CS3.301: Operating Systems and Networks

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Offices: Data Sciences and Analytics Center (DSAC)/Software Engineering Research Cengter

Courses You Have Completed

- Digital logic design
  - Build an integrated circuit for a given function.
- Computer Architecture
  - Develop an assembly language program given a problem
- Programming language
  - Develop a high level program to solve a given problem.
    - printf()
    - scanf()
    - fopen()
    - …..

Outline

- **Introduction**
  - **What is an Operating System ?**
- Course topics and grading
- History, development and concepts of Oss
- Different kinds of Computer Systems
- Concept of virtual computer

Questions

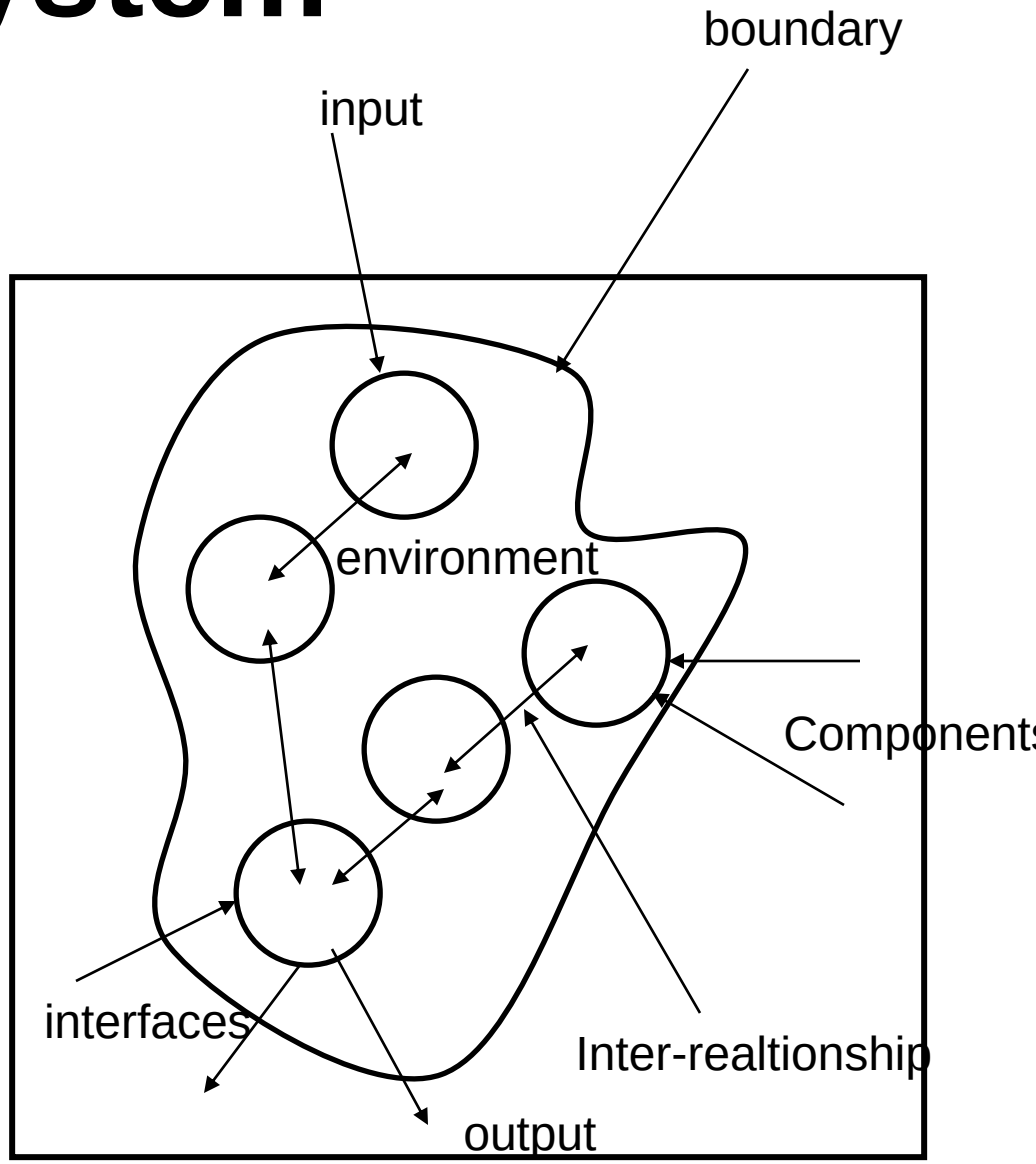
- What is a system ?
- What is an operating system ?
- What is a computer operating system ?

