REPRESENTATION AND REASONING

- Propositional logic
- Predicate calculus
- Other representations

Why study representation?

- Search is not enough
- Intelligent behavior requires a lot of varied knowledge
- Much knowledge is qualitative and general
- How can a computer represent & use it?
- AI system = Knowledge base + Inference engine

Logics

- Representation = Syntax + Semantics + Inference system
- Analogy: Algebra
- Formula = Symbolic expression
- Well-formed formula (wff) = Syntactically correct formula
- Formal language = Set of wffs
- Model: Are formulas true or false in the world?
- Expressiveness-tractability tradeoff

Other methods

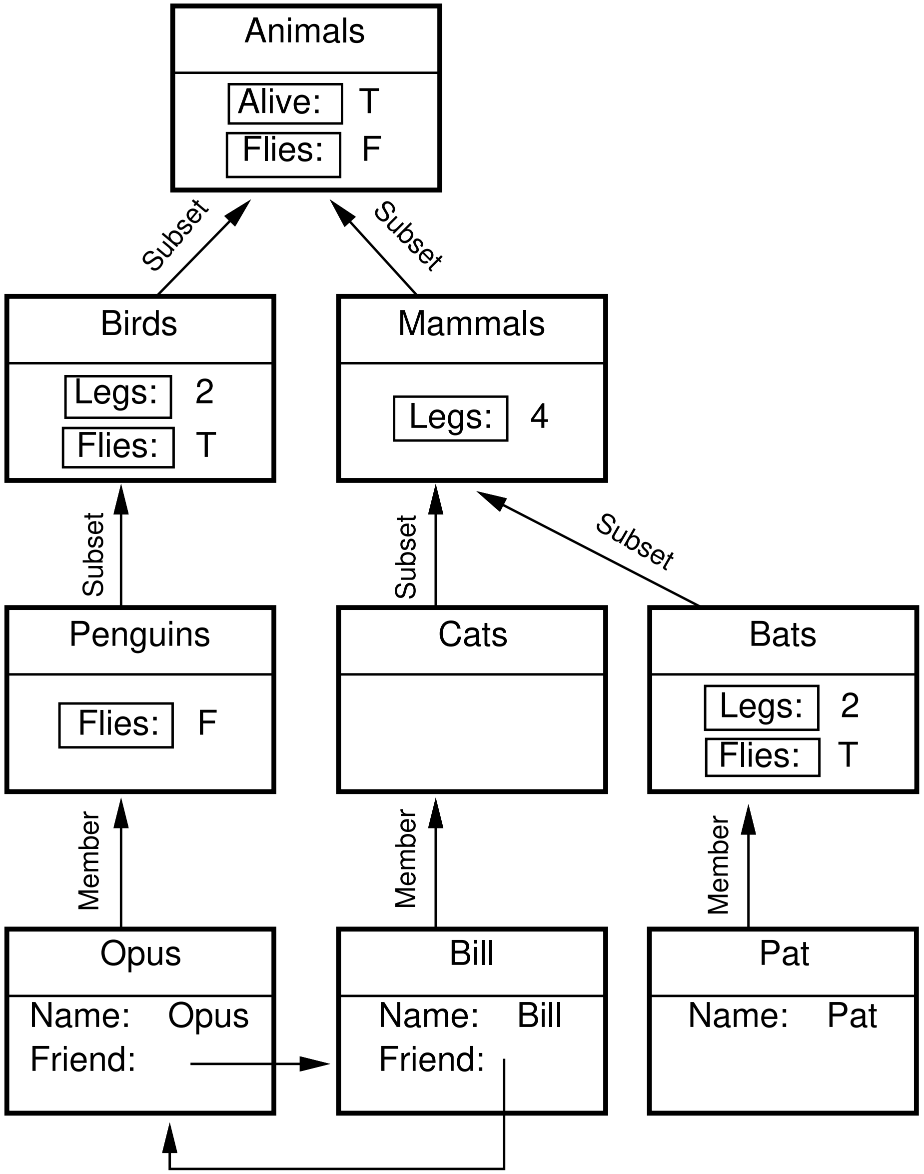
- Production systems
- Frames and semantic networks
- Concept description languages
- Nonmonotonic reasoning
- Abductive reasoning
- Etc.

Production systems

- Working memory and rule memory
- Production rules: Consequents are actions
- Forward chaining
- Match phase and conflict resolution phase
- Rete algorithm for efficient inference

Frames and semantic networks

- **Frames**
  - Concepts = Frames
  - Properties = Slots
- **Semantic nets**
  - Concepts = Nodes
  - Relations = Arcs
- **Inference:** Inheritance, procedural attachment, etc.



