

**California State University, Sacramento
Computer Science Department**

**CSc 131
Computer Software Engineering**

Fall 2022

Lecture # 3

**Requirement Engineering &
Analysis Modeling**

Requirements Analysis

- ❑ Two types of analysis methods:
 - Structured Analysis
 - Object-Oriented Analysis
- ❑ Each method has techniques for representing
 - Data
 - Processing/Function
 - Control/Behavior

Each technique/notation is used to model one or more type of information

Analysis Models: Three Primary Objectives

- ❑ Describe customer's needs and requirements.
- ❑ Establish a foundation for the creation of design.
- ❑ Define a set of requirements that can be validated once the software is developed.

Structured Analysis

- ❑ Primarily represents information flow
- ❑ Includes information processing model
- ❑ Hierarchical approach
 - Level 0, Level 1, Level 2 ... N

Three Primary Models (views)


Data
Model

Functional
Model

Behavioral
Model

Data Modeling?

- ❑ Examines data objects independently of processing.
- ❑ Focuses attention on the data domain
- ❑ Creates a model at the customer's level of abstraction.
- ❑ Indicates how data objects relate to one another.



Data Modeling and Entity Relationship Diagram (ERD)

ERD

An Entity Relationship Diagram (ERD) is a **snapshot of data structures**. ERDs show entities in the system and relationships between these entities within the system.

What is a Data Object?

Object-something that is described by set of attributes (Data Items) and that will be manipulated within the software (System).

- Each instance of an object (e.g. a book) can be identified uniquely (e.g. ISBN#)
- Each plays a necessary role in the system i.e., system could not function without access to instance of the object.
- Each is described by attributes that are themselves data items.

Typical Objects- examples

External entities	Things	Occurrences	Roles	Organizational	Places	Structures
<ul style="list-style-type: none">• printer• user• sensor	<ul style="list-style-type: none">• Reports• displays• Signals	<ul style="list-style-type: none">• Interrupt• Alarm	<ul style="list-style-type: none">• manager• engineer• salesperson	<ul style="list-style-type: none">• division• team	<ul style="list-style-type: none">• manufacturing floor	<ul style="list-style-type: none">• employee record

Data Objects and Attributes

- A data object contains a set of attributes that act as an aspect, quality, characteristic, or descriptor of the object.

Object: automobile

Attributes:

Make

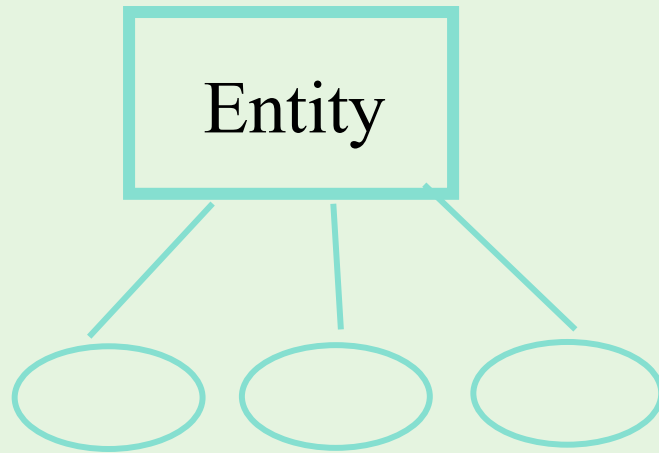
Model

Body type

Price

Options code

Entity-Relationship Diagram (ERD)



- ❑ Data object
- ❑ Attributes associated with connected entity
- ❑ Relationship between entities



What is a Relationship?

Relationship - indicates “**connectedness**”;
a "**fact**" that must be "**remembered**"
by the system and cannot or is not computed
or derived mechanically.

- several instances of a relationship can exist
- objects can be related in many different ways

ERD Notation

One common form:



Cardinality

- ❑ Cardinality: number of occurrences
- ❑ The maximum number of objects that participate in a relationship...
- ❑ One – One (1:1) I----- I
- ❑ One- Many (1:N) I----- <
- ❑ Many – Many (M:N) >----- <

Modality

- ❑ Modality is either 0 or 1
- ❑ Modality is 0 if there is no explicit need for the relationship to occur or the relationship is optional.
- ❑ The Modality is 1 if an occurrence of the relationship is mandatory.



