ECON 21410 Quantitative Economics

Object Oriented Programming

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Function

Arguments, Name Space, Scope

- Some Statement We could repeatedly use
- Positional Arguments and Keyword Arguments

```
def my_func(*args, **kwargs):
    do some thing
    return value # if not specified, will return None
```

- LEGB Rule:
  - Local - Enclosing - Global - Built-in

Object Oriented Programming 1

Basic Concept

- Every thing in Python is a Object
- In Python, an object is a collection of data and instruction held in computer memory that consists of:
  - a type
  - a unique identity
  - data
  - methods
- Classes group together data(attributes) and Functions(methods):
  - Methods can access and modify the attributes
  - Methods are also considered attributes in Python
- Difference of Types and Classes

Object Oriented Programming 2

Mutable and Immutable Type; Equality vs Identity

- An Object is immutable if it cannot be changed in place after it has been created
- Immutable types in Python:
  - int, float, complex
  - str
  - tuple
- == tells us if two objects are equal, is tell us if two objects identities are the same

Identity Example

```
a = [1, 2, 3, 4]
b = [1, 2, 3, 4]
c = a
print(a == b, a is b, a == c, a is c)
```

Object Oriented Programming 3

Construct A Class

- Classes are blueprints that for creating your specific realizations (instances) of the data structure
- Provide a layer of abstraction that help human to understand

Class Example

```
class Consumer:
    def __init__(self, w):
        "Initialize consumer with w dollars of wealth"
        self.wealth = w
    def earn(self, y):
        "The consumer earns y dollars"
        self.wealth += y
```

Object Oriented Programming 4

Class Inheritance

- Initial Method
- Attribute search order:
  - Instance
  - Class
  - Superclass

Inheritance

```
class VIPConsumer(Consumer):
    def __init__(self, w):
        "Initialize consumer with w dollars of wealth"
        if w > 1,000,000:
            self.wealth = w
        else:
            print('Not a VIP Consumer')
```

Solow Growth Model

Model

The Solow growth model is a neoclassical growth model where the amount of capital stock per capital k_t evolves according to the rule

$$k_{t+1} = \frac{szk_t^{\alpha} + (1-\delta)k_t}{1+n}$$

where s,z,α, n, δ is exogenously given saving rate, productivity, capital share of income, population growth rate, depreciation rate.
So our task is just to find a **Fixed point** and a **Path** to this steady state such that $k_{t+1} = k_t$.

Linear State Space Model

Linear State-Space System

Here is the linear state-space system:

$$x_{t+1} = AX_t + Cw_{t+1}$$
$$y_t = Gx_t$$
$$x_0 \sim N(\mu_0, \Sigma_0)$$

Primitives, 1) the matrices A, C, G, 2); the shock distribution N(0, I); 3) the initial condition x_0, which we have set to $N(\mu_0, \Sigma_0)$

- x_t is $n \times 1$ vector of the state
- y_t is $k \times 1$ vector of the observations
- A is $n \times n$ transition matrix
- C is $n \times n$ volatility matrix
- G is $n \times n$ output matrix

Second-Order Difference Equation

- By Setting those primitives, a variety of dynamics model could be represented in terms of the linear state space model.
- Say we have a deterministic sequence that satisfies

$$y_{t+1} = \phi_0 + \phi_1 y_t + \phi_2 y_{t-1}$$

- Now we could map this equation to state space model

$$x_t = \begin{bmatrix} 1 \\ y_t \\ y_{t-1} \end{bmatrix}; A = \begin{bmatrix} 1 & 0 & 0 \\ \phi_0 & \phi_1 & \phi_2 \\ 0 & 1 & 0 \end{bmatrix}; C = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}; G = [0\ 1\ 0]$$

- Notice because we set C as zero matrix then it is a deterministic model, and the setup of y_0 is also a deterministic.

$$y_t = \phi_0 + \phi_1 y_t + \phi_2 y_{t-1}$$
$$y_{t+1} = y_t$$

Samuelson's Accelerator I

Samuelson's Accelerator Model Set Up

$$C_t = aY_{t-1} + \gamma \tag{1}$$

$$I_t = b(Y_{t-1} - Y_{t-2}) \tag{2}$$

$$Y_t = C_t + I_t + G_t \tag{3}$$

- C_t, Y_t, I_t is consumption are endogenous variable of consumption, national income, and rates of investment
- a is the marginal propensity to consume(relative to income), γ is the autonomous consumption, b is the **Investment Accelerator Coefficient** people invest more if their income is increasing and disinvest o.w.
- We are interested in studying the transient fluctuation in Y_t as it converges to its steady state level, and the rate at which it converges to a steady state level.

Samuelson's Accelerator II

Model Results

The model predicts a second order difference equation:

$$Y_t - \rho_1 Y_{t-1} - \rho_2 Y_{t-2} = 0 \tag{4}$$

where $\rho_1 = a + b$, $\rho_2 = -b$

Reference


Thomas J. Sargent and John Stachursk
OOP II: Building Classes
Lectures in Quantitative Economics