What is a system ?

- A system is an inter-related set of components with an identifiable boundary working together for some purpose.
- System can be natural or fabricated
  - Natural systems: human body or solar system
  - Fabricated systems: cycle, bus, computer, government, boat

System

- A system has nine characteristics
  - Components
  - Inter-related components
  - A boundary
  - A purpose
  - An environment
  - Interfaces
  - Input
  - Output
  - Constraints.



A general depiction of a system

Characteristics…

- Components:
  - A system is made up of components
  - A component is either an irreducible part or aggregation of parts that make-up a system. A component is also called a sub-system.
- Interrelated:
  - The components of interrelated
  - Dependence of one subsystem on one or more subsystems.

Characteristics…

- Boundary (Scope):
  - A system has a boundary, within which all of its components are contained and which establishes the limits of a separating the system from other systems.
- Purpose
  - The overall goal of function of a system. The system's reason for existing.

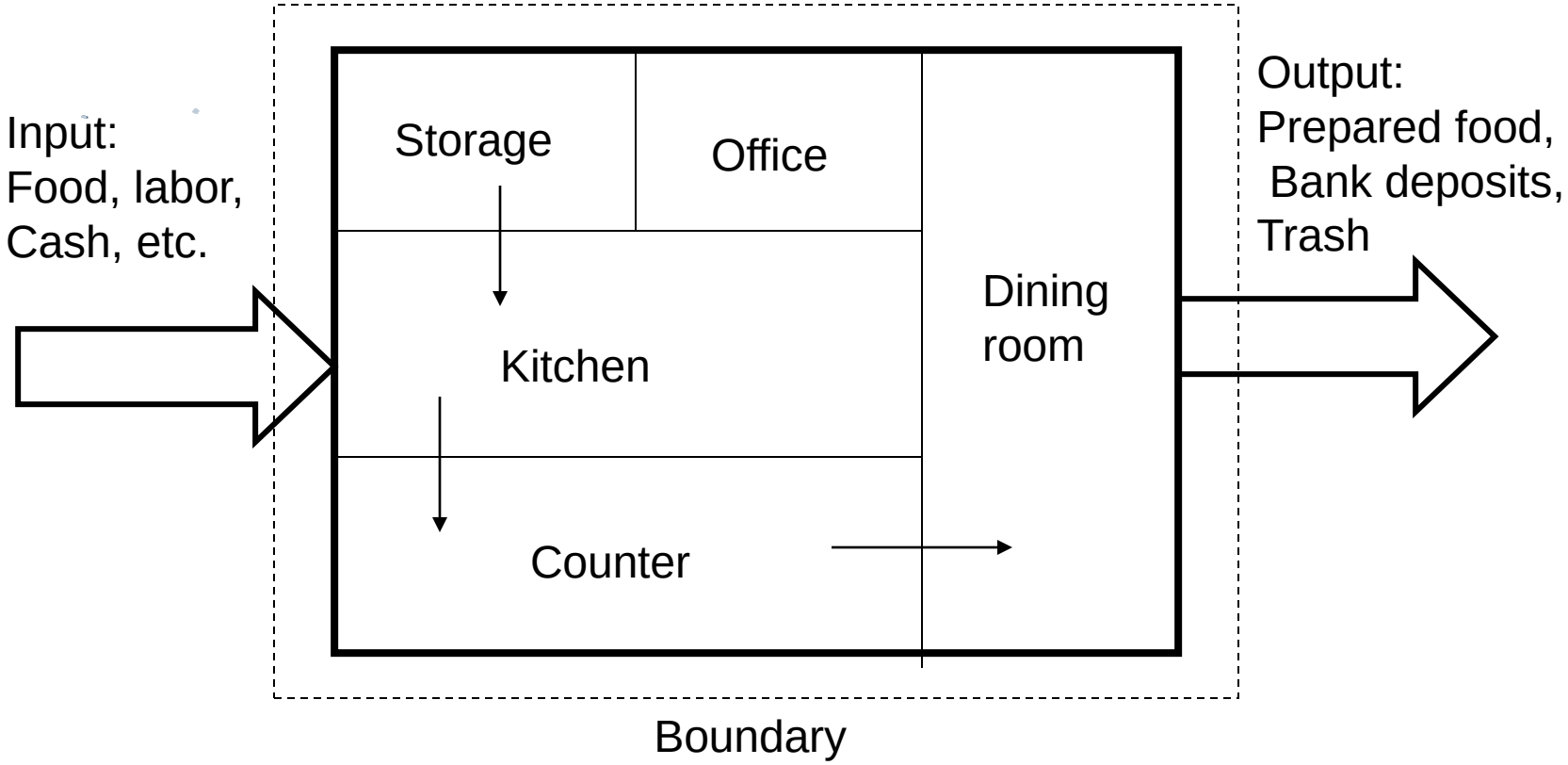
Characteristics…

- Environment
  - Everything external to the system that interacts with the system.
- Interface
  - Point of contact where a system meets its environment or subsystems meet each other.
- Constraint:
  - A limit what a system can accomplish: Capacity, speed or capabilities.

Characteristics…

- Input
  - Whatever a system takes from its environment in order to fulfill its purpose.
- Output:
  - Whatever a system returns to its environment in order to fulfill its purpose.

Example: A fast food restaurant as a system



Environment: Customers, food distributors, banks etc

Represents an inter-relationship

Constraints: Popular foods, Health dept., constraints of storage

Important System Concepts