Functional Model: Creating A Flow Model

Functional Model

Focuses on the functionality and flow of information in the system.

Functional Model

Data Flow Diagram (Model)

Data Flow Diagram (DFD):

- DFDs show the flow of data from external entities into the system, also show how the data moves from one process to another, as well as its logical storage.

Data Flow Diagrams

External Entity

- ❑ Producer/Consumer of information outside the bounds of the system

Process

- ❑ Transformer of information

Data Item

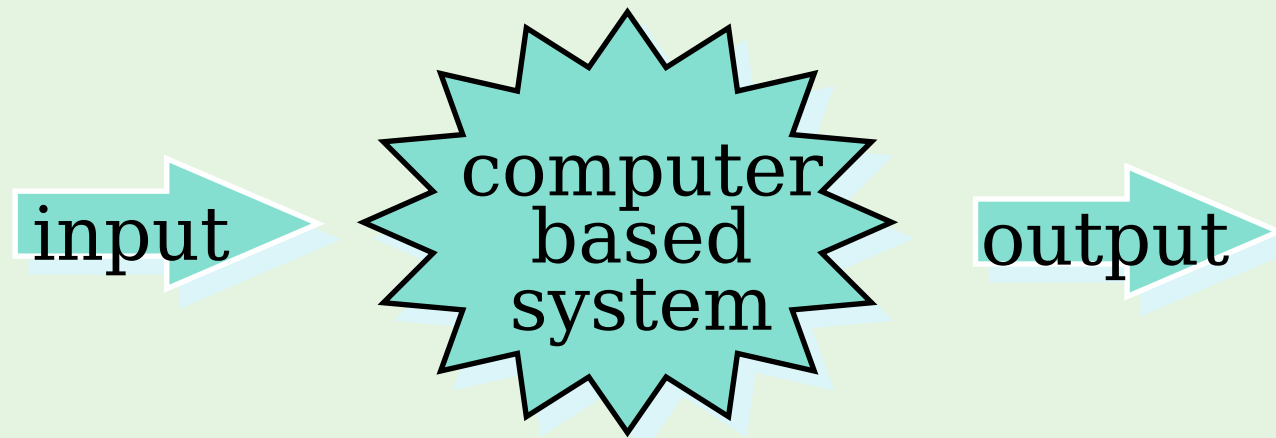
- ❑ Data item or collection of data items

Data Store

- ❑ Repository of data stored for one or more processes

The Flow Model

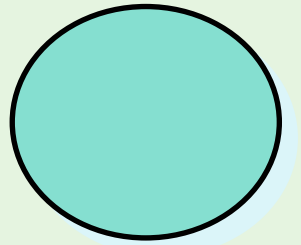
- Every computer-based system is an information transform



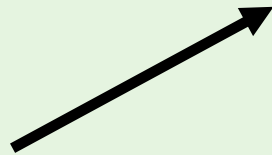
Flow Modeling Notation



External Entity



Process



Data Flow



Data Store

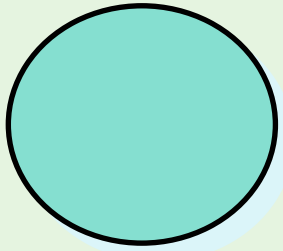
External Entity



A producer or consumer of data

- ❑ Examples: a person, a device, a sensor
- ❑ Another example: computer-based system
- ❑ Data must always originate from somewhere and must always be sent to something

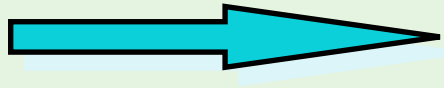
Process



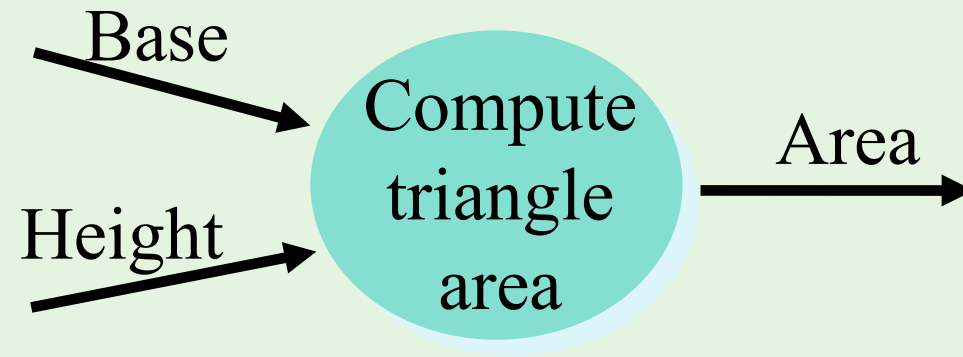
A data transformer (changes input to output)

