Artificial Intelligence
09/16/2002

Intelligent Agent Demonstration (cont'd)

- Simulating Dynamical Features of Escape Panic: an individual-based model of panic evacuations of human crowds from rooms and corridors.
  - Explanation of escape panics by modelling the crowd dynamics of pedestrians in the spirit of self-driven many-particle systems
  - http://angel.elte.hu/~panic/
- Behavior Library for Autonomous Character Locomotion
  - This is a library of behaviours for Autonomous Character Locomotion in Director. This library should help reduce the time it takes to develop any type of character movement in games and other applications, which require an object to move about on it's own accord.
  - http://www.atomicmedia.com/autonomous/
  - http://www.crash.de/bort/shock/love.html

Intelligent Agent Demonstration (cont'd)

- Applets for Swarm, Forming Lines, Predator and Tag: The Examination and Exploration of Algorithms and Complex Behaviour to Realistically Control Multiple Mobile Robots
  - The goals of this project are to closely examine the algorithms that can control multiple mobile robots and to study the complexity of such systems.
- Steering Behaviors
  - Steering Behaviors are the next logical step in the further development of the 'boids' model created by Craig Reynolds in 1986. The 'boids' computer based model is a way to simulate the coordinated movements seen in flocks of birds or fish.
  - http://www.steeringbehaviors.de/

Intelligent Agent Demonstration (cont'd)

- **Other types:**
  - **Learning Curve: A Simulation-based Approach to Dynamic Pricing**
    - http://web.media.mit.edu/~joanie/learningcurve/
  - **Cooperating Mobile Agents for Mapping Networks**
    - http://xenia.media.mit.edu/~nelson/research/routes-coopagents/

AI=Knowledge Representation & Reasoning

- Syntax
- Semantics
- Inference Procedure
  - Algorithm
  - Sound?
  - Complete?
  - Complexity

Some KR Languages

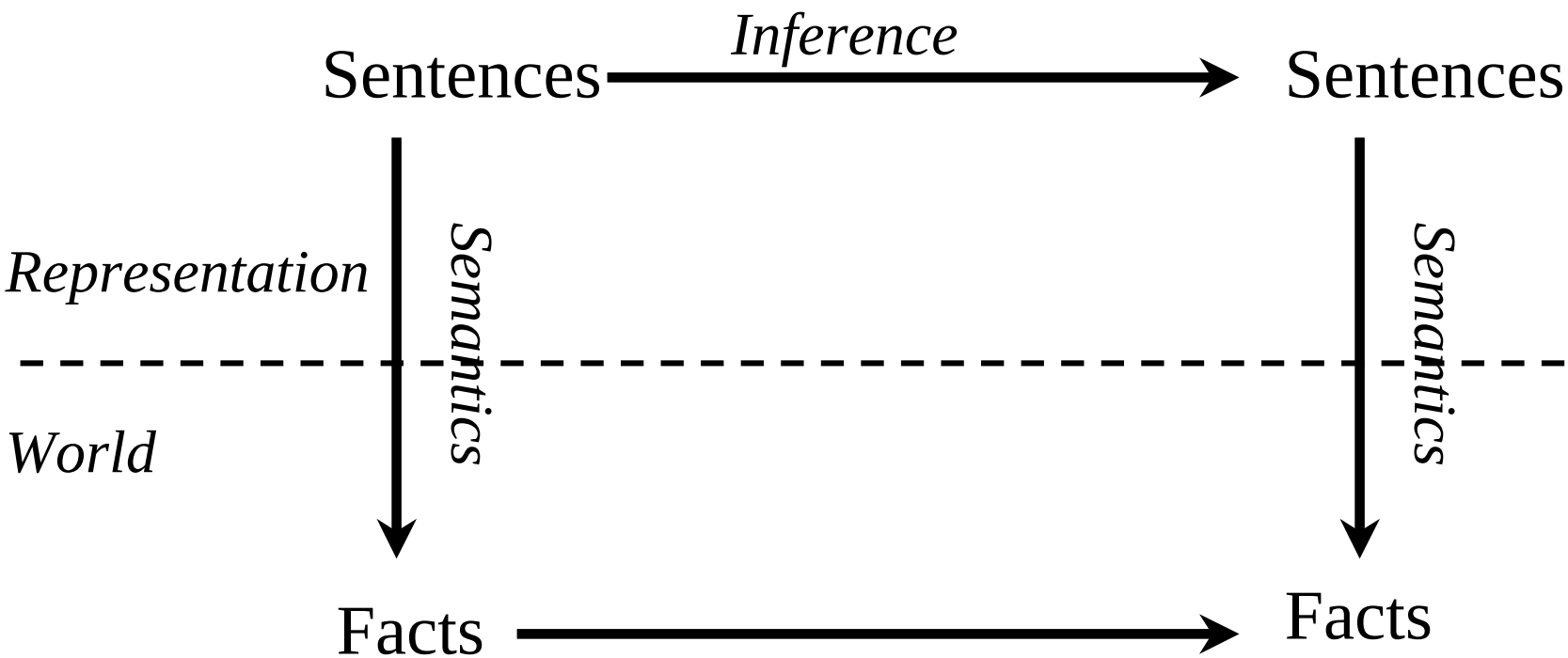
- Propositional Logic
- Predicate Calculus
- Frame Systems
- Rules with Certainty Factors
- Bayesian Belief Networks
- Influence Diagrams
- Semantic Networks
- Concept Description Languages
- Nonmonotonic Logic