- Decomposition
- Modularity
- Coupling
- Cohesion

Decomposition (Divide and Conquer)

- It deals with being able to break down a system into its components.
- Decomposition results in smaller and less complex pieces that are easier to understand than larger, complex pieces.
- Decomposing a system also allows to focus on one particular part of a system, making easier to think of how to modify that part independently of the entire system.

Modularity

- Modularity refers to dividing a system up into chunks or modules of a relatively uniform size.
- You can replace or add any other module (or a component) without effecting the rest of the system.
- It is a design strategy in which system is composed of relatively small and autonomous routines fit together.

Coupling

- Coupling is the extent to which subsystems are dependent on each other.
  - Subsystems should be as **independent** as possible.
  - If a subsystem fails and other subsystems are highly dependent on it, the others will either fail themselves or have problems in functioning.

Cohesion

- The extent to which a system or a subsystem performs a single function.

What is an operating system ?

- Operating system is a system.
- Operating system is a subsystem of any tool.
- Each tool constitutes machine part and operating part.
- **The operating part of a tool is called as operating system of that tool.**
- The purpose of operating system is to facilitate the operation of the underlying machine or tool.
- For some tools, operating system may not exist.
  - Example: Pen.
- For a user, the operating system abstracts the machine part in terms of simple services by hiding the details of the machine. The OS can provide services to users or other subsystems.
- Examples of typical operating systems:
  - Car operating system, Telephone operating system, TV operating system and so on.