- ❑ Examples: compute taxes, determine area, format report, display graph
- ❑ Data must always be processed in some way to achieve system function

Data Flow

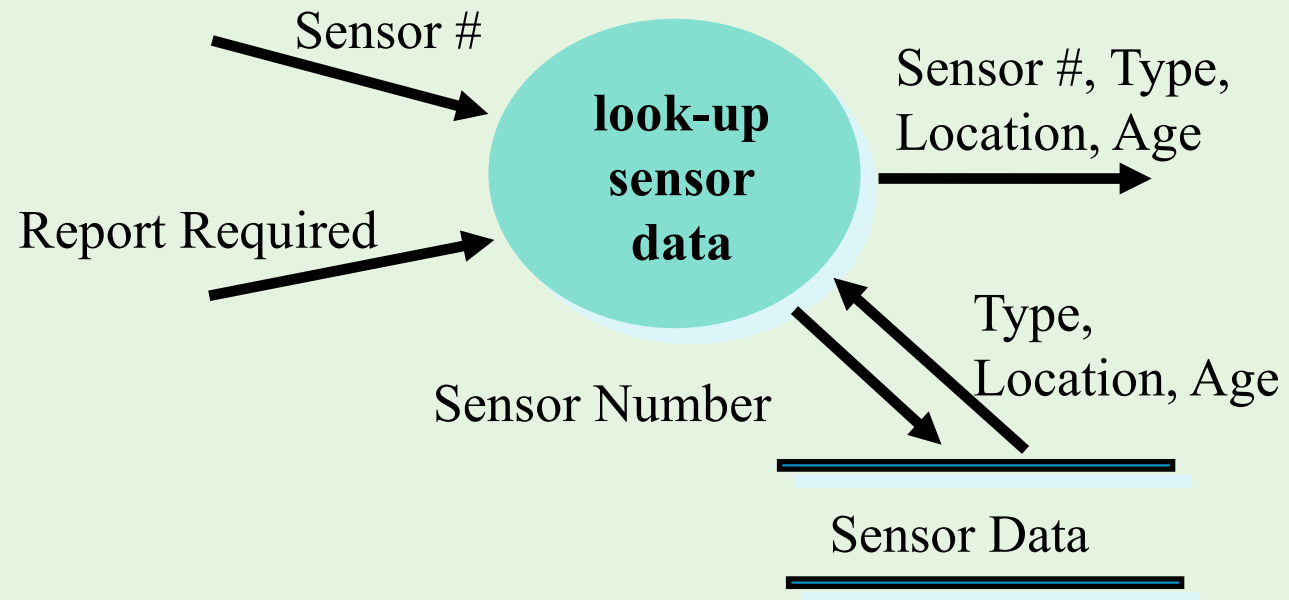


Data flows through a system, beginning as input and be transformed into output.



Data Stores

Data is often stored for later use.



