Pramod Parajuli
Simulation and Modeling, CS-331

Chapter 2
System Studies

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Sub Systems

-System consists of interacting ***subsystems***

-Each subsystem has its own inputs and outputs

-Similarly, a model can also be broken into ***sub-models***

-Sometimes, the terms subsystem, sub-model, and blocks are interchangeable

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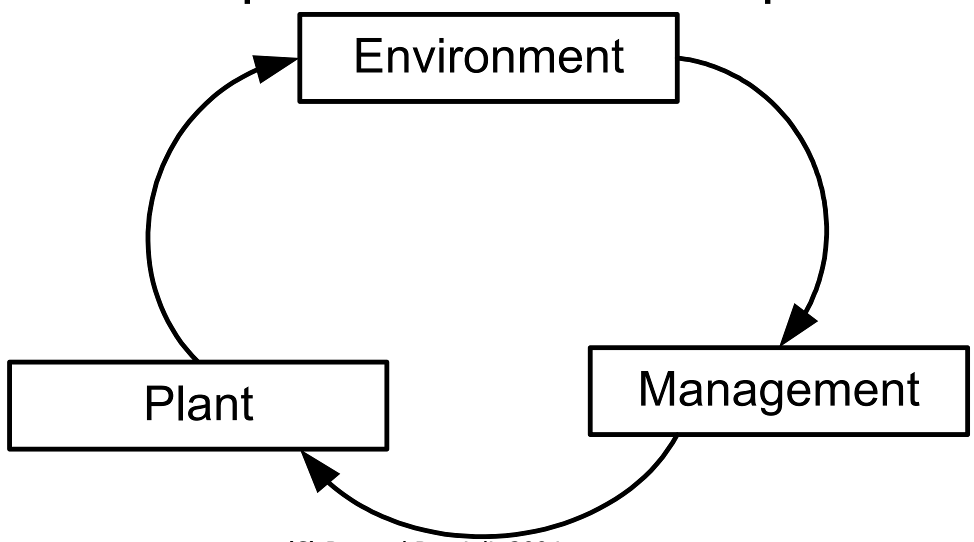
A Corporate Model

- Model that exhibits the property of a corporation
- 3 essentials
  - Environment: the corporation exists within the environment
  - Management: responsible for all of the planning, risk analysis, scheduling, marketing etc.
  - Plant: the real implementation of the plan and design



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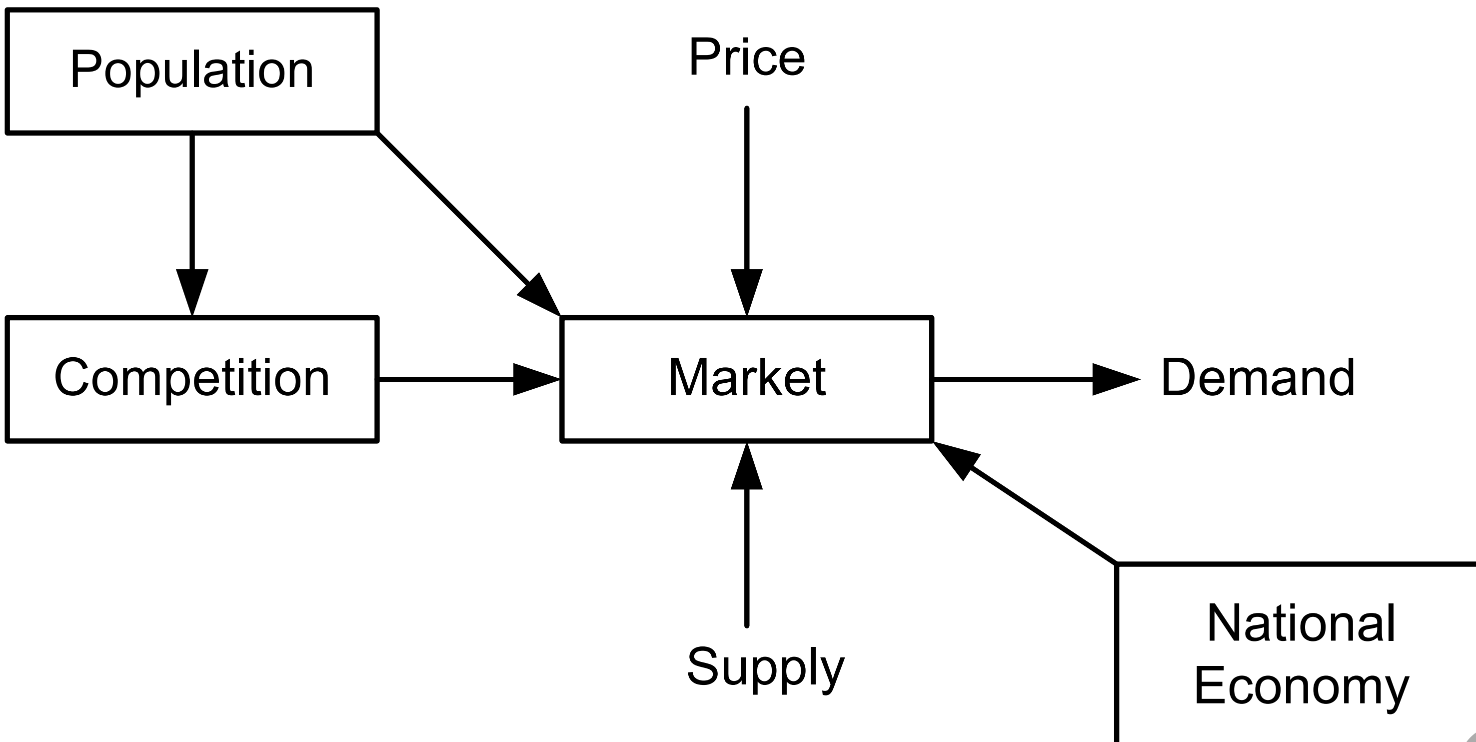
Environment