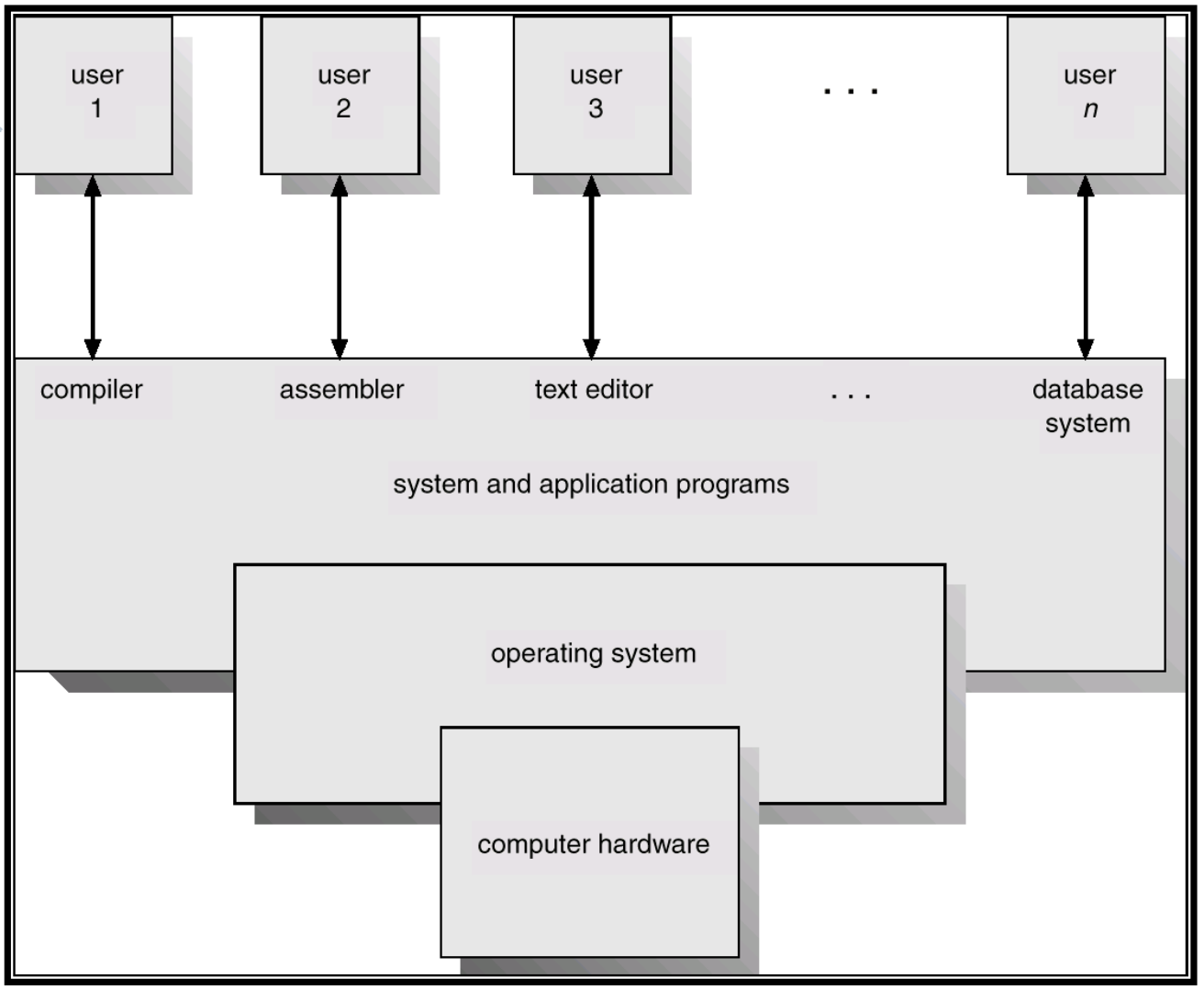
What is a computer operating system ?

- A computer is also a tool that contains the machine part and the operating part.
- The operating part of a computer is called Computer Operating System.
  - The operating system abstracts the underlying hardware in terms of simple services by hiding the details of the hardware. The OS can provide services to users or other subsystems.
- Examples of Computer operating systems:
  - WINDOWS 10, Macintosh, UNIX, SOLARIS, LINUX, Android, MAC IOS and so on.
- In the rest of this course, operating system means computer operating system.

Computer System Components

1. **Hardware** – provides basic computing resources (CPU, memory, I/O devices).
2. **Operating system** – controls and coordinates the use of the hardware among the various application programs for the various users.
3. **Applications programs** – define the ways in which the system resources are used to solve the computing problems of the users (compilers, database systems, video games, business programs), Internet.
4. **Users** (people, machines, other computers).

Abstract View of System Components



What is an Operating System?...

- A program that acts as an intermediary between a user of a computer and the computer hardware.
- Operating system goals:
  - Make the computer system convenient to use.
  - Use the computer hardware in an efficient manner.

Operating System Definitions…

- **Resource allocator** – manages and allocates resources.
  - Resources: CPU time, Memory Space, file storage space, I/O devices and son on.
- **Control program** – controls the execution of user programs and operations of I/O devices .
- **Kernel** – the one program running at all times (all else being application programs).
- The two goals, efficiency and convenience are sometimes contradictory
- Much of OS theory is concentrates on optimal use of resources.

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Objectives

- Understand the operational part of any computer.
  - learn the important concepts which have been evolved for building **modern operating systems and networking protocols.**
- Understanding the general principles of OS design.
  - Focus on general-purpose, multi-user systems.
  - Emphasis on widely applicable concepts rather than any specific features of any specific OS.
- Understanding problems, solutions and design choices.
- Understanding the structure of specific OSs: UNIX, LINUX, WINDOWS 10