Propositional Logic

- Syntax
  - Atomic sentences: P, Q, …
  - Connectives: $\wedge$, $\vee$, $\neg$, $\Rightarrow$
- Semantics
  - Truth Tables
- Inference
  - Modus Ponens
  - Resolution
  - Soundness and completeness
- Complexity issues.

Semantics

- Syntax: a description of the legal arrangements of symbols (Def "sentences")
- Semantics: what the arrangement of symbols means in the world



Propsitional Logic: Syntax

- Atoms
- Literals
- Sentences
  - Any literal is a sentence
  - If S1 and S2 are sentences, then
    - Then (S1 $\wedge$ S2) is a sentence
    - Then (S1 $\vee$ S2) is a sentence
    - Then (S1 $\Rightarrow$ S2) is a sentence
    - Then $\neg$S1 is a sentence

Propositional Logic: **SEMANTICS**

- An interpretation is an assignment to each variable either True or False.
- Assignments to compound sentences are defined by the standard truth tables:

P \ Q	T	F
T		
F		

$P \wedge Q$

P \ Q	T	F
T		
F		

$P \vee Q$

P \ Q		
T		
F		

$\neg P$

- A propositional knowledge base says which sentences must be true in the world.

Example Knowledge Base

- (Smoke $\vee$ fire) <=> Alarm
- Alarm

More Definitions

- **valid** = tautology = always true
- **satisfiable** = sometimes true
- **unsatisfiable** = never true

1) $\text{smoke} \Rightarrow \text{fire}$

2) $\text{smoke} \Rightarrow \text{smoke}$

3) $\text{smoke} \vee \text{fire} \vee \neg\text{fire}$

4) $(\text{smoke} \Rightarrow \text{fire}) \Rightarrow (\neg\text{smoke} \Rightarrow \neg\text{fire})$

Making Inferences

- A knowledge base gives us partial information about the world: it constrains the world to a set of possible truth assignments.
- By inference, we decide what else holds in all of the truth assignments allowed by the knowledge base.

Proof Procedures

- To decide whether KB $\models$ S, we can try to look for a proof of S from KB
  - KB $\models$ S means 'KB entails S'
- A proof procedure is some algorithm that we apply to a KB to produce its logical consequences.
- A proof uses:
  - the knowledge base,
  - axiom schemas
  - inference rules.

Soundness and Completeness

- KB |- S: S is provable from KB
  - KB |- S means ‘S is derived from KB’
- A proof procedure is sound if:
  - If KB |- S, then KB |= S.
  - That is, the procedure produces only correct consequences.
- A proof procedure is complete if:
  - If KB |= S, then KB |- S.
  - That is, the procedure produces all the consequences.
- Ideally, the procedure should be sound and complete. (Ideals are nice in theory).

Seven Inference Rules for Proposition Logic

Modus Ponens

- Implication-Elimination
  - From an implication and the premise of the implication, you can infer the conclusion

$$\frac{A \Rightarrow B, \qquad A}{B}$$

And-Elimination

- From a conjunction, you can infer any of the conjuncts

$$\frac{A_1 \wedge A_2 \wedge \ldots \wedge A_n}{A_i}$$

And-Introduction

- From a list of sentences, you can infer their conjuncts

$$\frac{A_1 , A_2 , \ldots , A_n}{A_1 \wedge A_2 \wedge \ldots \wedge A_n}$$

Or-Introduction

- From a sentence, you can infer its disjunction with anything else at all

$$\frac{A_i}{A_1 \vee A_2 \vee \ldots \vee A_n}$$

Double-Negation Elimination

- From a doubly negated sentence, you can infer a positive sentence

$$\frac{\neg \neg A}{A}$$

Unit Resolution

- From a disjunction, if one of the disjuncts is false, then you can infer the other one is true

$$\frac{A \vee B, \qquad \neg B}{A}$$

Resolution

- Most difficult rule. Because B cannot be both T and F, one of the other disjuncts must be true in oen of the premises.

$$\frac{A \vee B, \qquad \neg B \vee C}{A \vee C}$$

$$\frac{\neg A \Rightarrow B, \qquad B \Rightarrow C}{\neg A \Rightarrow C}$$

- $\wedge$, $\vee$, $\neg$, $\Rightarrow$