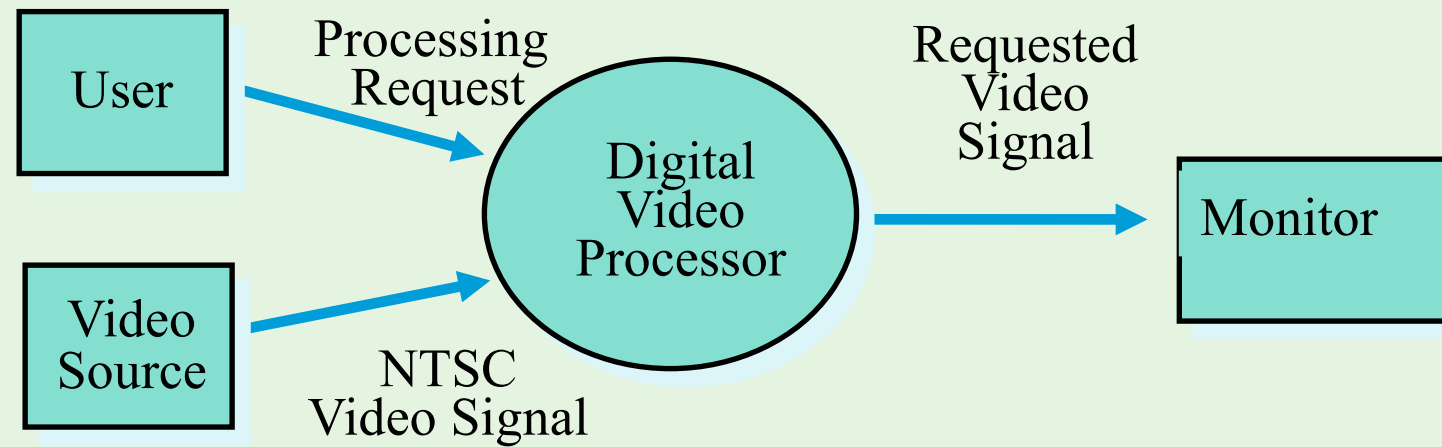
Data Flow Diagramming: Guidelines

- ❑ All icons must be labeled with meaningful names
- ❑ The DFD evolves through a number of levels of detail
- ❑ Always begin with a context level diagram
- ❑ Always show external entities at level 0
- ❑ Always label data flow arrows
- ❑ Do not represent procedural logic

Constructing a DFD—I

- ❑ Review ERD to isolate data objects and grammatical parse to determine “operations”
- ❑ Determine external entities (producers and consumers of data)
- ❑ Create a level 0 DFD