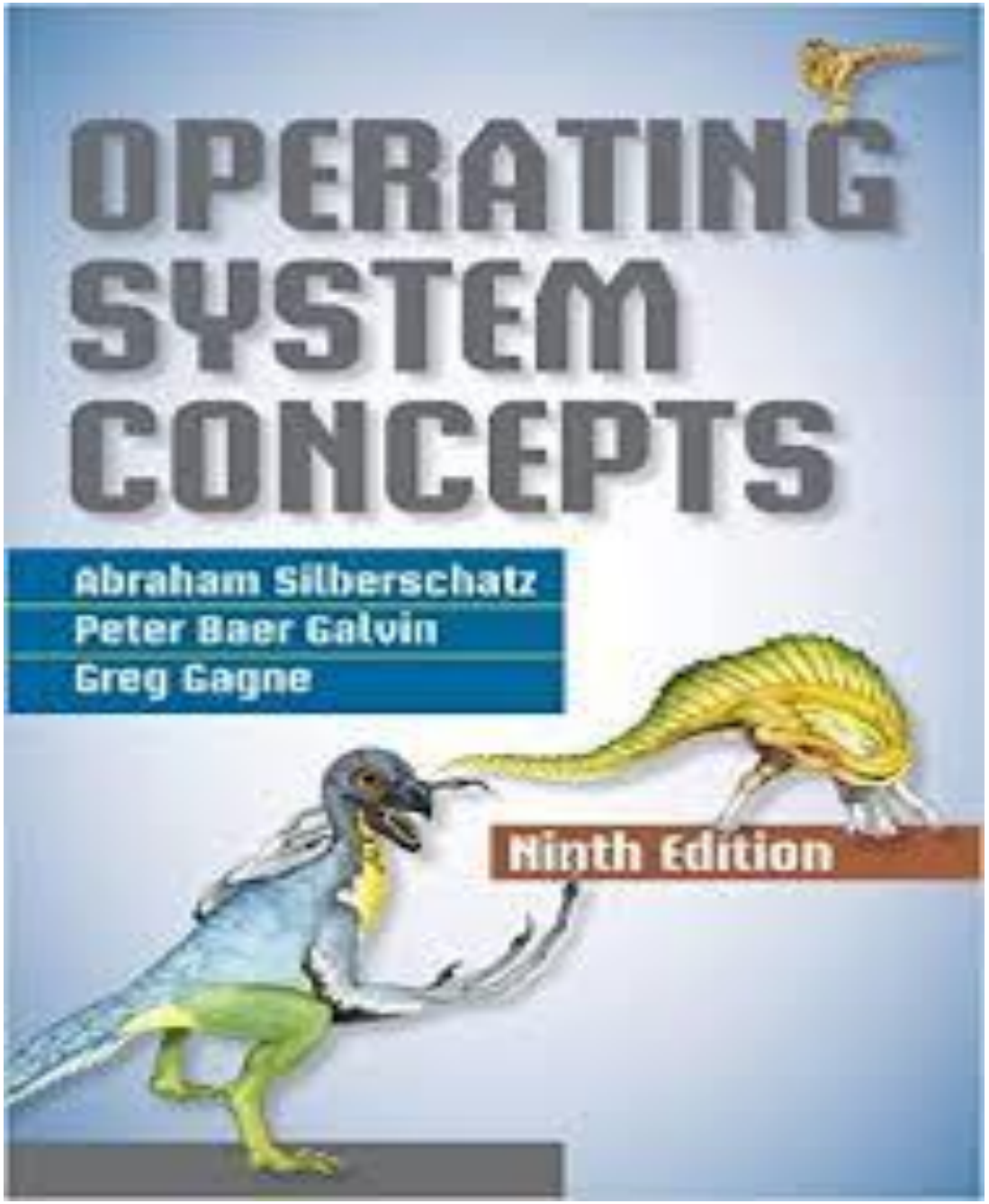
Course topics

- Introduction (3 hours)
- Process and thread management (6 hours)
- CPU Scheduling (3 hours)
- Process Synchronization (4.5 hours)
- Deadlocks (1.5 hours)
- Memory management (4.5 hours)
- Virtual Memory (4.5 hours)
- File Systems (1.5 hours)
- Protection and Security (1.5 hours)
- Networking (9 hours)

References

- Text books:
  - **Silberschatz, A, Galvin, P, Gagne, G. Operating System Concepts, Addison-Wesley (8th or latest edition).**
  - **Computer Networks (5th Edition) Andrew S. Tanenbaum, David J. Wetherall Prentice Hall.**

- Other References
  - William Stallings, Operating systems, Prentice-Hall, 1998.
  - Operating Systems, Gary Nutt, Pearson Education
  - Charles Crowley, Operating Systems: A design-oriented approach, Tata McGraw-Hill, 1997.
  - Operating Systems: Concepts and Design, Milan Milenkovic, TATA McGRAW-HILL
  - Tanenbaum, A., Modern Operating Systems, Prentice-Hall, second edition, 2000.
  - Research Papers


