# Software Engineering

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## System Modeling

**(Structure and Behavior)**

Chapter 5

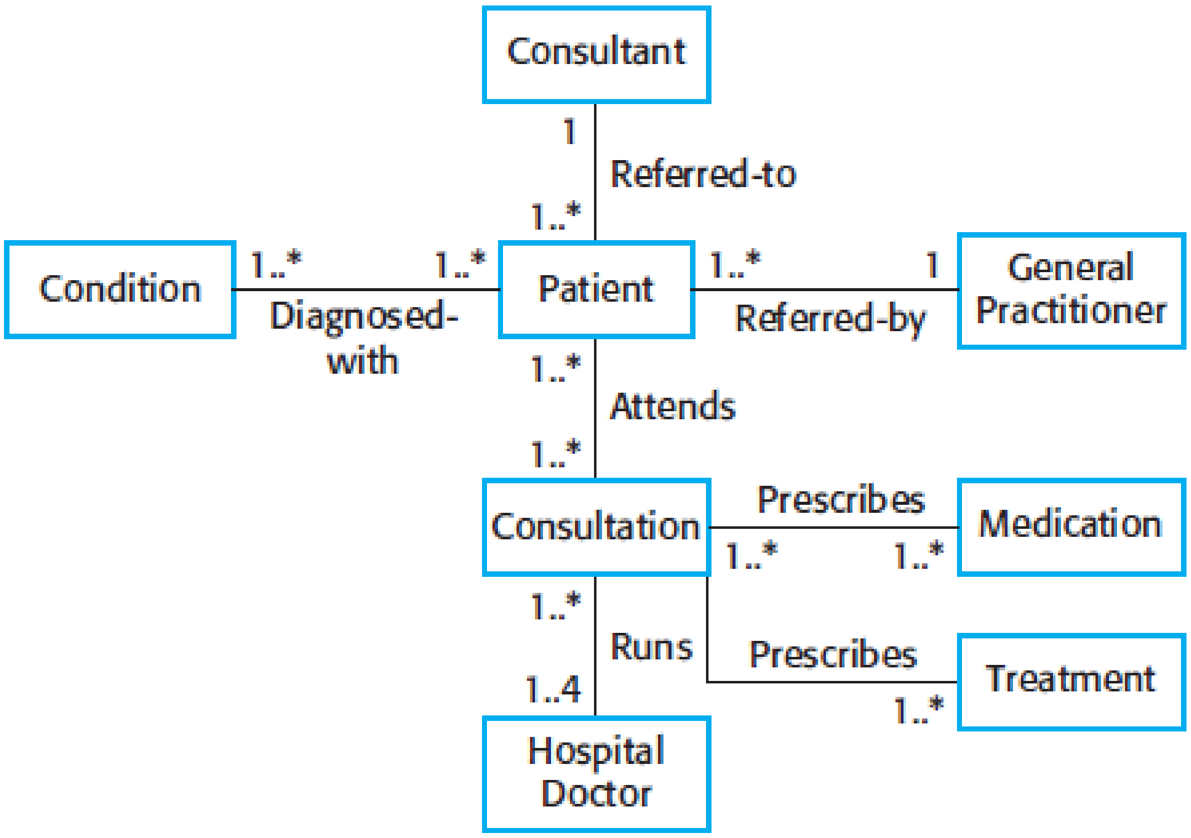
# Structural models

- Structural models of software display the organization of a system in terms of the components that make up that system and their relationships.
- Structural models may be static models, which show the structure of the system design, or dynamic models, which show the organization of the system when it is executing.
- You create structural models of a system when you are discussing and designing the system architecture.

