Planning

R&N Chap. 11

(and a tiny snippet of Chap. 8-9)

Limitations of Prop. Logic

- Not very expressive: To represent the fact that a flight can originate from any of *n* airports, we need *n* symbols: FlyFromPITT, FlyFromSFO, FlyFromORC,…
- Instead we would like to use more expressive sentences like:

  For any airport *x*, FlyFrom(*x*)

  → First order logic (FOL)

FOL (The *extremely* short version!!)

- Same as before, plus:
  - Quantifiers: $\forall, \exists$
  - Variables: *x*, *y*, *z*
  - Predicates: P(*x*,*y*) = logical expression with value True/False
  - Functions: F(*x*)

$$\forall\, x, y, z \;\; \text{Parent}(z, x) \wedge \text{Parent}(z, y) \Rightarrow \text{Sibling}(x, y)$$

FOL

- *Substitution:* Replace a part of the sentence by another one.

  SUBST({*x*/*John*}, Rich(*x*)) → Rich(*John*)

- *Unification:* Find parts of two sentences that are identical after some substitution

UNIFY(SameCountry(F(*x*), *y*),
SameCountry(*John*,*Mary*)) =
{F(x)/*John*, *y*/*Mary*}

FOL Inference: Resolution

- Resolution: Resolution can be extended to FOL, but more complicated

$$\frac{l_1 \vee l_2 \quad m_1 \vee m_2}{\text{SUBST}(\theta, l_1 \vee m_1)}$$

$$\theta = \text{UNIFY}(l_2, \neg m_2)$$

After some substitution, l_2 and $\neg m_2$ are the same

$$\frac{\text{UnHappy}(x) \vee \neg \text{Rich}(x) \quad \text{Rich}(\textit{John})}{\text{UnHappy}(\textit{John})}$$

$$\theta = \{x / \textit{John}\}$$

FOL Inference: Chaining

- Chaining: Forward/backward chaining idea can be extended to KBs with sentences of the form:
- A_1 ^ A_2 ^ A_3…. => B

$$\text{WindowsLocked}(x) \wedge \text{DoorLocked}(x) \Rightarrow \text{RoomSecure}(x)$$