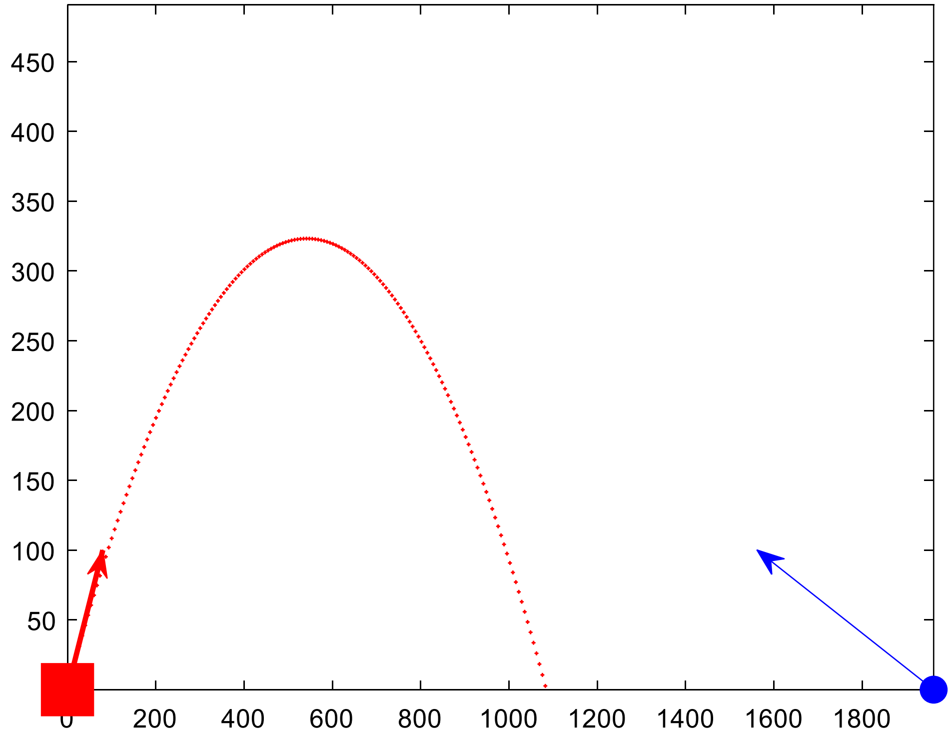
Model Parameter Estimation
Example-II

- Estimate the trajectory of the object from measurements collected until it reaches the peak of the trajectory.
- That means you will try to obtain a mathematical model for the moving object.
- Try to hit the object with another object.
- For simplicity, first consider the case with no measurement error.

Textbooks: Fikri Öztürk, Levent Özbek, “Matematiksel Modelleme ve Simülasyon”, 2004.
Averill M. Law, “Simulation Modeling and Analysis”, McGraw-Hill, 2015.

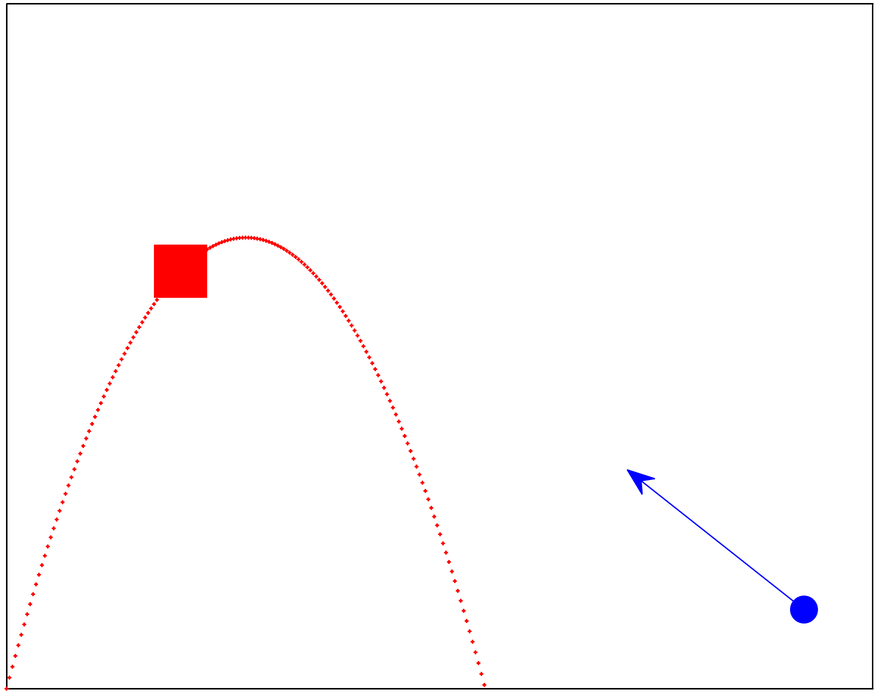
Model Parameter Estimation
Example-II



Initial positions of the objects

Textbooks: Fikri Öztürk, Levent Özbek, “Matematiksel Modelleme ve Simülasyon”, 2004.
Averill M. Law, “Simulation Modeling and Analysis”, McGraw-Hill, 2015.