market model



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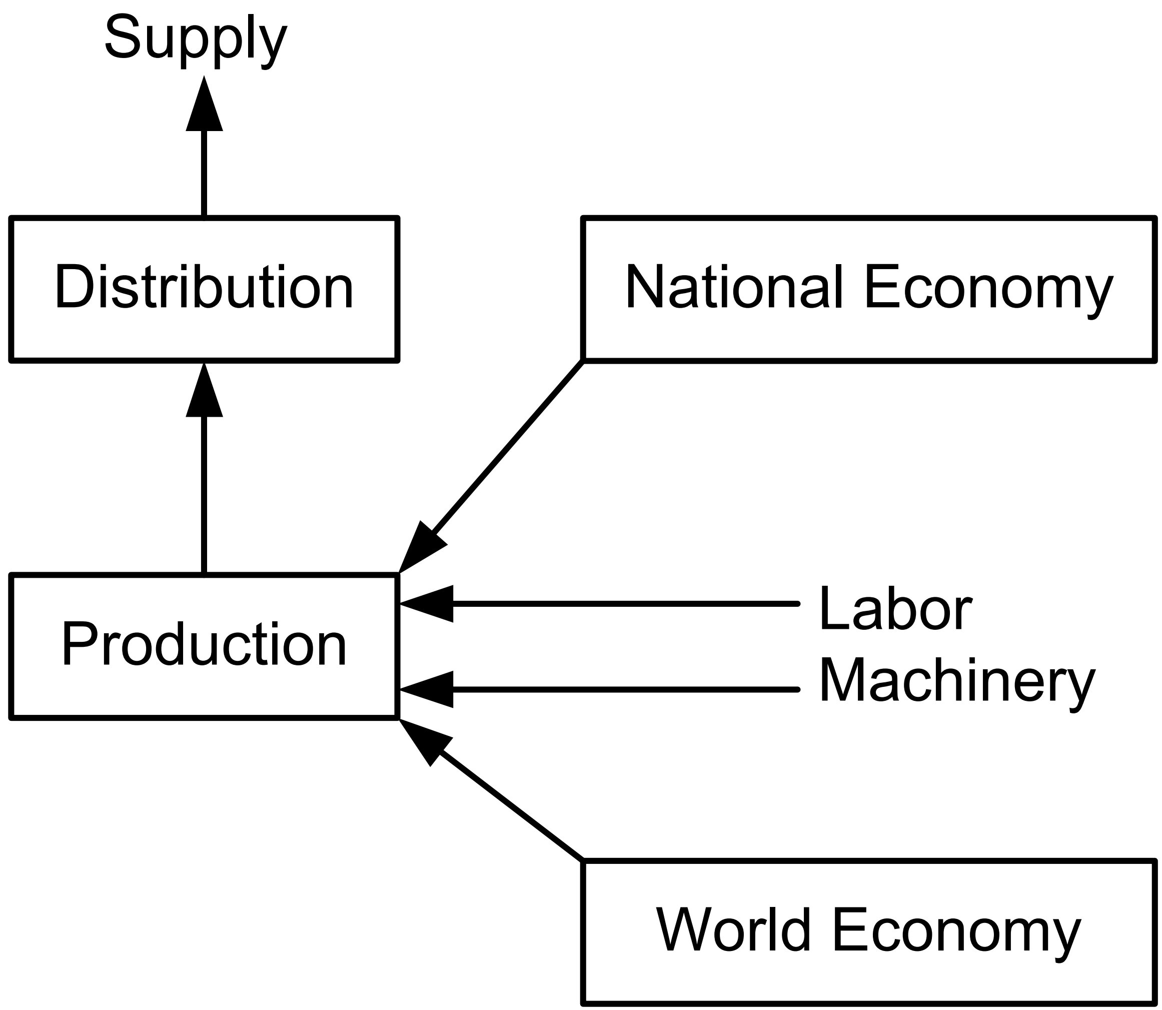
Production



