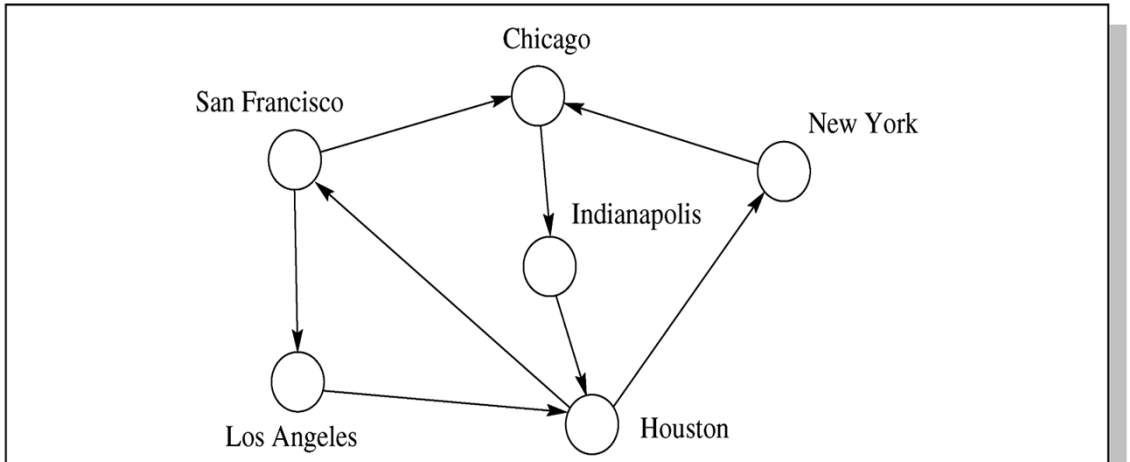
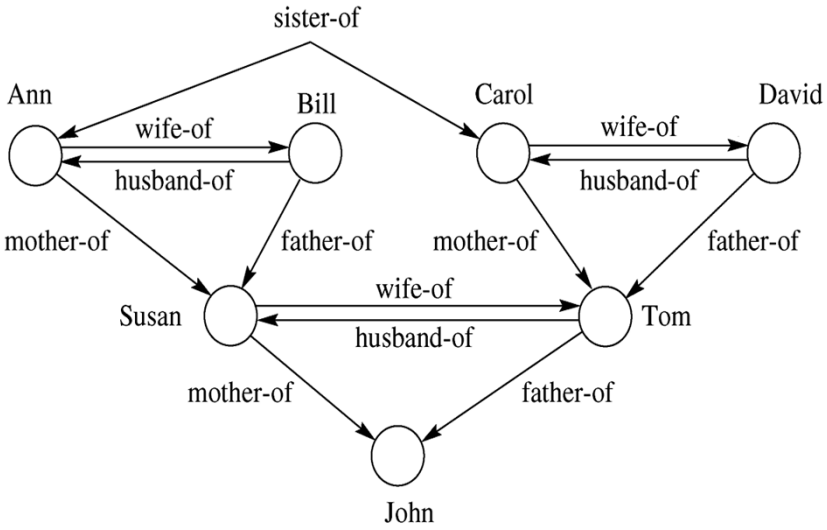
Semantic Nets and Frames

Semantic Nets

- A semantic network
  - a classic AI representation technique used for propositional information
  - a propositional net
- A proposition
  - a statement that is either true or false
- A semantic net
  - a labeled, directed graph
- The structure of a semantic net is shown graphically in terms of nodes and the arcs connecting them.
  - Nodes are sometimes referred to as objects
  - arcs as links or edges
  - The links are used to express relationships
  - Nodes are to represent physical objects, concepts, or situation