OPERATING
SYSTEM
CONCEPTS
Abraham Silberschatz
Peter Baer Galvin
Greg Gagne
Ninth Edition

FIFTH EDITION

COMPUTER NETWORKS

TANENBAUM | WETHERALL

LAB WORK

- Five mini projects related to the above syllabus will be done by students in the laboratory

- Experiments will be on the exposing the working of several system calls of LINUX OS:
  - Installation; reversing a file; Shell writing
  - Process communication
  - Bounded buffer,
  - semaphores,
  - shared memory,
  - threads;
  - Replace "ls" with lookup;
  - Command line for /proc;
  - Memory management
- Note: The lab is very intensive. Please do not ask for the extension of deadline. Each experiment will be evaluated.

Related Research Papers

1. H. M. Levy and P. H. Lipman. Virtual Memory Management in the VAX/VMS Operating Systems. IEEE Computer, 15(3), March 1982, pp. 35-41.

2. Thompson, K., "UNIX Implementation," The Bell System Technical Journal, Vol. 57, No. 6 (July-August 1978), Part 2, pp. 1931-1946.

3. F. J. Corbato and V. A. Vyssotsky, "Introduction and overview of the Multics system," In Proceedings AFIPS 1965 Fall Joint Computer Conference (FJCC), Vol. 27, No. 1, 1965, Spartan Books: New York, pp. 185-196

4. Windows NT and VMS: The Rest of the Story, by Mark Russinovic

5. E. W. Dijkstra, "The Structure of the THE ##Multiprogramming System," Communications of the ACM, Vol. 11, No. 5, May 1968, pp. 341-346

6. C. Daley and J. B. Dennis. Virtual Memory, Processes, and Sharing in MULTICS. Communications of the ACM, 11(5), May 1968, pp. 306-312.

7. Ritchie, D.M., and Thompson, K., "The UNIX Time-Sharing System,"The Bell System Technical Journal, Vol. 57, No. 6 (July-August 1978), Part 2, pp. 1905-1929.

Reading/Practicing Assignments

- Problems will be given
- You have to solve on your own

COURSE OUTCOMEs

- After completion of this course successfully, the students will be able to,
  - Explain the concepts of several modern computer operating systems (SOLARIS, LINUX, WINDOWS, MAC, Adroid,…) and network based services (Skype, Google Hangouts,..)
  - Implement the task on the top of given operating system in an efficient manner based on process and thread framework available in the given operating system.
  - Prescribe the appropriate scheduling/synchronization/ memory management/virtual memory/protection module for a given application.
  - Architect the new application by selecting the appropriate system calls of the given operating system services.
  - Develop a network-based application by exploiting networking related system calls.

GRADING

Type of Evaluation	Weightage (in %)
Class room test 1	5%
Mid Sem Exam	15%
Class room test 2	5%
End Sem Exam	40%
Attendance	5%
Lab Assignments (mini projects)	30%

Lab Assignments

- You will be given the lab assignments in advance
  - The instructor will provide you with adequate background information to do the assignment
  - Some installations will be necessary. Install well in advance and if you encounter any problems with any installation, you can contact your TA
- Policies for lab
  - You should try to solve any programming issues by yourself first, remember that troubleshooting is how you would actually be learning a lot
  - Every time you encounter any minor programming problem, if you ask the TA or instructor, you will lose out on an excellent learning experience
  - Only if you are unable to solve the problem after putting in a reasonable amount of effort, you should contact your TA or your instructor
  - You should also look online for solutions to your problems, but do not copy code from anywhere
- Grading criteria
  - The overall quality of your lab assignment submission in terms of correctness, quality of code, system design etc.

Plagiarism

- This course has a zero-tolerance policy w.r.t. plagiarism
- Any instance of plagiarism will result in serious penalties (e.g., an F grade for the entire course, among other penalties)
- Forget about doing any kind of plagiarism

Deadlines

- Strict deadlines: You will not be able to submit after the deadline has already passed.