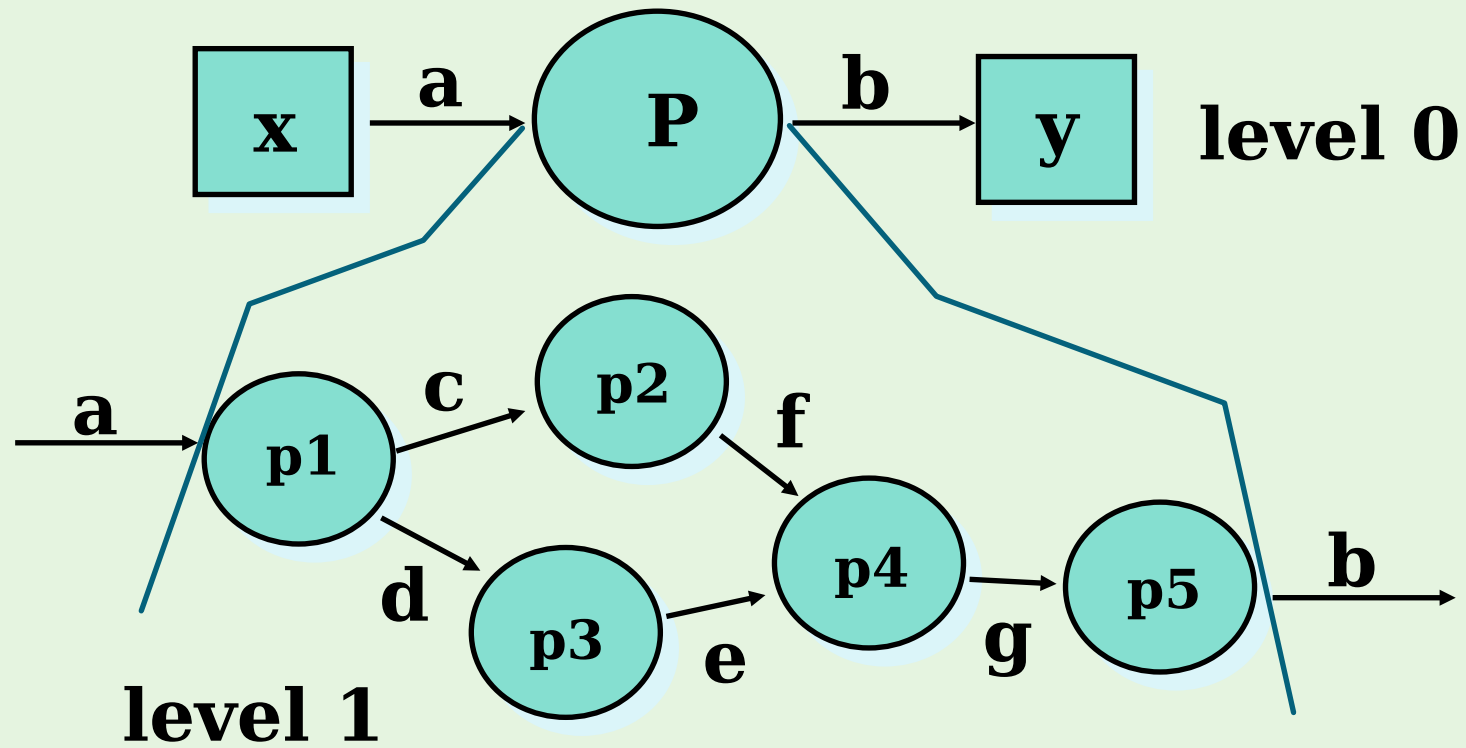
SCD



Constructing a DFD

- ☐ Write a narrative describing the transform
- ☐ Parse to determine next level transforms
- ☐ “Balance” the flow to maintain data flow continuity
- ☐ Develop a level 1 DFD

The Data Flow Hierarchy



DFD Flow Modeling Notes

- ❑ Each bubble is refined until it does just one thing
- ❑ A single data flow item (arrow) may be expanded as levels increase (data dictionary provides information)
- ❑ What is the content of data implied by the arrow or contained in data store?
 - Data Dictionary is the answer

A Process Specification (PSPEC)

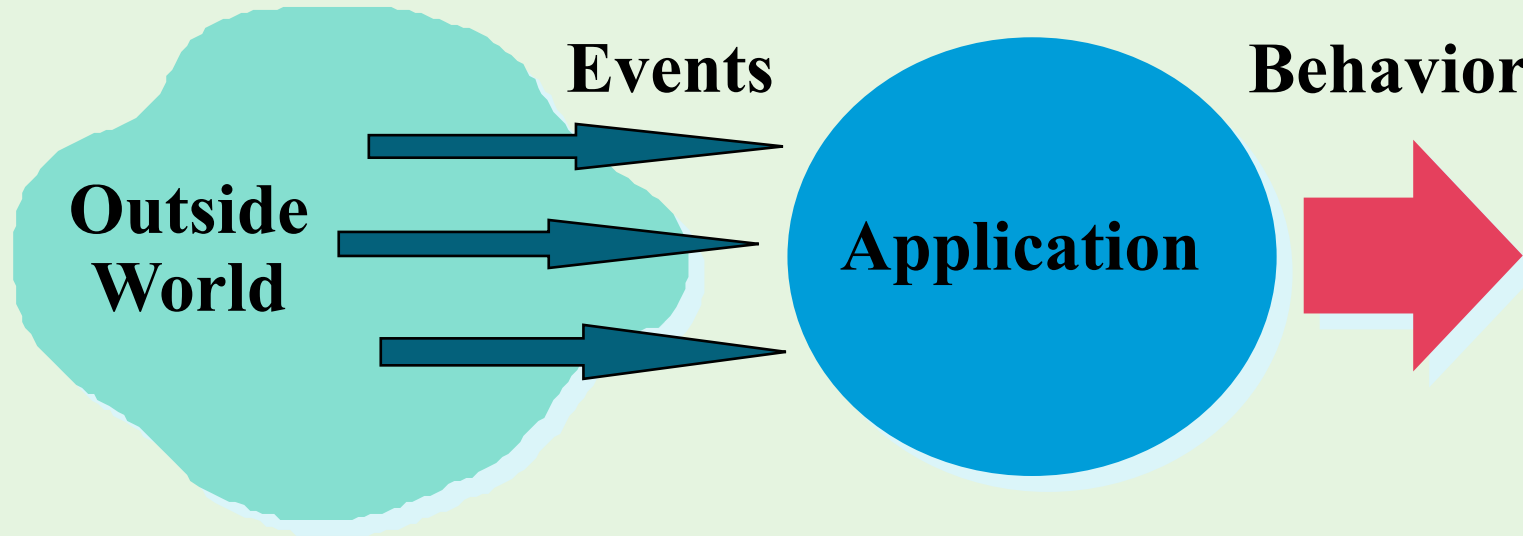
It is a descriptive text that is used to:

- ☐ Specify the processing details implied by the different bubbles within the DFD.
- ☐ Describe the input to a function.
- ☐ Describe the algorithm that is used.
- ☐ Describe the output that is produced.