(a) A General Net

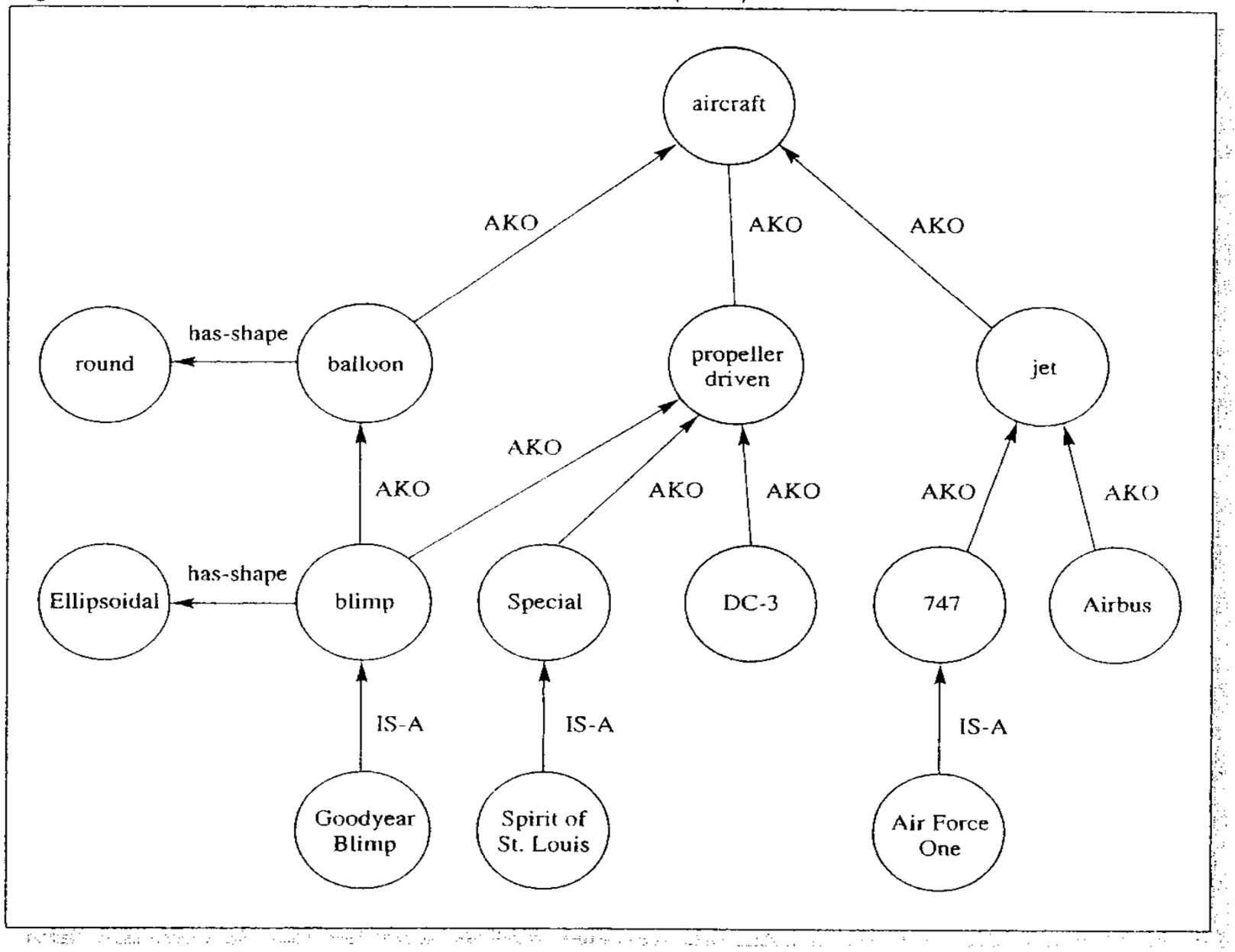


(b) A Semantic Net

Semantic Nets

- Two types of commonly used links are
  - IS-A, and
  - A-KIND-OF
- IS-A means "is an instance of' and refers to a specific member of a class
  - A class is related to the mathematical concept of a set in that it refers to a group of objects
  - For example,
    - {3, eggs, blue, tires, art}

Figure 2.5 A Semantic Net with IS-A and A-Kind-Of (AKO) Links



Semantic Nets

- The link AKO is used here to relate one class to another
  - AKO relates generic nodes to generic nodes while the IS-A relates an instance or individual to a generic class
  - The more general class that an AKO arrow points to is called a superclass
  - AKO points from a subclass to a class
- The objects in a class have one or more attributes in common
  - Each attribute has a value
  - The combination of attribute and value is a property
  - For example, a blimp has attributes of size, weight, shape, and color. The value of the shape attribute is ellipsoidal