Accessing the Course Materials

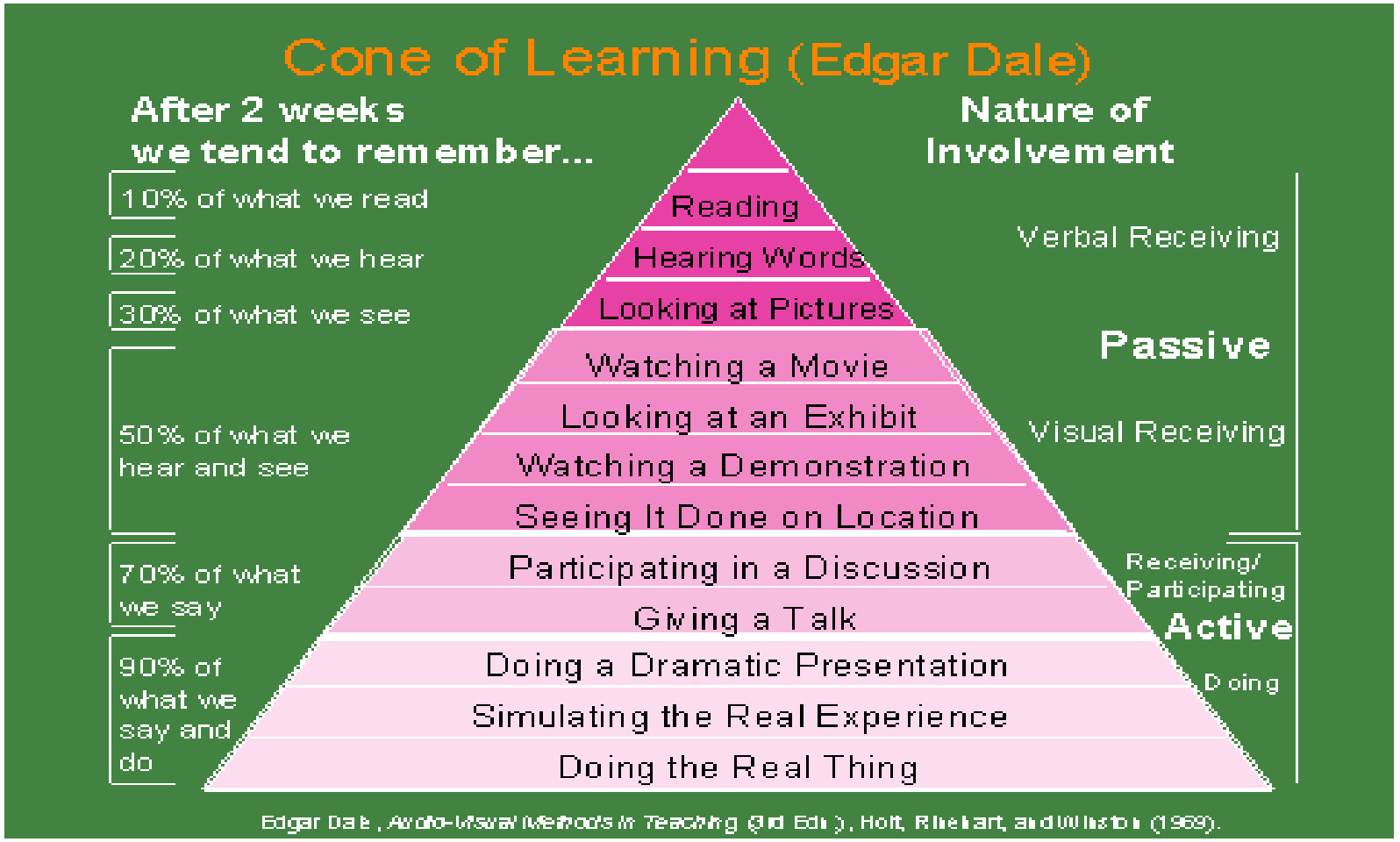
- The presentations, the materials, lab assignments are available on the course portal
  - The slides will be posted prior to each lecture (well in advance)
  - Please ensure that you download the slides & go through them before attending the given lecture
  - Pls. access the course portal regularly
- All students should procure two books, as soon as possible
  - Silberschatz, A, Galvin, P, Gagne, G. Operating System Concepts, Addison-Wesley (8^{th} or latest edition).
  - Computer Networks (5th Edition) Andrew S. Tanenbaum, David J. Wetherall Prentice Hall.