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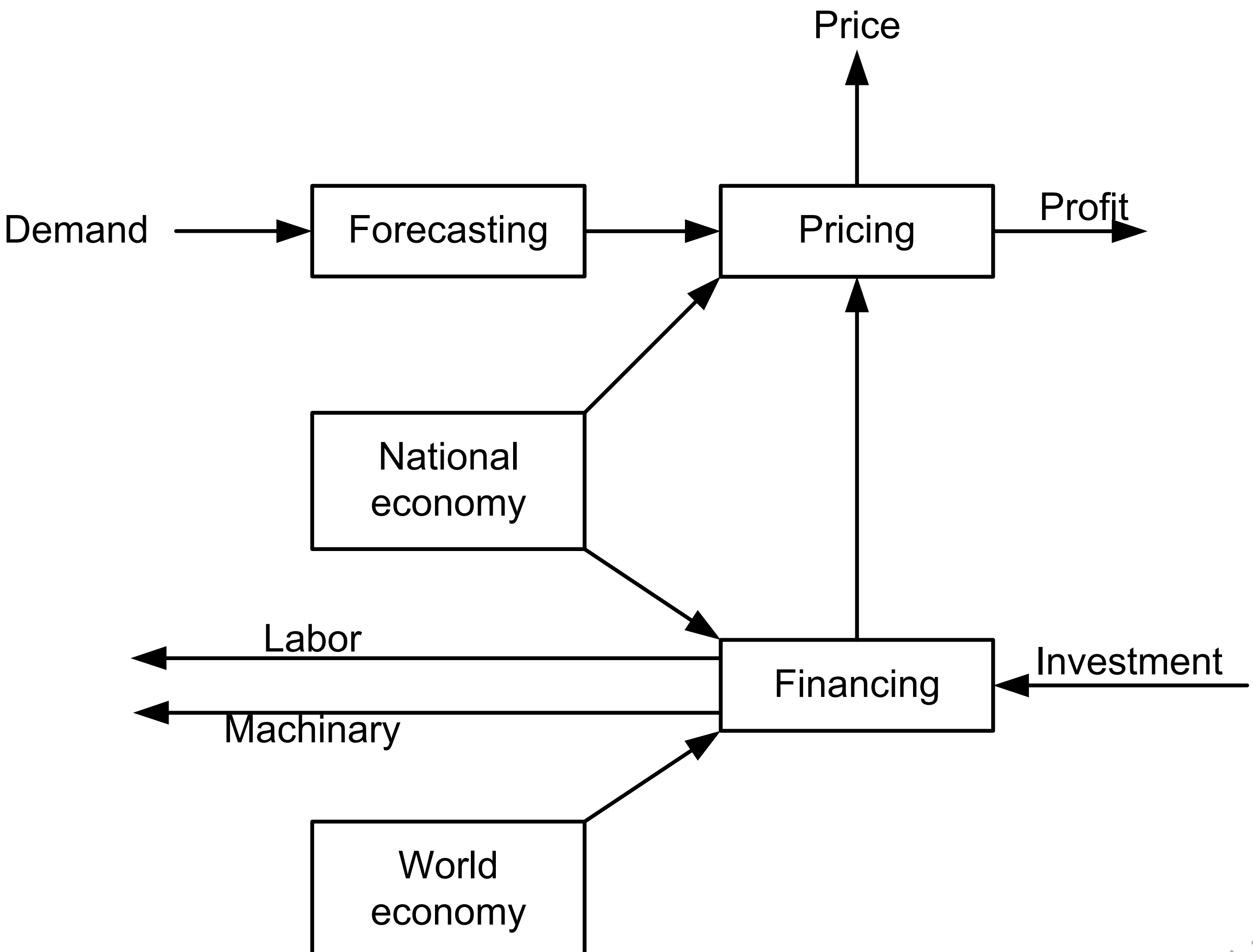
Management