Behavioral Modeling and Control Specification

Behavioral Modeling



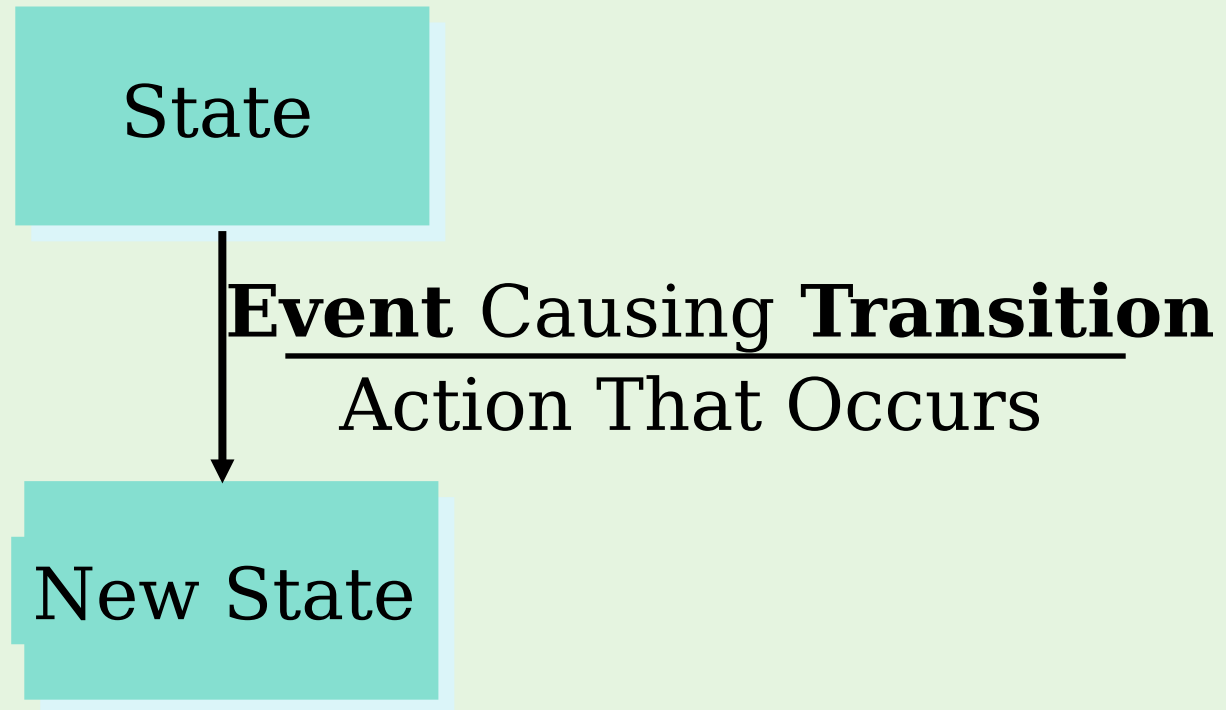
The States of a System

- ❑ State—a set of observable circumstances that characterizes the behavior of a system at a given time.
- ❑ State transition—the movement from one state to another.
- ❑ Event—an occurrence that causes the system to exhibit some predictable form of behavior.
- ❑ Action—process that occurs as a consequence of making a transition.