Schemata

- Semantic nets have limitations
  - such as the lack of link name standard
- In AI, the term schema (plural schemas or schemata) is used to describe a more complex knowledge structure than the semantic net
  - For example, the acts of eating and drinking are pleasurable sensorimotor schemata that involve coordinating information from the senses with the required motor (muscle) movements to eat and drink
- Another type of schema is the concept schema by which we represent concepts.
  - For example,
    - we all have stereotypes in our minds of concepts
    - a stereotype of an animal might be a dog to many people

Schemata

- A conceptual schema is an abstraction in which specific objects are classified by their general properties
  - The conceptual schema of a real apple will include general properties of apples such as sizes, colors. tastes, uses, and so forth
- Schemas have internal structure to their nodes while semantic nets do not

Frames

- One type of schema that has been used in many AI applications is the frame
- Another type of schema is the script,
  - a time-ordered sequence of frames
- frames are useful for simulating commonsense knowledge, which is a very difficult area for computers to master
- While semantic nets are basically a two-dimensional representation of knowledge, frames add a third dimension by allowing nodes to have structures

Frames

- The basic characteristic of a frame is that it represents related knowledge about a narrow subject that has much default knowledge
- A frame system would be a good choice for describing a mechanical device, for example a car
- The frame contrasts with the semantic net, which is generally used for broad knowledge representation
- Just as with semantic nets, there are no standards for defining frame-based systems
- A frame is analogous to a record structure, corresponding to the fields and values of a record are the slots and slot fillers of a frame
- A frame is basically a group of slots and fillers that defines a stereotypical object

Frames

- The car is the object, the slot name is the attribute, and the filler is the value

Slots	Fillers
manufacturer	General Motors
model	Chevrolet Caprice
year	1979
transmission	automatic
engine	gasoline
tires	4
color	blue

Frames

- By using frames in the filler slots and inheritance, very powerful knowledge representation systems can be built.
- frame-based expert systems are very useful for representing causal knowledge because their information is organized by cause and effect
- Frames are generally designed to represent either generic or specific knowledge
- The slots may also contain procedures attached to the slots, called procedural attachments
  - The if-needed type is executed when a filler value is needed but none are initially present or the default value is not suitable
    - Defaults are often used to represent commonsense knowledge

Frames

Figure 2.9 A Generic Frame for Property

Slots	Fillers
name	property
specialization_of	a_kind_of object
types	(car, boat, house) if-added: Procedure ADD_PROPERTY
owner	default: government if-needed: Procedure FIND_OWNER
location	(home, work, mobile)
status	(missing, poor, good)
under_warranty	(yes, no)

Frames

- The if-added type is run for procedures to be executed when a value is to be added to a slot
- An if-removal type is run whenever a value is to be removed from a slot

- Slot fillers may also contain relations,

  e.g. a-kind-of and is-a relations

  - Figure 2.11 is a specific frame because it is an instance of the car frame

Frames

Figure 2.10 Car Frame—A Generic Subframe of Property

Slots	Fillers
name	car
specialization_of	a-kind-of property
types	(sedan, sports, convertible)
manufacturer	(GM, Ford, Toyota)
location	mobile
wheels	4
transmission	(manual, automatic)
engine	(gasoline, hybrid gas/electric)

Frames

Figure 2.11 An Instance of a Car Frame

Slots	Fillers
name	John's car
specialization_of	is_a car
manufacturer	GM
owner	John Doe
transmission	automatic
engine	gasoline
status	good
under_warranty	yes

Frames

- Frame systems are designed so that more generic frames are at the top of the hierarchy
- Frames attempt to model real-world objects by using generic knowledge for the majority of an object's attributes and specific knowledge for special cases
- The object that has all of the typical characteristics is called a prototype
- Frames may also be classified by their applications
  - A situational frame contains knowledge about what to expect in a given situation
  - An action frame contains slots that specify the actions to be performed in a given situation
  - The combination of situational and action frames can be used to describe cause-and-effect relationships in the form of causal knowledge frames