Semantic Nets, Petri Nets, Frames

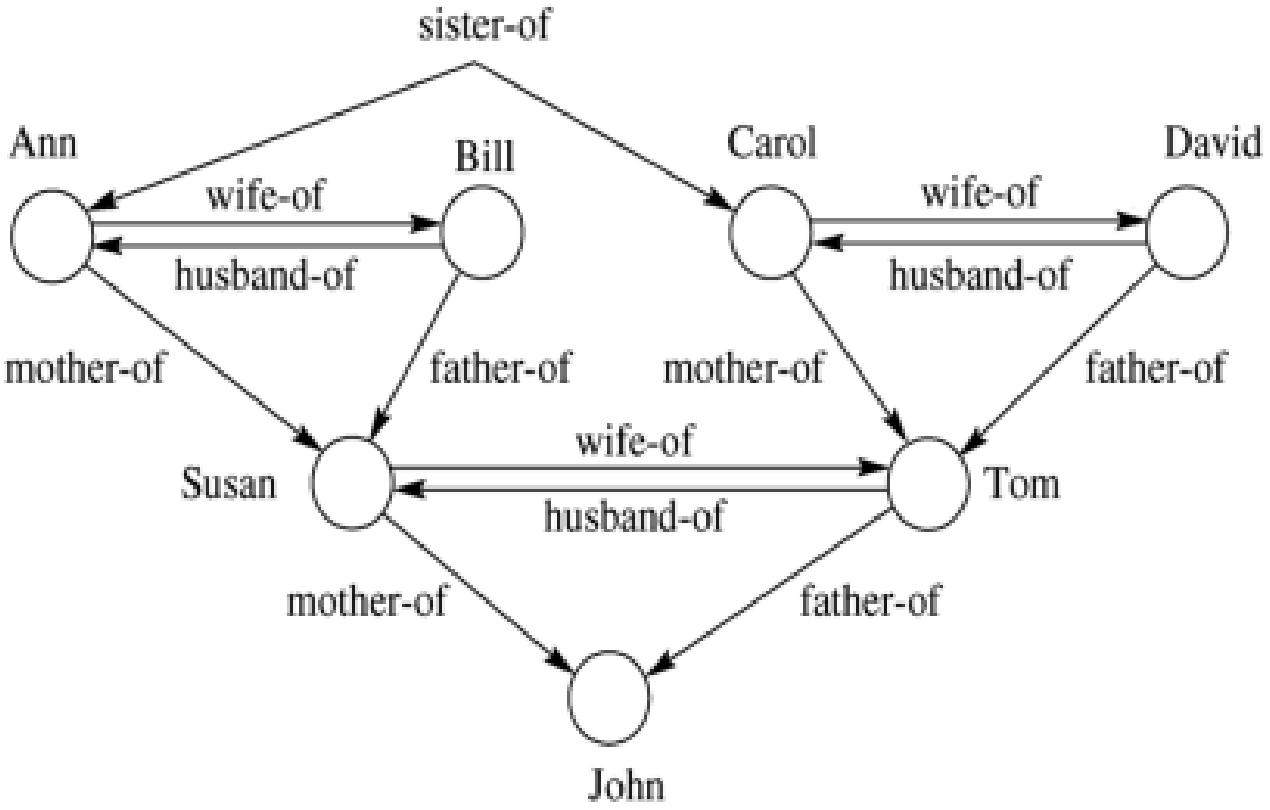
Mahit Kumar Paul
Assistant Professor, Dept. of CSE
RUET, Rajshahi-6204

mahit.cse@gmail.com

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

Semantic Nets (Contd.)



(b) A Semantic Net

Types of Links in 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}

Types of Links in Semantic Nets (Contd.)