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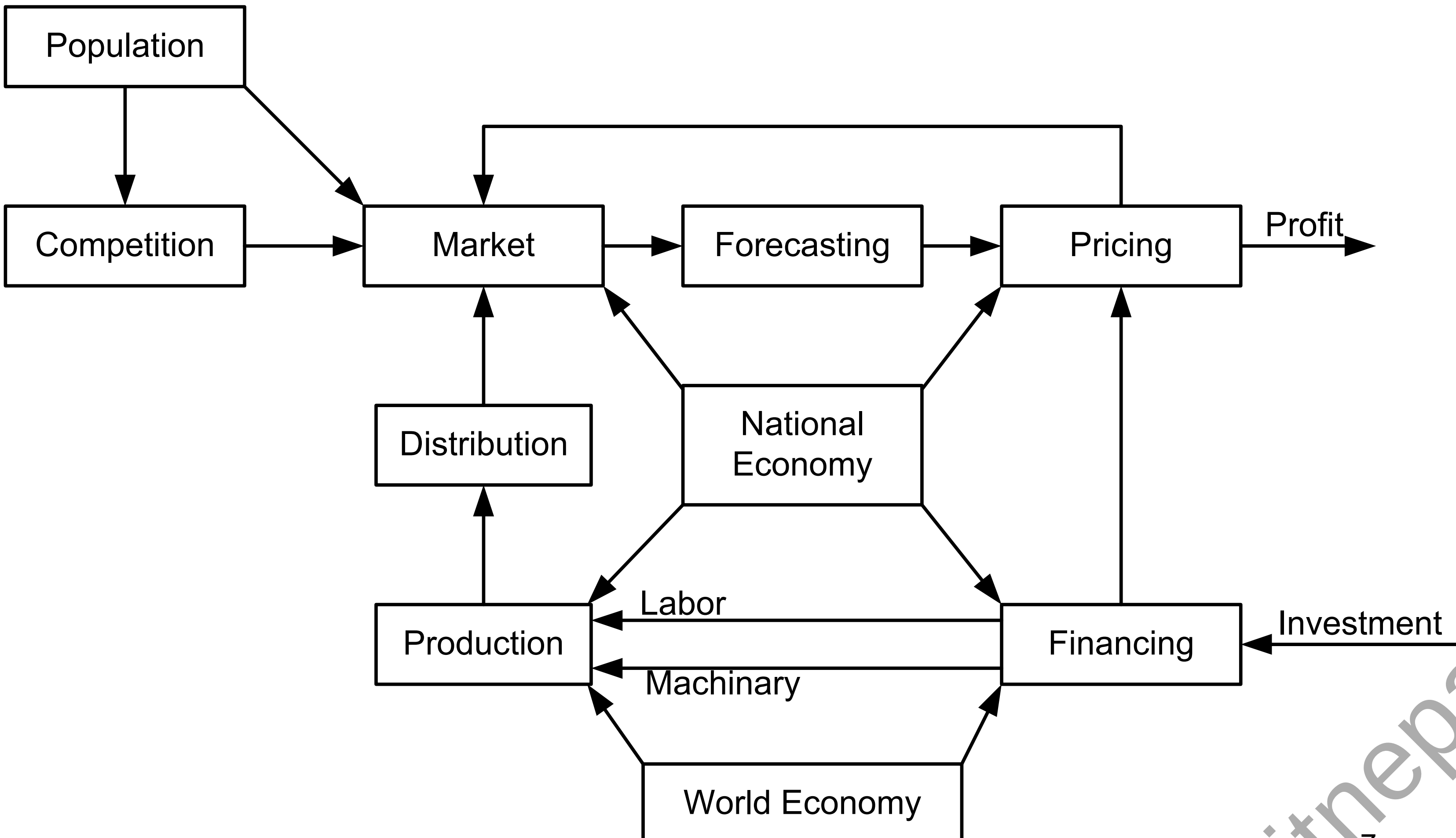
Full Corporate Model

Combine



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Types of System Studies

- System analysis
  - understand the system under study
  - focus on system performance

- System design
  - develop the logical objects that meet some specification
  - calculate the performance and compare with the prediction
  - if not satisfied, then redesign and repeat again

- System postulation
  - Characteristic of the way models are employed in other disciplines

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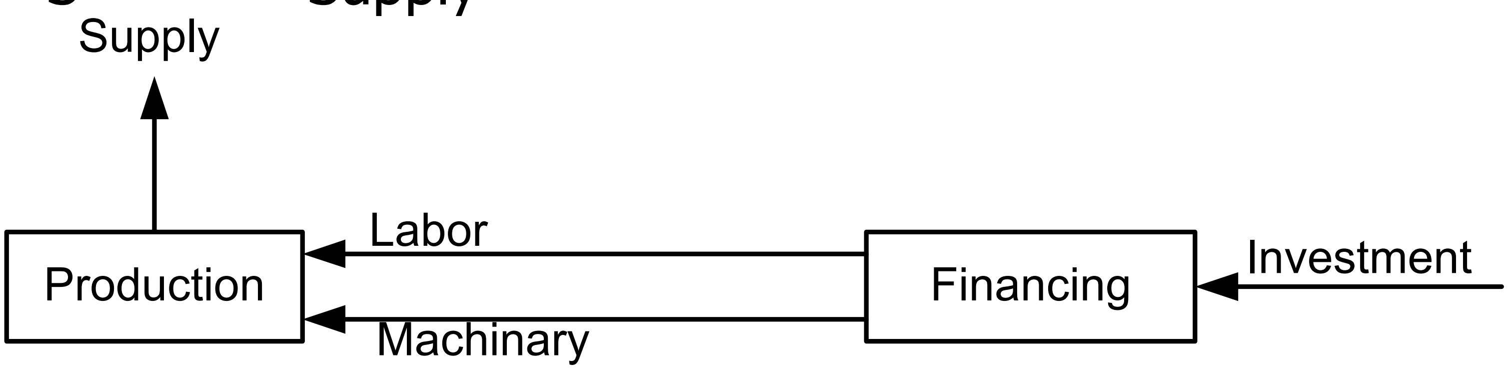
System Analysis

Considerations;

K	Capital investment
L	Labor
M	Machinery
S	Supply



$$S = f.L^{a1}.M^{a2}$$

Cobb-Douglas model. For simplicity consider; a1=a2=1

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System Analysis

As far as financial model is considered, it is modeled as;

$$K = eL + M$$

Since the interdependency of K, L, M, and S has been found, can we find an assignment of L and M that maximizes supply for a given investment?