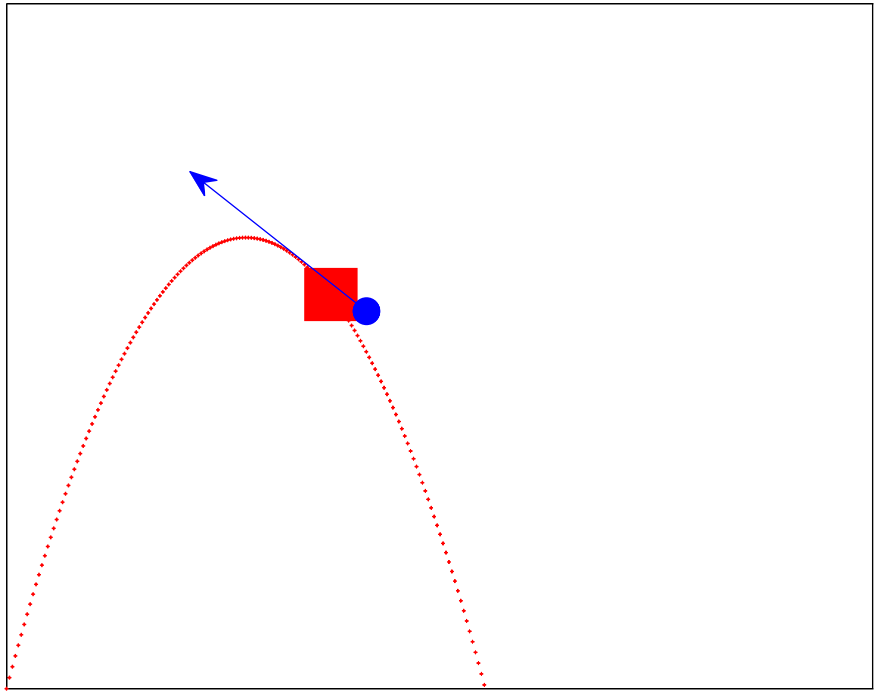
Model Parameter Estimation
Example-II



After observing sufficient data, estimate its motion parameters and try to hit it with another object

Textbooks: Fikri Öztürk, Levent Özbek, "Matematiksel Modelleme ve Simülasyon", 2004.
Averill M. Law, "Simulation Modeling and Analysis", McGraw-Hill, 2015.

Model Parameter Estimation
Example-II



Is it possible to hit the object with a high probability?

Textbooks: Fikri Öztürk, Levent Özbek, “Matematiksel Modelleme ve Simülasyon”, 2004.
Averill M. Law, “Simulation Modeling and Analysis”, McGraw-Hill, 2015.

Model Parameter Estimation
Example-II

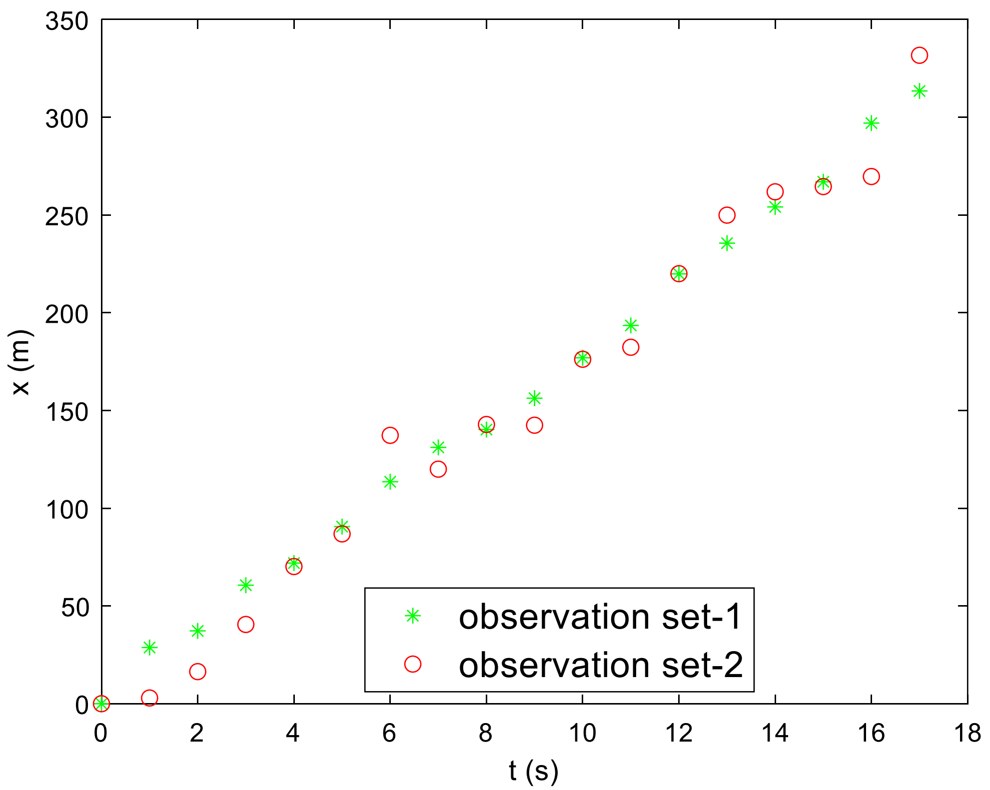
Let us consider more realistic situation:

- Observations are subject to measurement errors
- measurement errors in the coordinates (both x- and y-coordinates) are i.i.d and Gaussian

- ➢ Investigate the effect of number of observations you have using Monte Carlo simulations.
- ➢ Investigate the effect of measurement error variance using Monte Carlo simulations.
- ➢ Find minimum number of observations in order to hit the object with %0.95 success rate for two different variance values of measurement error using Monte Carlo simulations.

Textbooks: Fikri Öztürk, Levent Özbek, “Matematiksel Modelleme ve Simülasyon”, 2004.
Averill M. Law, “Simulation Modeling and Analysis”, McGraw-Hill, 2015.

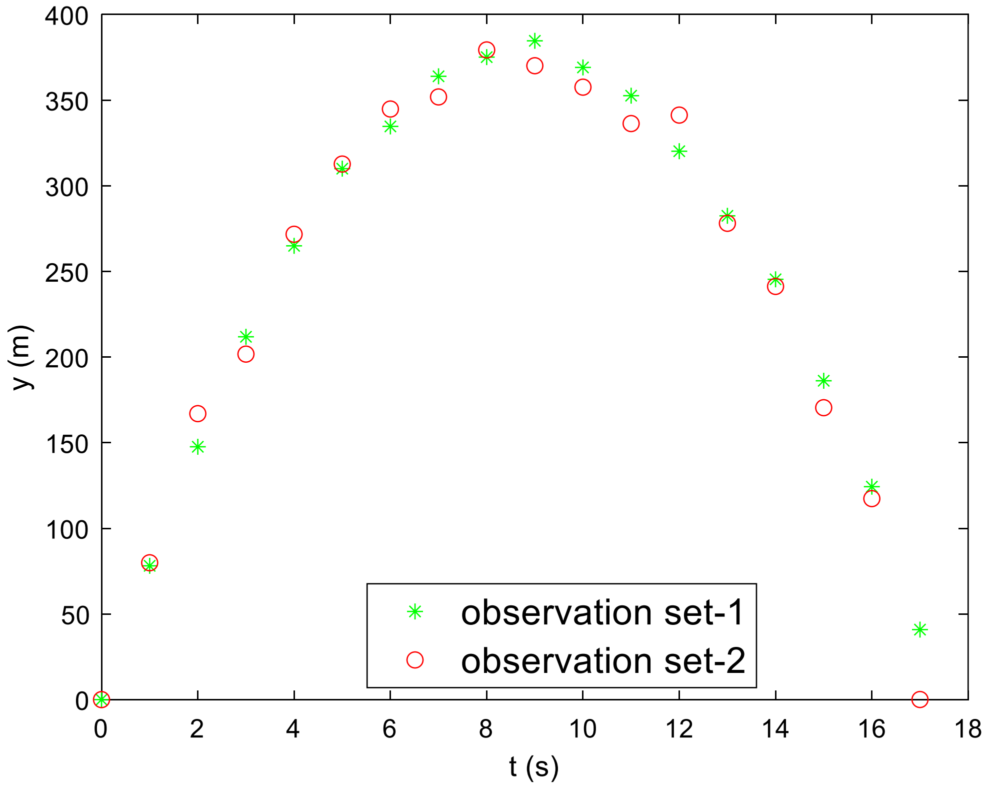
Model Parameter Estimation
Example-II



Two different observation sets for *x*-coordinates

Textbooks: Fikri Öztürk, Levent Özbek, “Matematiksel Modelleme ve Simülasyon”, 2004.
Averill M. Law, “Simulation Modeling and Analysis”, McGraw-Hill, 2015.