- 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

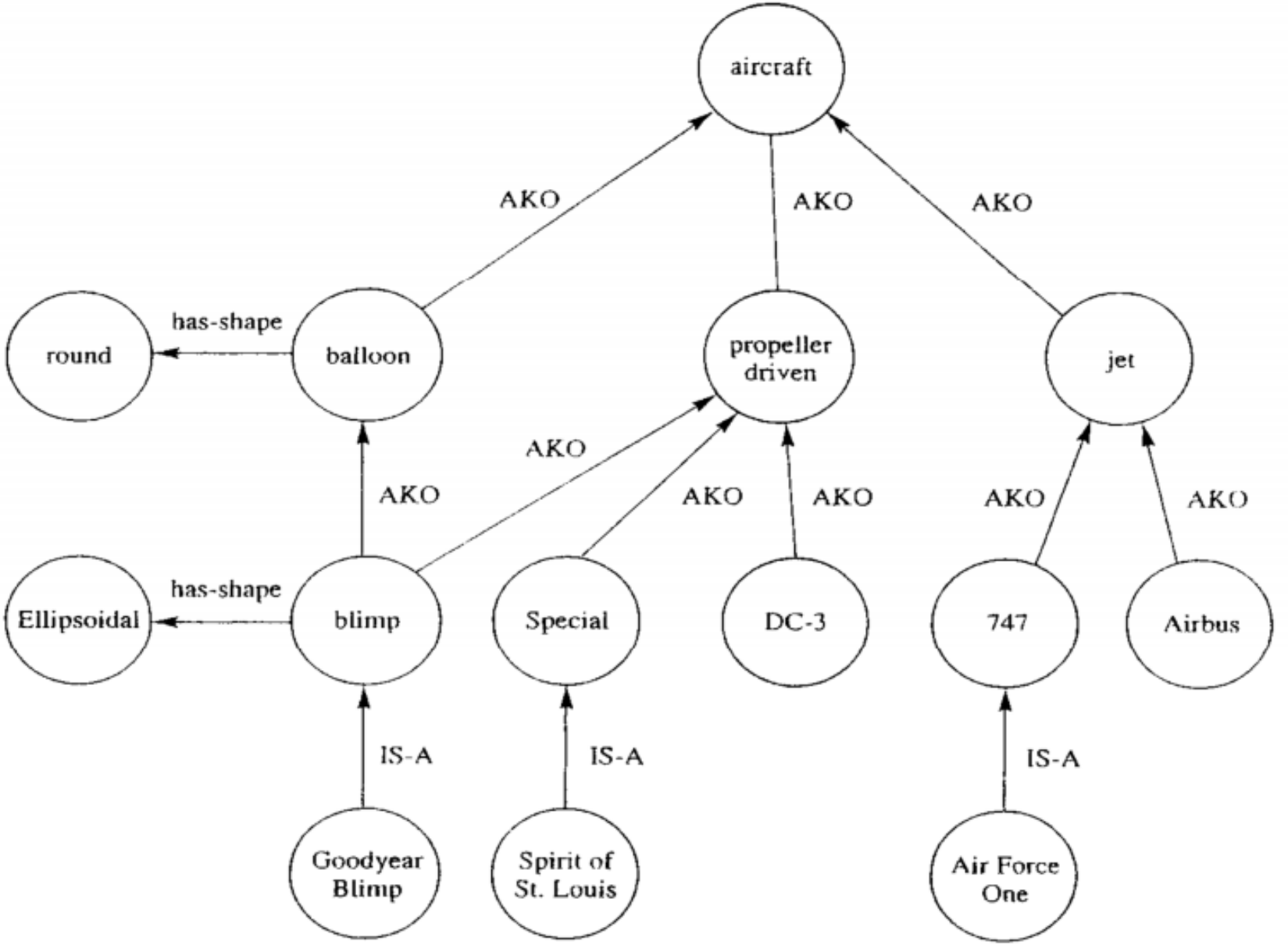


Fig 01: A semantic Net with IS-A and A-KIND-OF (AKO) Links

Frames

- Frames – semantic net with properties
- A frame represents an entity as a set of slots (attributes) and associated values
- A frame can represent a specific entry, or a general concept
- Frames are implicitly associated with one another because the value of a slot can be another frame

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 (Contd.)

- 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 (Contd.)

- 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 (Contd.)