Let's see the graph plot of the relationships.

Let's consider that e = 0.75 and f = 0.1

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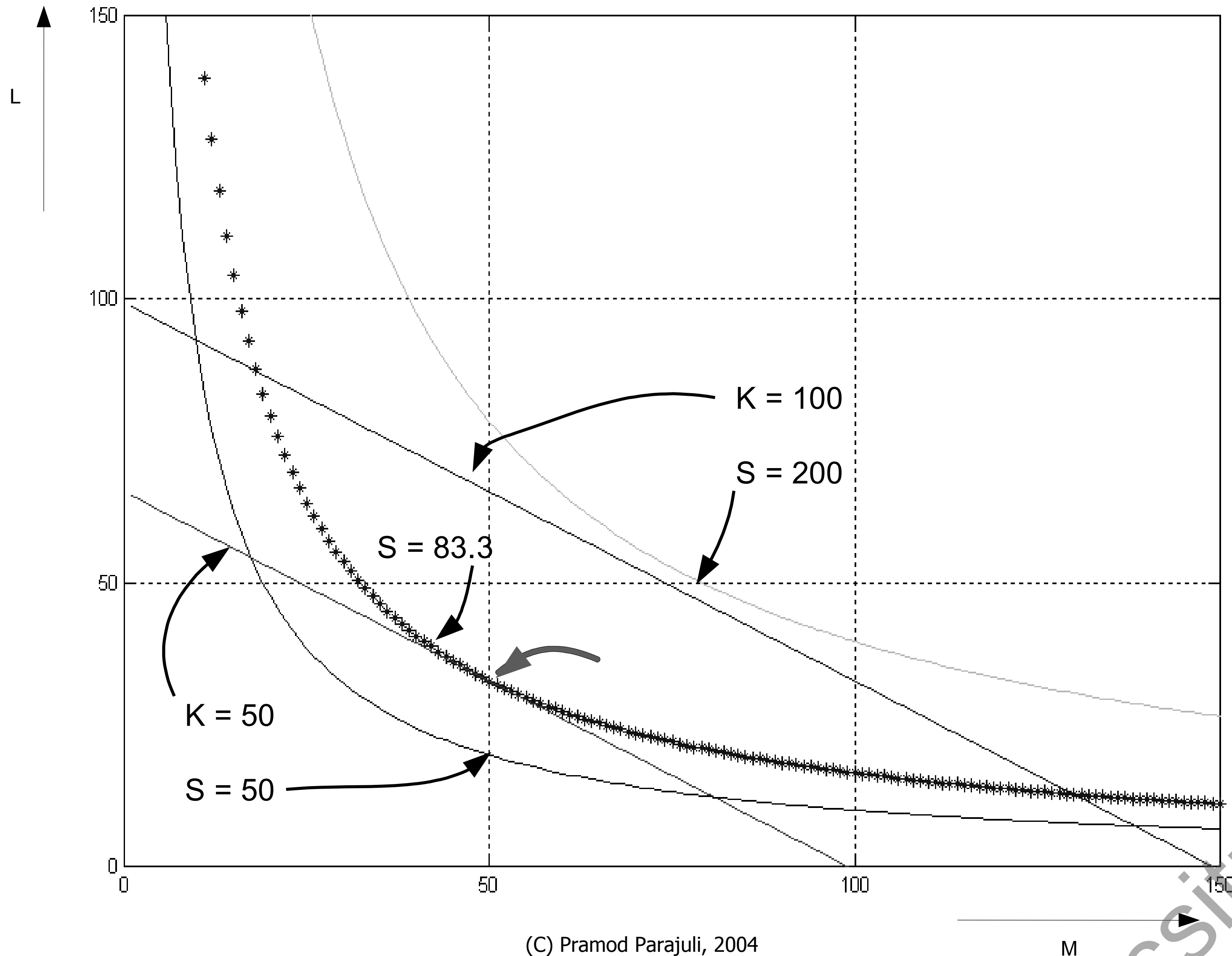
System Analysis – The optimal solution



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System Analysis – The optimal solution

The optimal point is;

M = 50

L = 33.3

Depending on the samples taken, the optimal point changes.

Here, only a part of the corporate model is optimized and hence known as ***sub-optimization***.

In general, when the system is giving the maximum performance, most of the sub-systems are at their peek performance.