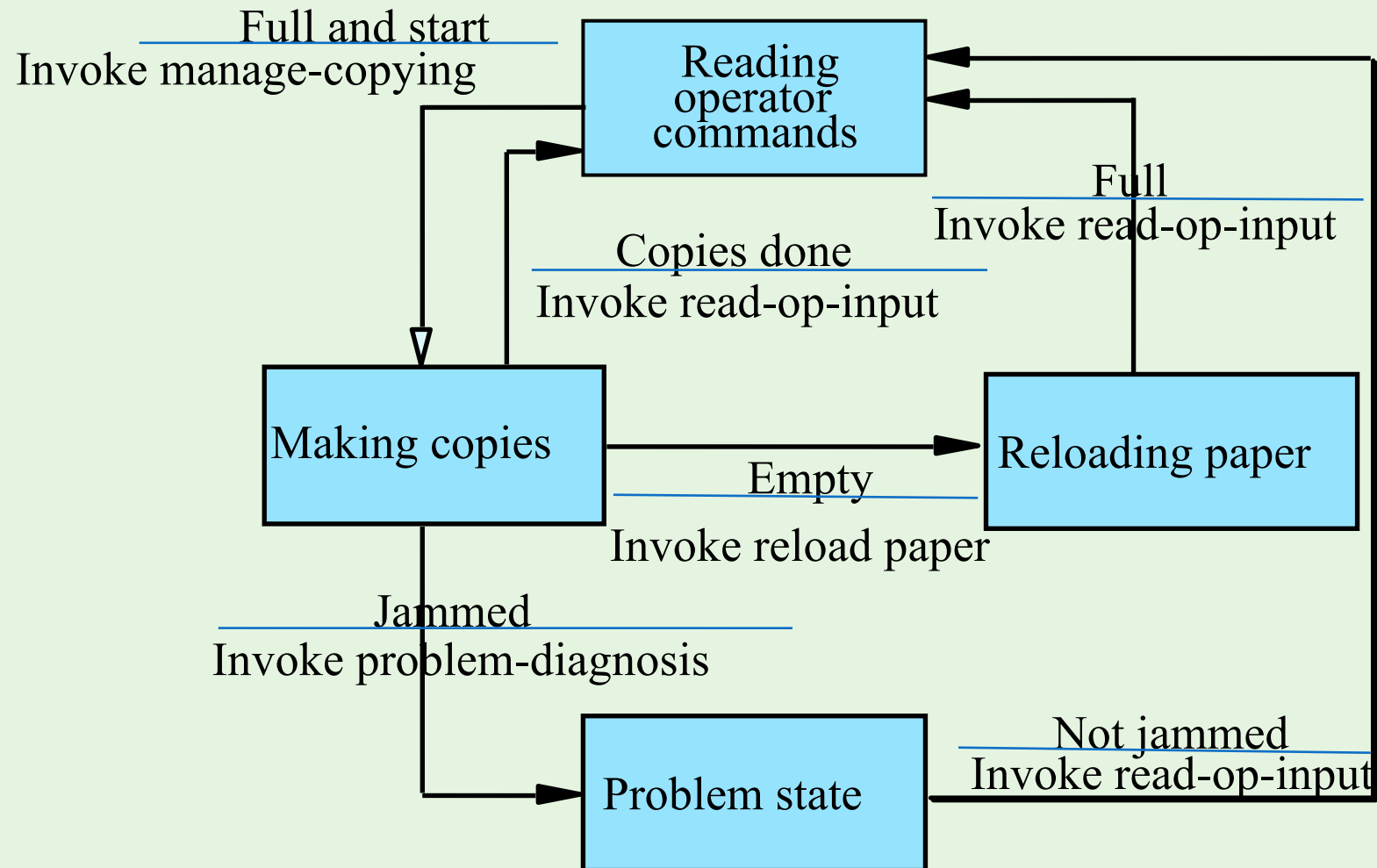
Behavioral Modeling

- ❑ Make a list of the different states of a system (How does the system behave?)
- ❑ Indicate how the system makes a transition from one state to another (how does the system change state?)
 - Indicate event
 - Indicate action
- ❑ Draw a state transition diagram

State Transition Diagram Notation



State Transition Diagram



The Data Dictionary

- ❑ A notation for describing control data and the values that control data can take, e.g., "on," or "off"
- ❑ A repository that also contains "where-used" / "how used" information

Building a Data Dictionary

Name:	the primary name of the composite data item
Aliases:	other names for the data item
Where used:	data transforms (processes) that use the composite data item
How used:	the role of the data item (input, output, temporary storage, etc.
Description:	a notation for representing content (presented on next slide)
Format:	specific information about data types, pre-set values (if known)

Analysis Modeling: Where to Begin?

- The statement of scope must be “parsed” to extract data, function and behavioral domain information

Identifying Objects and Operations

- ❑ Define “objects” by underlining all nouns in the written statement of scope
 - Producers/consumers of data
 - Places where data are stored
 - “Composite” data items

- ❑ Define “operations” by double underlining all active verbs
 - Processes relevant to the application
 - Data transformations

- ❑ Consider other “services” that will be required by the objects

Questions...

What is next?

- *More on Analysis Models: ERD, DFD, STD*
- *UML models*