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)

Fig 02: A generic frame for property

Frames (Contd.)

- 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,

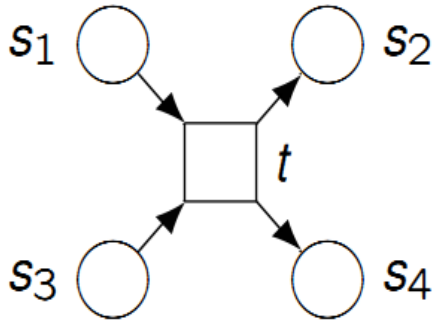
  e.g. a-kind-of and is-a relations

Frames (Contd.)

- 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

Petri Nets

Petri nets are a basic model of parallel and distributed systems (named after Carl Adam Petri). The basic idea is to describe state changes in a system with transitions.



Petri nets contain places ○ and transitions □ that may be connected by directed arcs.

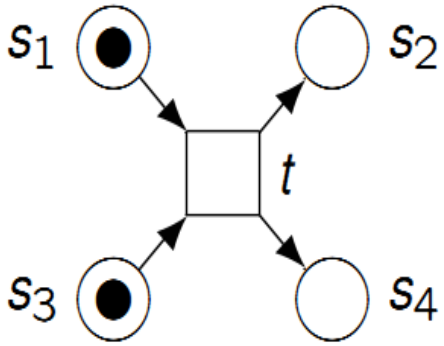
Places symbolise states, conditions, or resources that need to be met/be available before an action can be carried out.

Transitions symbolise actions.

Behavior of Petri Nets

Places may contain tokens that may move to other places by executing ("firing") actions.

A token on a place means that the corresponding condition is fulfilled or that a resource is available:



In the example, transition t may "fire" if there are tokens on places s_1 and s_3. Firing t will remove those tokens and place new tokens on s_2 and s_4.

Why Petri Nets?

low-level model for concurrent systems

expressly models concurrency, conflict, causality, . . .

finite-state or infinite-state models

Content:

Semantics of Petri nets

Modelling with Petri nets

Analysis methods: finite/infinite-state case, structural analysis

Remark: Many variants of Petri nets exist in the literature; we regard a special simple case also called P/T nets.

Petri Nets Representation

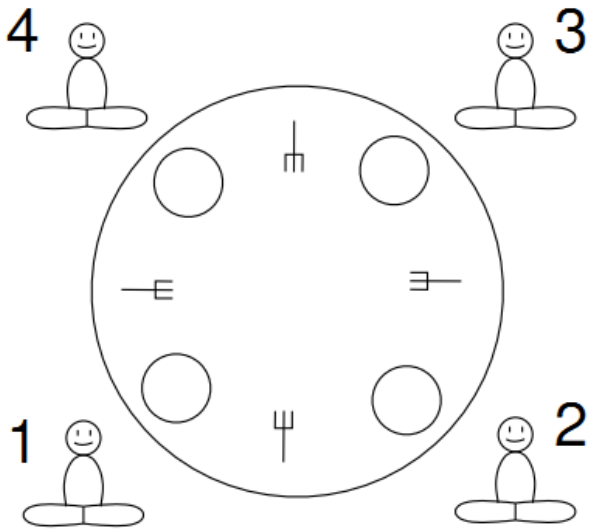
A Petri net is a tuple $N = \langle P, T, F, W, m_0 \rangle$, where

- P is a finite set of places,
- T is a finite set of transitions,
- the places P and transitions T are disjoint ($P \cap T = \emptyset$),
- $F \subseteq (P \times T) \cup (T \times P)$ is the flow relation,
- $W : ((P \times T) \cup (T \times P)) \to \mathbb{N}$ is the arc weight mapping (where $W(f) = 0$ for all $f \notin F$, and $W(f) > 0$ for all $f \in F$), and
- $m_0 : P \to \mathbb{N}$ is the initial marking representing the initial distribution of tokens.