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System Analysis – The optimal solution

The example we saw is a static one.

If the market competition, economy influence etc are to be considered, then the system will be dynamic and required even more sophisticated study

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System Design

Online computer system

- '***M***' number of messages are received in a second
- '***m***' number of characters in one message
- A buffer that can hold '***b***' number of characters at a time
- Fraction '***k***' of the messages are replied
- The replied messages have '***r***' number of characters on the average
- Same buffer used for sending and receiving
- ***2,000*** instructions are required to process a message
- ***10,000*** instructions require to generate the reply message
- To read and reply the messages requires ***1,000*** instructions each

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System Design

Online computer system

- 3 computer systems,
  - 25,000 instruction per second
  - 50,000 instruction per second
  - 100,000 instructions per second
- Buffer size can be
  - 1 character buffer
  - 2 character buffer
  - 5 character buffer
  - 10 character buffer
- Altogether, 12 different configurations
- Which computer with which buffer size will be the best for the implementation given the price of the systems

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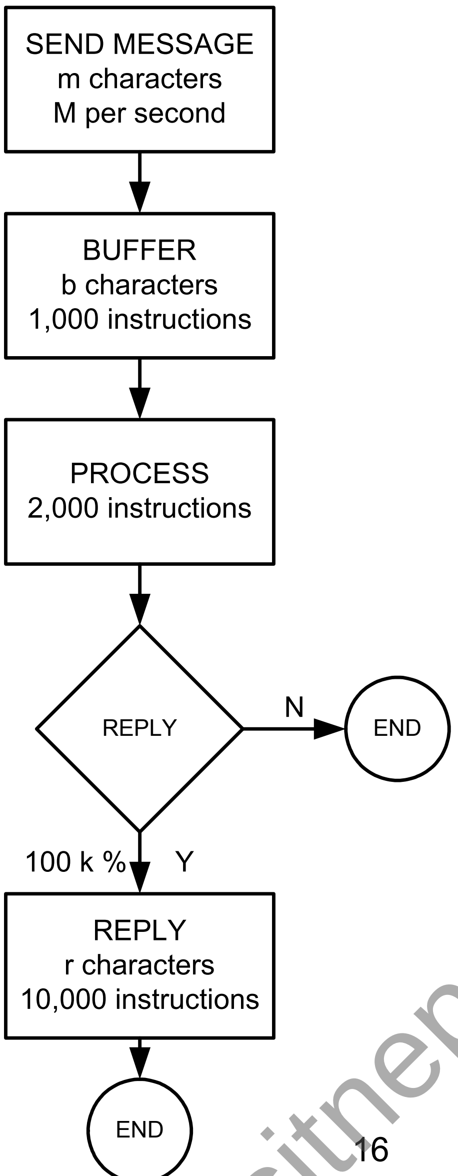
System Design

Here,

- M messages per second
- kM messages replied per second
- (M.m + k.M.r) characters pass thro buffer
- Since the buffer can hold ‘b’ chars, M (m+k.r)/b incomings per second

Altogether, the total number of instructions required;

$$N = 2{,}000M + 10{,}000M.k + \frac{1{,}000M(m + kr)}{b}$$



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System Design

- If ‘s’ is the number of instructions per second that the computer can execute then, the value of ‘s’ to be able to process the given messages M, must be

$$N \leq s$$

- Let’s consider that,

  M = 5 m = 15

  k = 0.1 r = 50

- When simplified, N ≤ s becomes;

