# Euler Discretization and SciPy ODE Solver

## Euler Discretization

Euler discretization is a method used to convert a continuous-time state-space model into a discrete-time model. This process is essential for digital simulations and control applications where the system operates in discrete time intervals.

The Euler discretization of the state-space equation is given by:  
  
x[k+1] = x[k] + Ts \* (Ax[k] + Bu[k])  
  
Where:  
- x[k] represents the state at the k-th time step.  
- Ts is the sampling time.

In this discretization:  
  
The state transition matrix (Phi) and the input matrix (H) are defined as follows:  
  
Phi = I + Ts \* A  
  
H = Ts \* B  
  
These matrices approximate the system's behavior in discrete time. The discrete-time state-space equation using Euler's method becomes:  
  
x[k+1] = Phi \* x[k] + H \* u[k]

## SciPy ODE Solver

SciPy's ODE solvers (such as 'odeint') offer a more sophisticated approach to solving continuous-time state-space models. These solvers use advanced numerical integration techniques to provide accurate solutions over time, automatically adjusting the step size for efficiency.

## Matrix Exponential

Do not understand quite well…

matrix exponential used in the discretization of continuous-time state-space models, providing a way to translate the system's continuous dynamics into a discrete-time framework