Model Parameter Estimation
Example-II



Two different observation sets for *y*-coordinates

Textbooks: Fikri Öztürk, Levent Özbek, “Matematiksel Modelleme ve Simülasyon”, 2004.
Averill M. Law, “Simulation Modeling and Analysis”, McGraw-Hill, 2015.

Generating Random Numbers

Inverse Transform Sampling

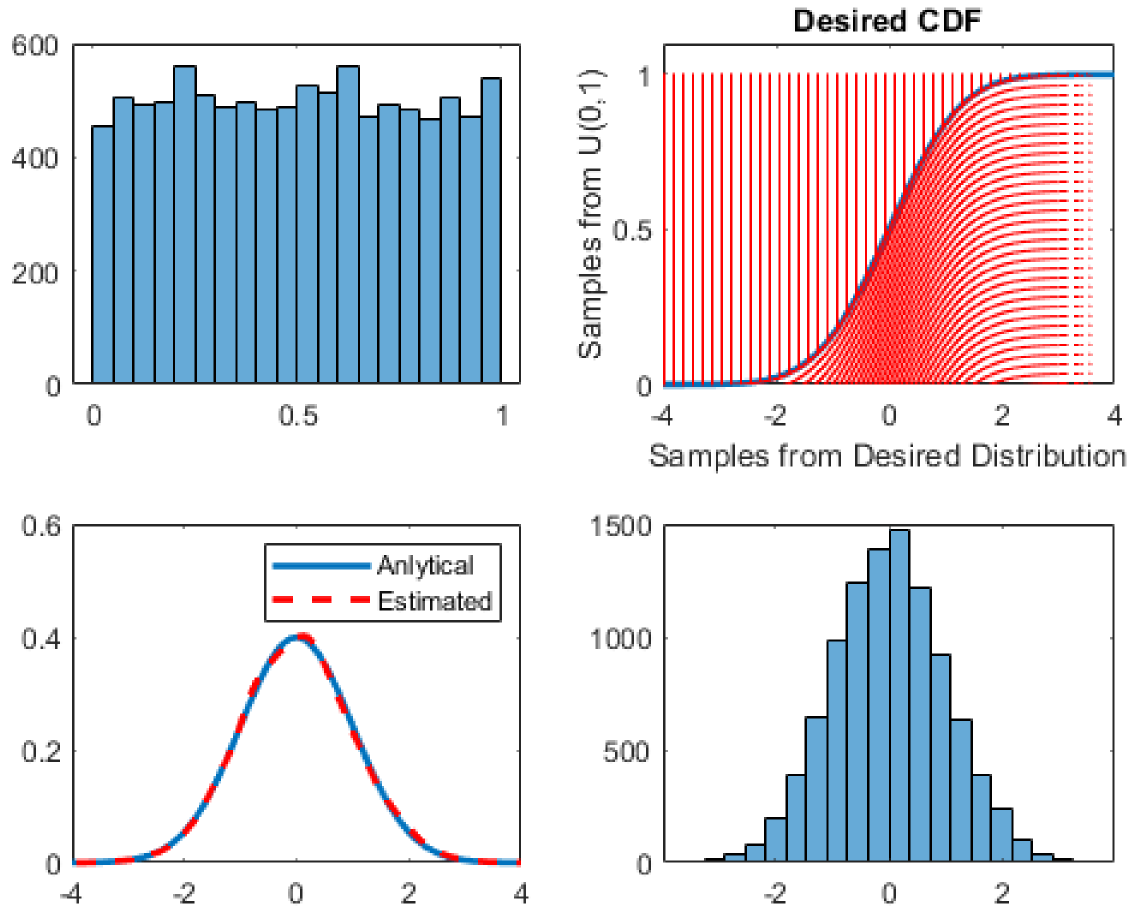
Generate random numbers from a uniform distribution in the interval [0,1] $u \sim U(0,1)$

Evaluate the inverse of the desired CDF for these uniform random samples, $x = F_X^{-1}(u)$.

Obtained random numbers *x* has the desired distribution $F_X(x)$.

Textbooks: Fikri Öztürk, Levent Özbek, “Matematiksel Modelleme ve Simülasyon”, 2004.
Averill M. Law, “Simulation Modeling and Analysis”, McGraw-Hill, 2015.

Inverse Transform Sampling
Desired Distribution: Gaussian



Inverse transform sampling procedure. Number of random samples Ns=1e4

Textbooks: Fikri Öztürk, Levent Özbek, “Matematiksel Modelleme ve Simülasyon”, 2004.
Averill M. Law, “Simulation Modeling and Analysis”, McGraw-Hill, 2015.