$$\frac{20}{b} \leq \frac{s}{5{,}000} - 3$$

- Plot b against 20/b

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System Design

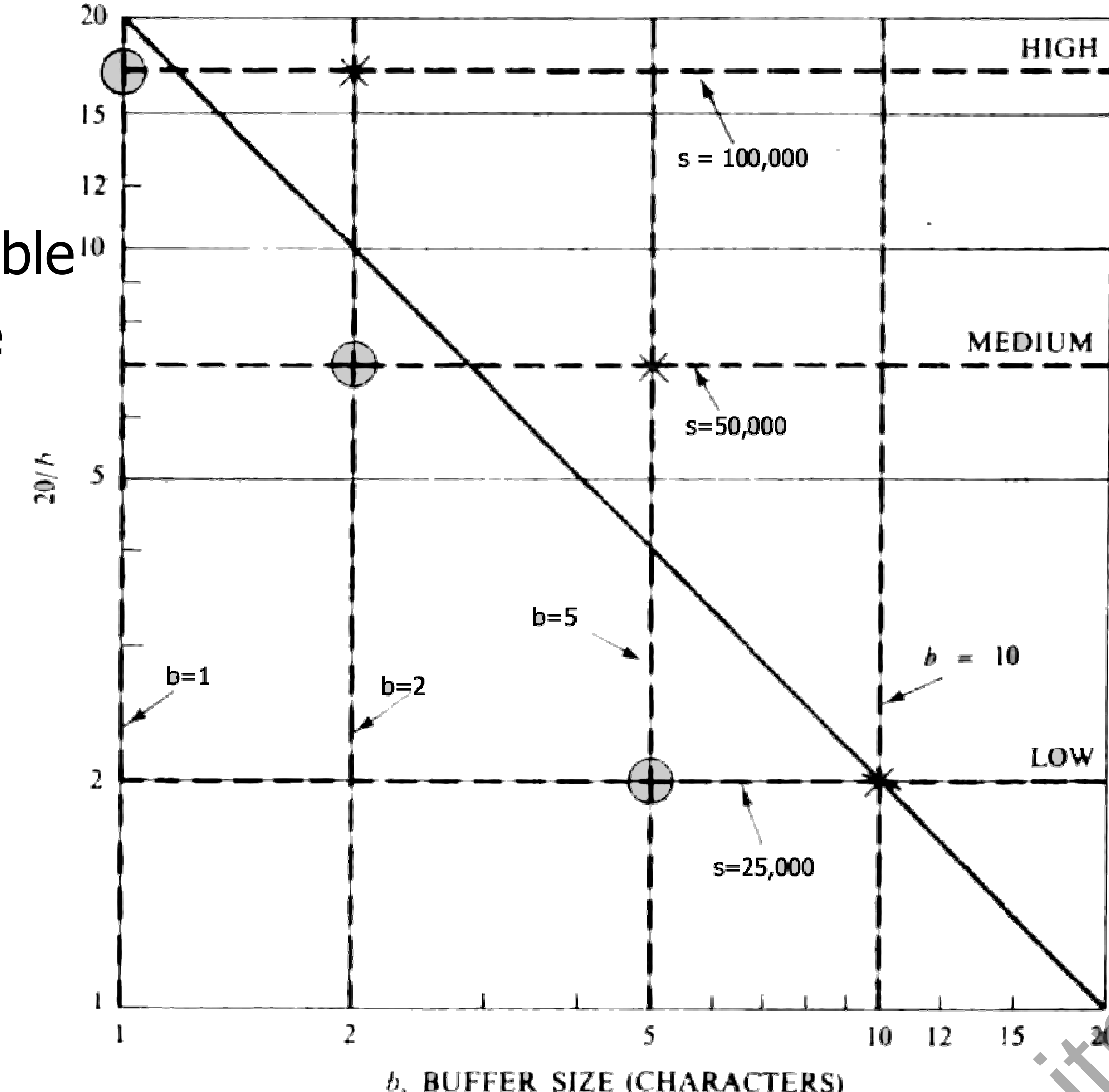
- Plot

+ are impossible

* are possible

Analyze for;

Cost



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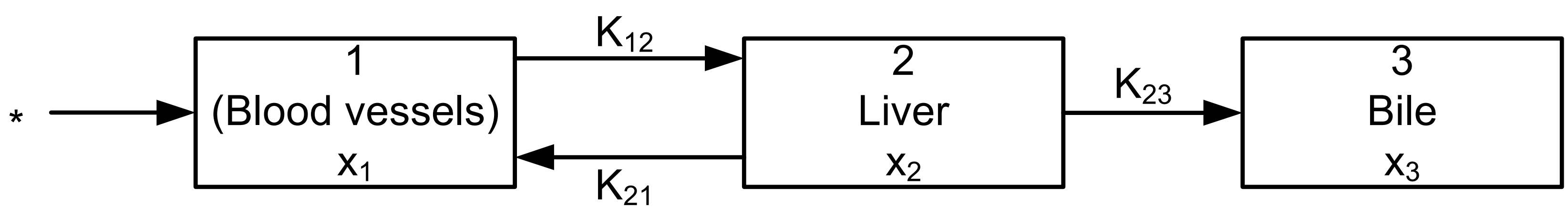
System Postulation

Blood filtration in human body

- Bloods from vessels come into the liver
- Liver filters the blood and re-circulates the refined blood to vessels and extracts bile
- The amount of blood filtered and re-circulated can be observed (medical studies) using thyroxine.
- Use of compartments (***compartmental model***) to represent the components



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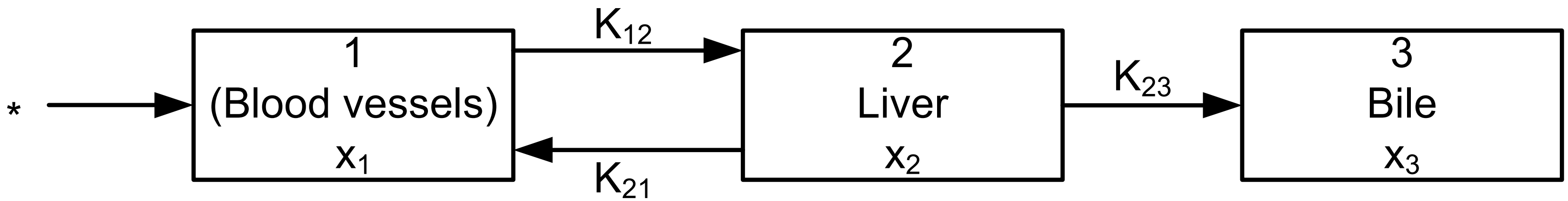
System Postulation