(a) A frame-based knowledge base

Rel(Alive,Animals,T)
Rel(Flies,Animals,F)

Birds $\subset$ Animals
Mammals $\subset$ Animals

Rel(Flies,Birds,T)
Rel(Legs,Birds,2)
Rel(Legs,Mammals,4)

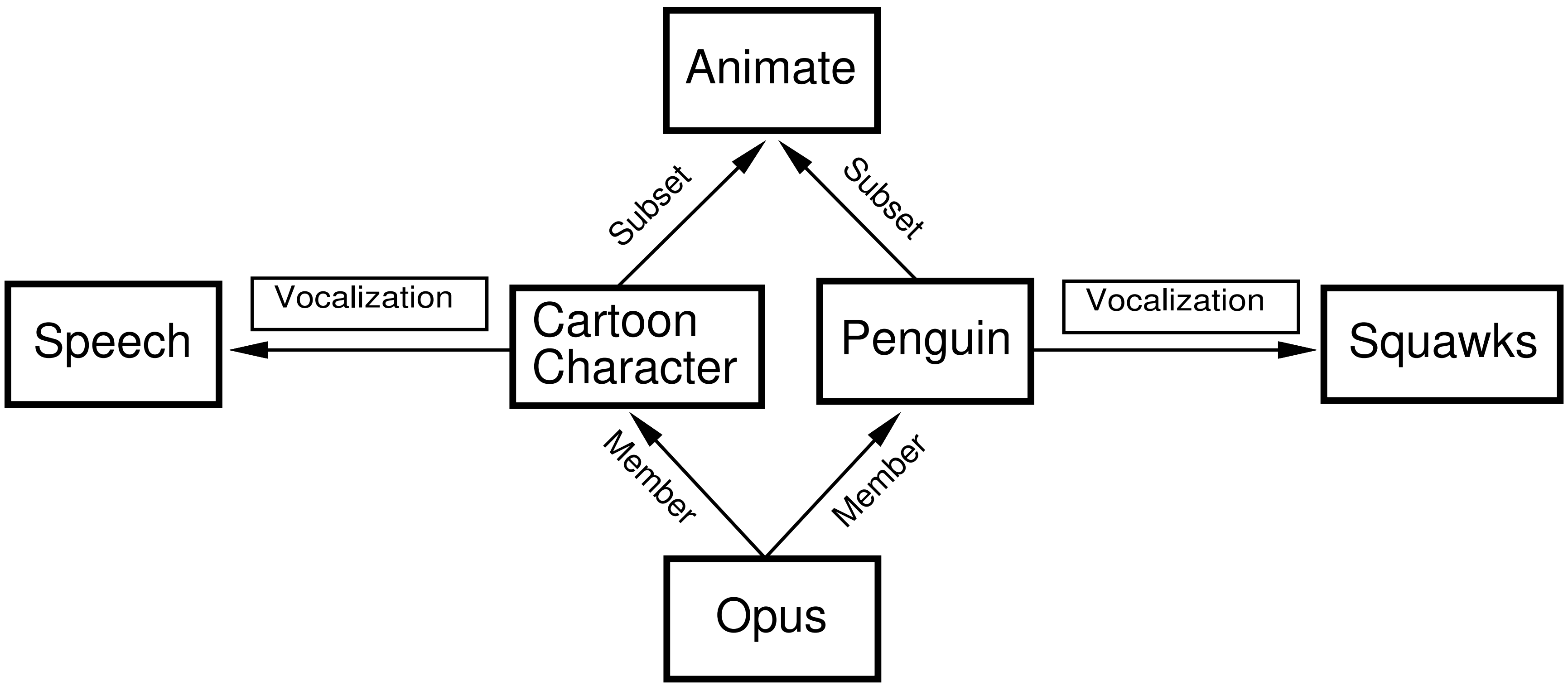
Penguins $\subset$ Birds
Cats $\subset$ Mammals
Bats $\subset$ Mammals

Rel(Flies,Penguins,F)
Rel(Legs,Bats,2)
Rel(Flies,Bats,T)

Opus $\in$ Penguins
Bill $\in$ Cats
Pat $\in$ Bats

Name(Opus,"Opus")
Name(Bill,"Bill")
Friend(Opus,Bill)
Friend(Bill,Opus)
Name(Pat,"Pat")

(b) Translation into first-order logic



Animate
Subset
Subset
Speech
Vocalization
Cartoon Character
Penguin
Vocalization
Squawks
Member
Member
Opus

Concept description languages

- Also called: description logics, terminological logics
- Formalization of frames / semantic nets
- Careful treatment of expressiveness vs. tractability

Nonmonotonic reasoning

- Closed-world assumption
- Frame problem
- Qualification problem
- Infer α if consistent with KB
- New information can cause α to be retracted

Abductive reasoning

- Inverse of *modus ponens*
- E.g.:
  - From "Car doesn't start"
  - And "If battery dead, then car doesn't start"
  - Infer "Battery dead"
- Unsound but useful
- Diagnostic reasoning