Expressing Knowledge

- *ontology* – the kinds of *objects* that will be important to the agent and the *properties* that these objects are thought of as having.
- Example: Soap Opera World

Vocabulary

named individulas

maryJones

johnQSmith

faultyInsuranceCompany

evilvilleTownCouncil

norasJacuzzi

earing35

butcherknife1

laurasMortgage

Basic Facts

$$\textsc{Man}(\textsc{john})$$

$$\textsc{Woman}(\textsc{jane})$$

$$\textsc{Company}(\textsc{faultyInsuranceCompany})$$

$$\textsc{Knife}(\textsc{butcherknife1})$$

$$\textsc{Rich}(\textsc{john})$$

$$\neg\textsc{HappilyMarried}(\textsc{jim})$$

$$\textsc{WorksFor}(\textsc{jim}, \textsc{fic})$$

$$\textsc{fic} = \textsc{faultyInsuraceCompany}$$

$$\textsc{bestFriend}(\textsc{jim}) = \textsc{john}$$

Complex Facts

$$\forall y \textsc{Rich}(y) \wedge \textsc{Man}(y) \rightarrow \textsc{Loves}(y, \textsc{jane})$$

"All the women, with the possible exception of Jane, love John."

$$\forall x, y \textsc{Loves}(x, y) \rightarrow \neg \textsc{Blackmails}(x, y)$$

$$\textsc{Loves}(\textsc{jane}, \textsc{john}) \vee \textsc{Loves}(\textsc{jane}, \textsc{jim})$$

$$\exists x \textsc{Adult}(x) \wedge \textsc{Blackmails}(x, \textsc{john})$$

Closure Sentences

$\forall x \textsc{Person}(x) \rightarrow (x = \textsc{jane} \vee x = \textsc{john} \vee x = \textsc{jim} \ldots)$

- Limit relation MarriedTo to a specific set of pairs.

- Limit the individuals that exist to 5 named individuals.

Terminological Facts

Disjointness

$$\forall x \textsc{Man}(x) \rightarrow \neg \textsc{Woman}(x)$$

Subtypes

$$\forall x \textsc{Surgeon}(x) \rightarrow \textsc{Doctor}(x)$$

Exhaustiveness

$$\forall x \textsc{Adult}(x) \rightarrow (\textsc{Man}(x) \vee Woman(x))$$

Terminological Facts (cont)

Symmetry

$$\forall x, y \textsc{MarriedTo}(x, y) \rightarrow \textsc{MarriedTo}(y, x)$$

Inverses

$$\forall x, y \textsc{ChildOf}(x, y) \rightarrow \textsc{ParentOf}(y, x)$$

Type Restrictions

$$\forall x, y \textsc{MarriedTo}(x, y) \rightarrow$$
$$(\textsc{Person}(x) \wedge \textsc{Person}(y) \wedge \textsc{OppositeSex}(x, y$$

Full Definitions

$$\forall x \textsc{RichMan}(x) \equiv \textsc{Rich}(x) \wedge \textsc{Man}(x)$$

Entailments/Questions

$$\exists x \textsc{Company}(x) \wedge \textsc{Loves}(\textsc{ceoOf}(x), \textsc{jane})$$

Assume that $\Im$ satisfies $\textsc{Rich}(\textsc{john})$,
$\textsc{Man}(\textsc{john})$,
$\forall y \textsc{Rich}(y) \wedge \textsc{Man}(y) \rightarrow \textsc{Loves}(y, \textsc{jane})$, and
$\textsc{john} = \textsc{ceoOf}(\text{fic})$.
$\textsc{Company}(\textsc{faultyInsuranceCompany})$,
$\textsc{fic} = \textsc{faultyInsuranceCompany}$,

An Important Fact

$$KB \models (\alpha \rightarrow \beta) \text{ iff } KB \cup \{\alpha\} \models \beta$$

Another Example

$$\forall x[\textsc{Man}(x) \rightarrow \neg \textsc{Blackmails}(x, \textsc{John})] \rightarrow$$
$$\exists y[\textsc{Loves}(\textsc{john}, y) \wedge \textsc{Blackmails}(y, \text{john})]$$

Assume that $\Im$ satisfies
$\exists x \textsc{Adult}(x) \wedge \textsc{Blackmails}(x, \textsc{john})$ and
$\forall y \textsc{Woman}(y) \wedge y \neq \textsc{jane} \rightarrow \textsc{Loves}(y, \textsc{john})$

Misc

- Proof
- What about negative answers? Not entailed. Must produce an interpretation that satisfies KB and the negation of the query.

Abstract Individuals(Reification)

e.g., purchase

$$\textsc{Purchase}(\textsc{p}23) \wedge \text{agent}(\textsc{p}23) = \textsc{john} \wedge$$
$$\text{object}(\textsc{p}23) = \textsc{bike}$$
$$\text{source}(\textsc{p}23) = \textsc{sears}$$
$$\text{amount}(\textsc{p}23) = \$20$$

$$\textsc{Marriage}(\textsc{m}17) \wedge \text{groom}(\textsc{m}17) = \textsc{john} \wedge$$
$$\text{wife}(\textsc{m}17) = \textsc{jane}$$
$$\text{date}(\textsc{m}17) = \textsc{june}10/2002$$
$$\text{witness}(\textsc{m}17) = y$$

Other Facts: Beyond FOL

- Statistical and Probabilistic Facts
- Default and Prototypical Facts
- Intentional facts (mental attitudes)