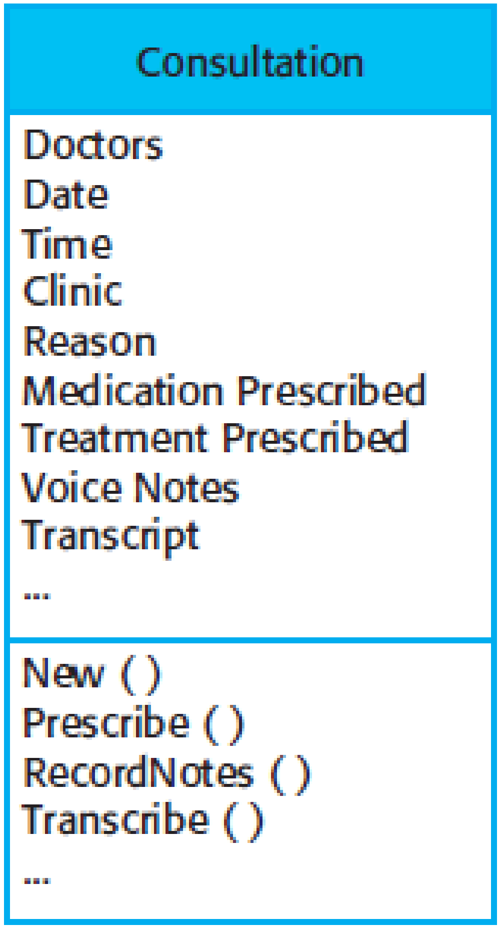
# Class diagrams

- Class diagrams are used when developing an object-oriented system model to show the classes in a system and the associations between these classes.
- An object class can be thought of as a general definition of one kind of system object.
- An association is a link between classes that indicates that there is some relationship between these classes.
- When you are developing models during the early stages of the software engineering process, objects represent something in the real world, such as a patient, a prescription, doctor, etc.

# Classes and associations



# The Consultation class



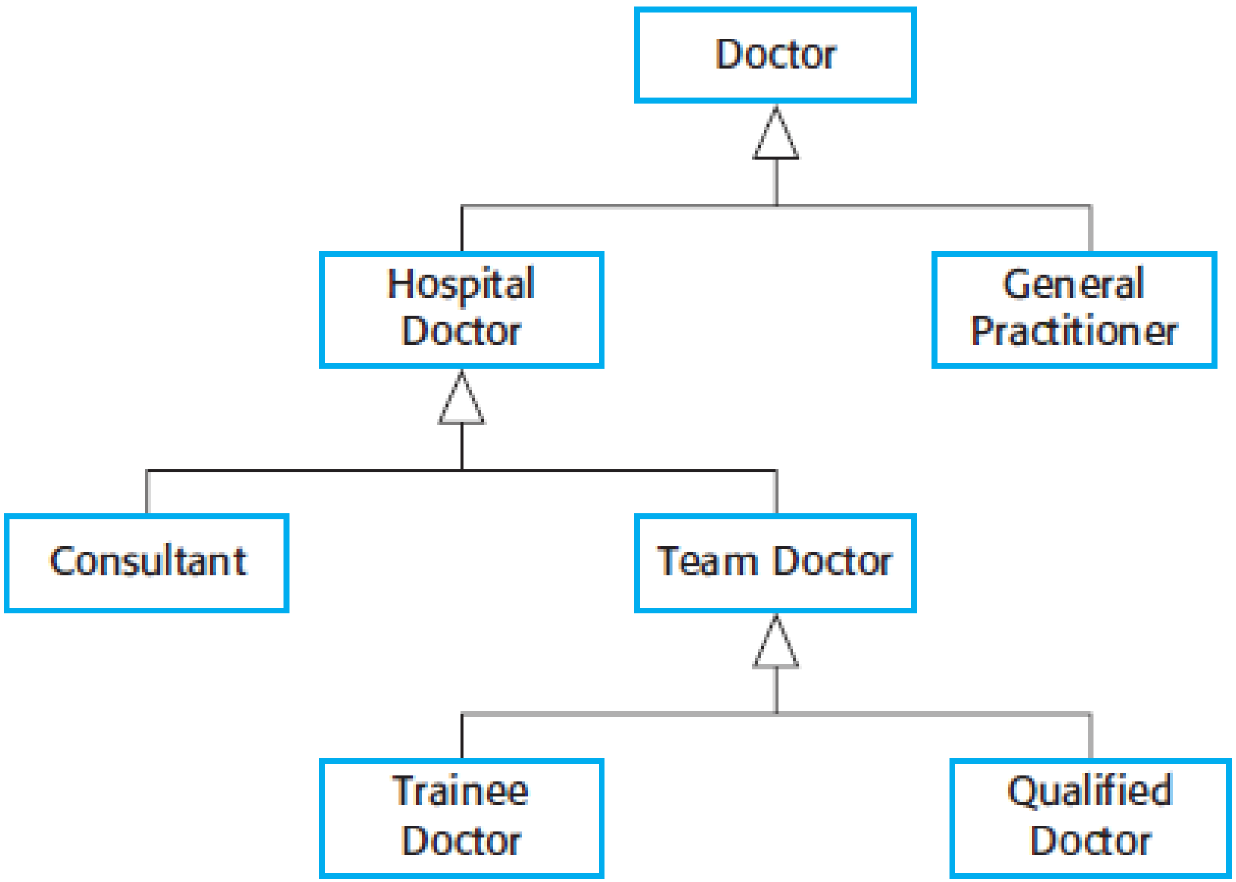

Patient object class will have the attribute Address and you may include an operation called ChangeAddress, which is called when a patient indicates that they have moved from one address to another.

Model it?