Asking Questions

- Theory and lab related questions can be asked through the course portal
  - It is better, because all other students can gain the related knowledge
  - Try to ask as many subject/lab questions as possible.
  - Do not hesitate to ask silly/simple questions regarding lab or theory
    - And try to get the problem resolved as soon as possible

Maximize the benefit from the course

- In the course, we are going study about how a wonderful artifact is being built through the efforts of thousands of researchers
  - Operating system has become part and parcel of every tool
    - Microsoft windows has **50 million** lines of code.
- Focus on a thorough understanding of the concepts, not on memorizing
  - Understand every sentence of the book



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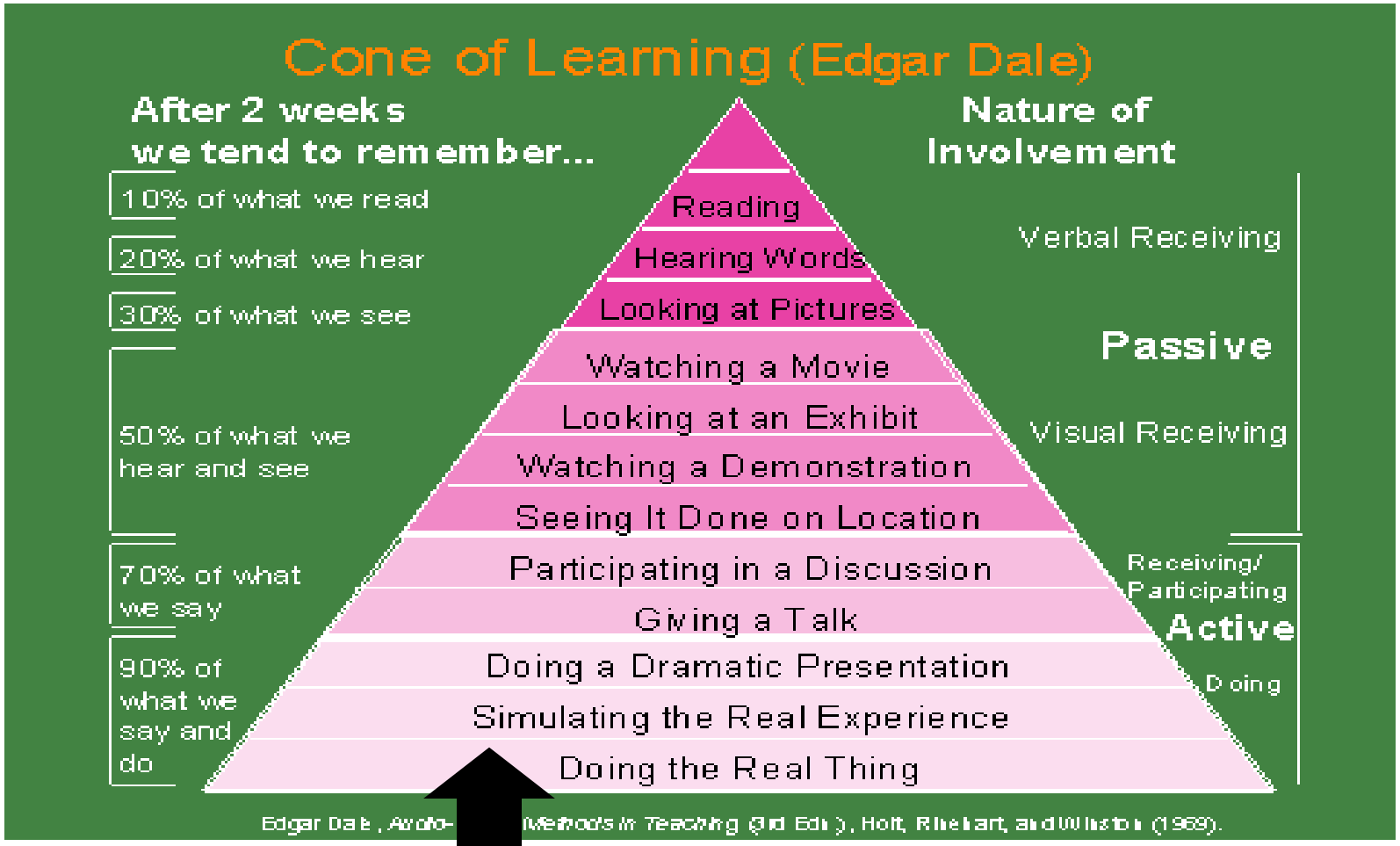

Bottomline: Do the assignments sincerely because it will facilitate you in **INTERNALIZING** the ideas/techniques you learnt in this course.

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