The overall function can be represented as;

$$\frac{dx_1}{dt} = -k_{12}.x_1 + k_{21}.x_2 \qquad x_1 = C_{11}.e^{-b_1 t} + C_{12}.e^{-b_2 t}$$

$$\frac{dx_2}{dt} = k_{12}x_1 - (k_{21} + k_{23}).x_2 \qquad x_2 = C_{21}.e^{-b_1 t} + C_{22}.e^{-b_2 t}$$

$$\frac{dx_3}{dt} = k_{23}.x_2 \qquad x_3 = C_{31} + C_{32}.e^{-b_1 t} + C_{33}.e^{-b_2 t}$$

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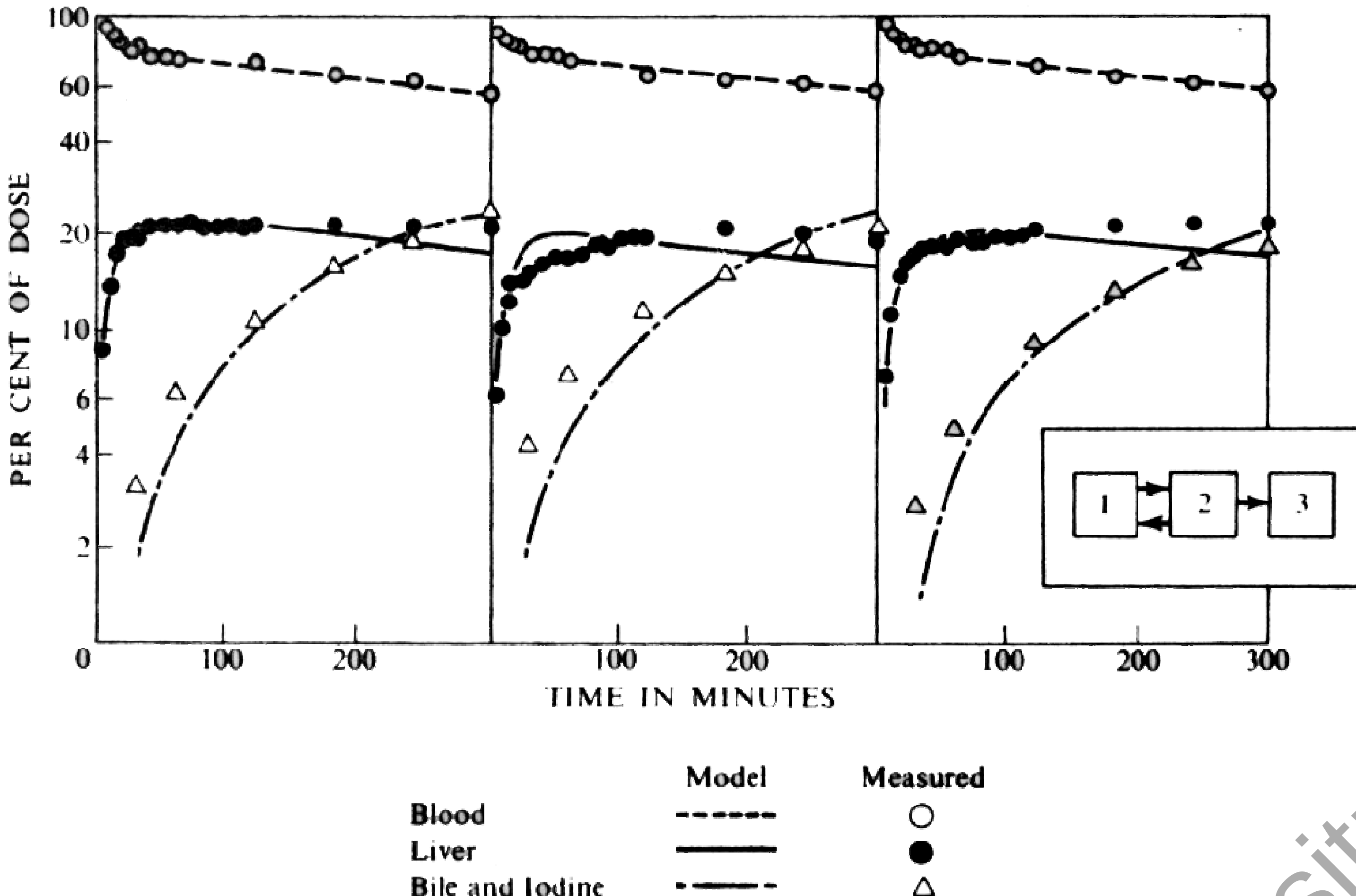
System Postulation

If the real world readings and the output of the models are plotted, then;



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