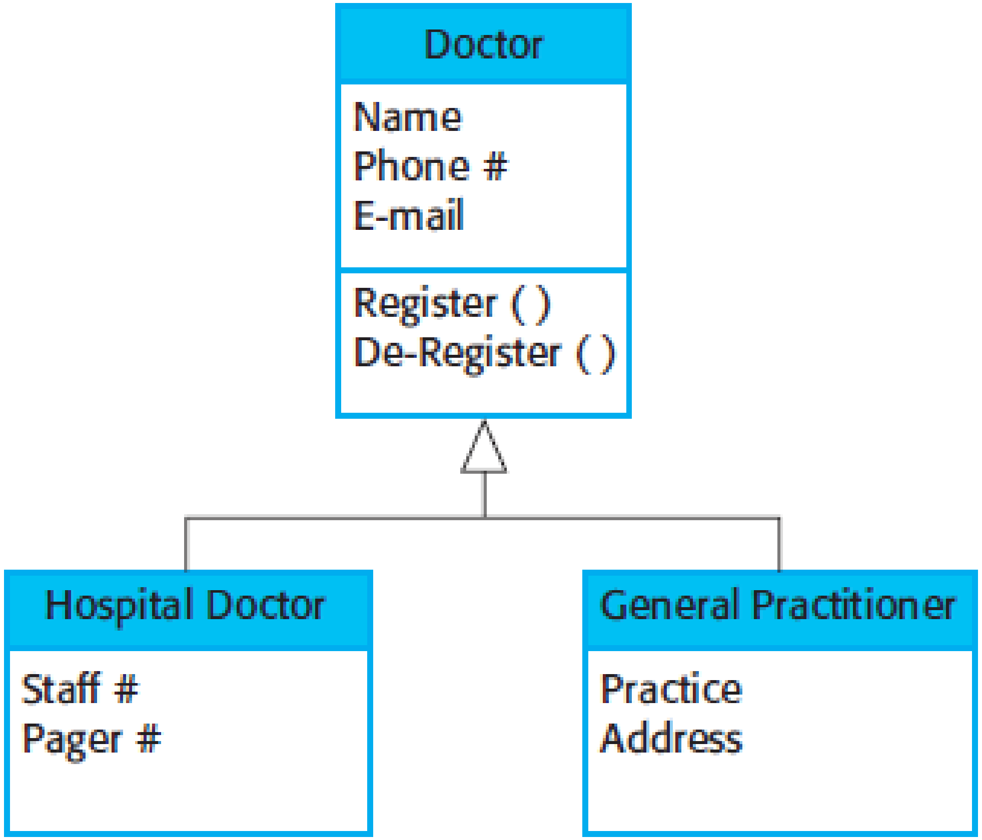
# Generalization (Inheritance)

- Generalization is an everyday technique that we use to manage complexity.
- Rather than learn the detailed characteristics of every entity that we experience, we place these entities in more general classes (animals, cars, houses, etc.) and learn the characteristics of these classes.
- This allows us to infer that different members of these classes have some common characteristics e.g. squirrels and rats are rodents.

# A generalization hierarchy



# A generalization hierarchy with added details



# Behavioral models

- Behavioral models are models of the dynamic behavior of a system as it is executing. They show what happens or what is supposed to happen when a system responds to a stimulus from its environment.
- You can think of these stimuli as being of two types:
  - Data Some data arrives that has to be processed by the system.
  - Events Some event happens that triggers system processing. Events may have associated data, although this is not always the case.

# Data-driven modeling

- Many business systems are data-processing systems that are primarily driven by data. They are controlled by the data input to the system, with relatively little external event processing.
- Data-driven models show the sequence of actions involved in processing input data and generating an associated output.
- They are particularly useful during the analysis of requirements as they can be used to show end-to-end processing in a system.