Example: Dining Philosophers

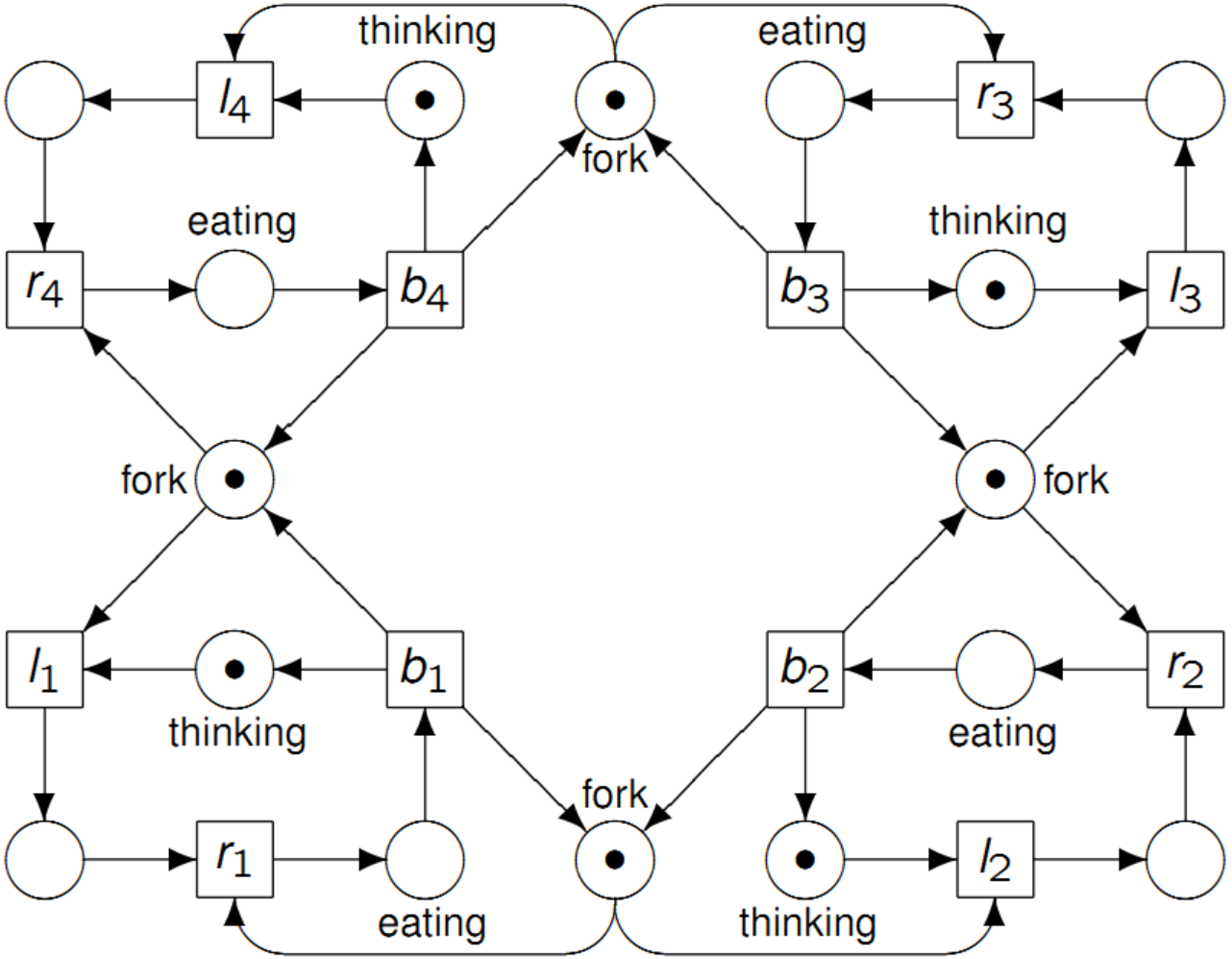
There are philosophers sitting around a round table.

There are forks on the table, one between each pair of philosophers.



The philosophers want to eat spaghetti from a large bowl in the center of the table.

Dining Philosophers (Petri Net)



Thank You