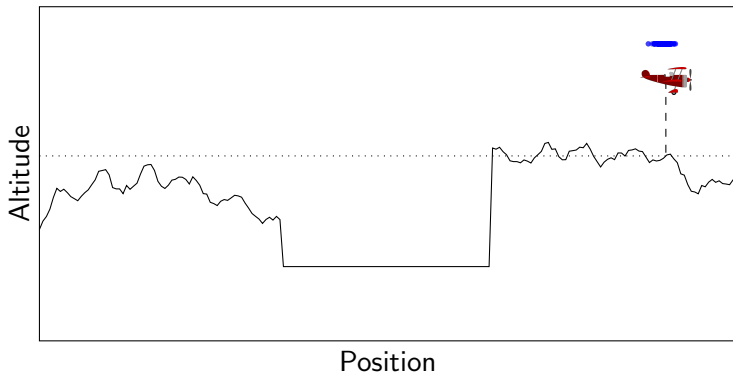
Sequential Monte Carlo inference

Propagate, weigh, resample



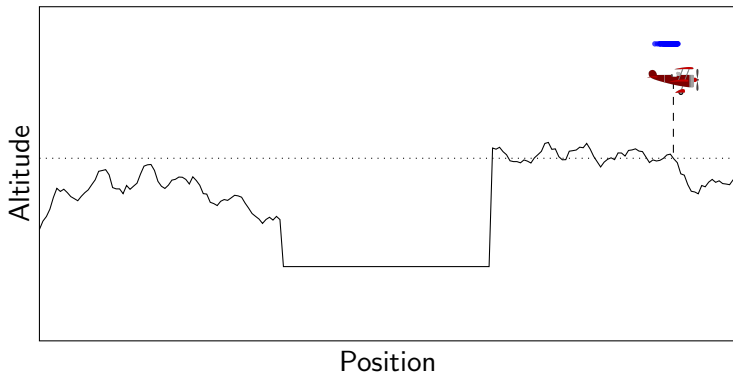
Sequential Monte Carlo inference

Propagate, weigh, resample



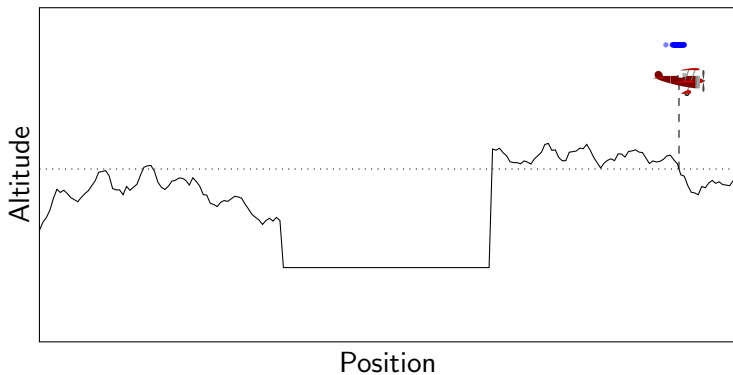
Sequential Monte Carlo inference

Propagate, weigh, resample



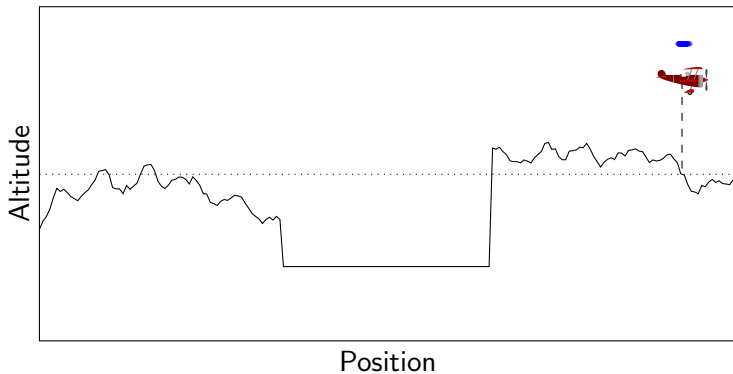
Sequential Monte Carlo inference

Propagate, weigh, resample



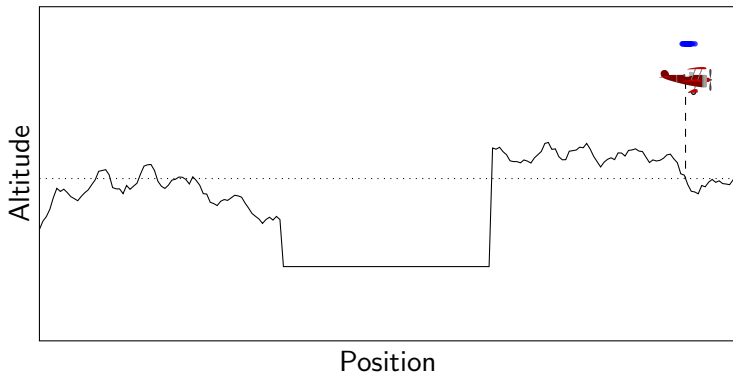
Sequential Monte Carlo inference

Propagate, weigh, resample



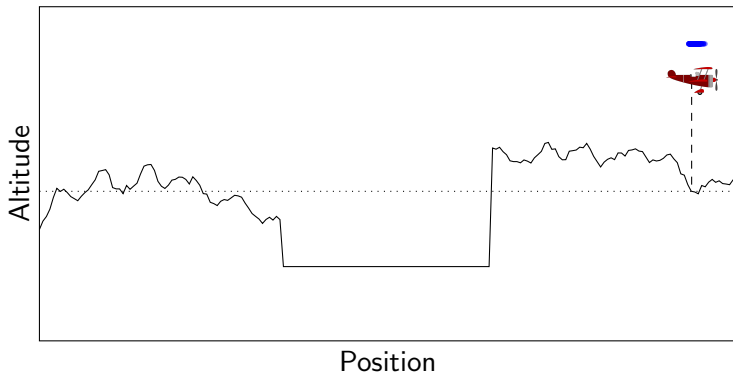
Sequential Monte Carlo inference

Propagate, weigh, resample



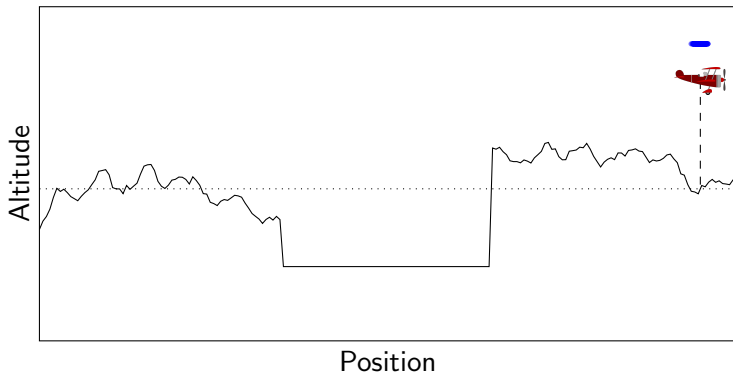
Sequential Monte Carlo inference

Propagate, weigh, resample



Sequential Monte Carlo inference

Propagate, weigh, resample



Sequential Monte Carlo inference

Propagate, weigh, resample