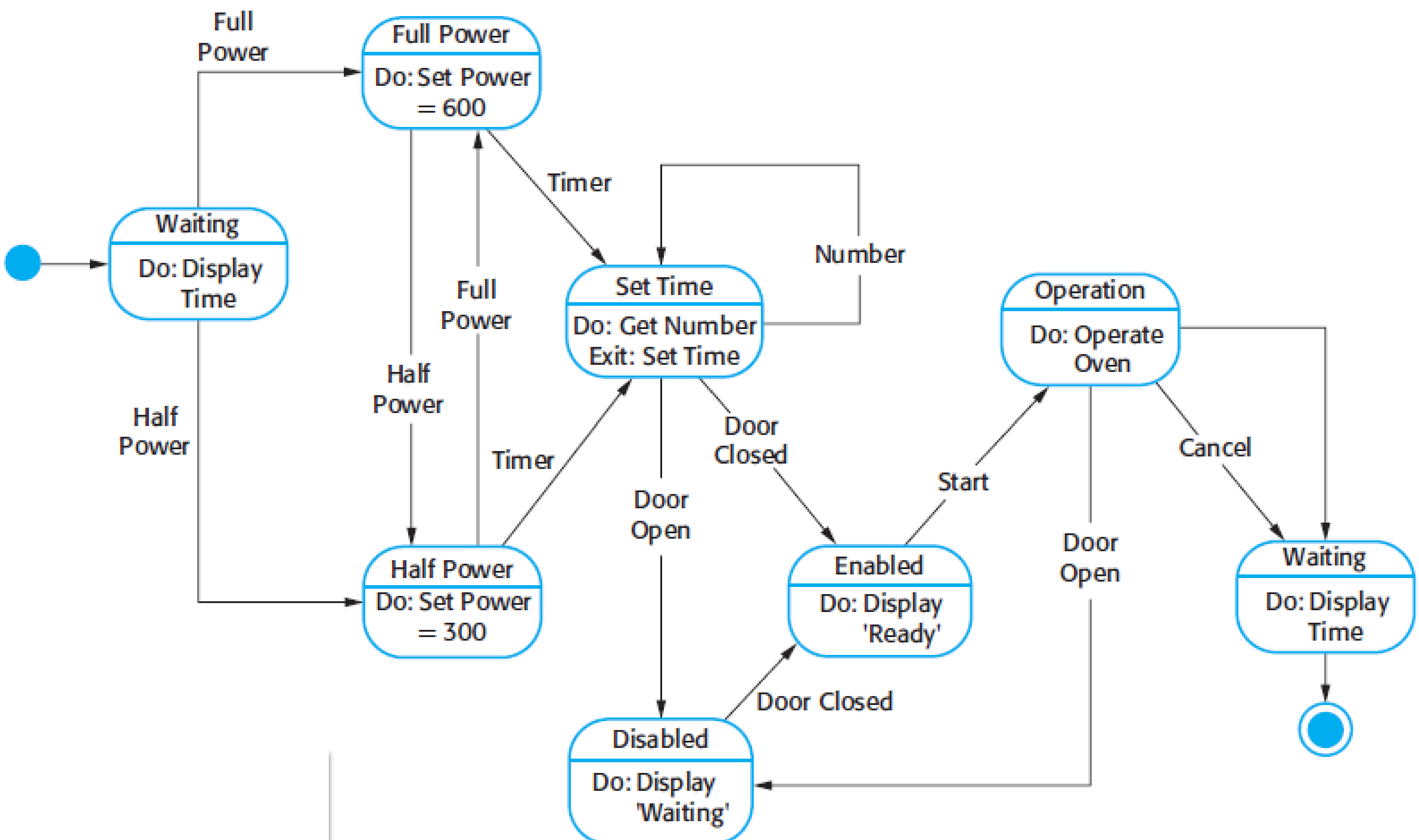
# Event-driven modeling

- Real-time systems are often event-driven, with minimal data processing.
- Event-driven modeling shows how a system responds to external and internal events.
- It is based on the assumption that a system has a finite number of states and that events (stimuli) may cause a transition from one state to another.

# State machine models

- State machine models show system states as nodes and events as arcs between these nodes. When an event occurs, the system moves from one state to another.

# State diagram of a microwave oven



# States and stimuli for the microwave oven (a)

| State | Description |
|---|---|
| Waiting | The oven is waiting for input. The display shows the current time. |
| Half power | The oven power is set to 300 watts. The display shows ‘Half power’. |
| Full power | The oven power is set to 600 watts. The display shows ‘Full power’. |
| Set time | The cooking time is set to the user’s input value. The display shows the cooking time selected and is updated as the time is set. |
| Disabled | Oven operation is disabled for safety. Interior oven light is on. Display shows ‘Not ready’. |
| Enabled | Oven operation is enabled. Interior oven light is off. Display shows ‘Ready to cook’. |
| Operation | Oven in operation. Interior oven light is on. Display shows the timer countdown. On completion of cooking, the buzzer is sounded for five seconds. Oven light is on. Display shows ‘Cooking complete’ while buzzer is sounding. |

# States and stimuli for the microwave oven (b)

| Stimulus | Description |
|---|---|
| Half power | The user has pressed the half-power button. |
| Full power | The user has pressed the full-power button. |
| Timer | The user has pressed one of the timer buttons. |
| Number | The user has pressed a numeric key. |
| Door open | The oven door switch is not closed. |
| Door closed | The oven door switch is closed. |
| Start | The user has pressed the Start button. |
| Cancel | The user has pressed the Cancel button. |

# Microwave oven operation