Predicate Logic Based Image Grammars for Complex Pattern Recognition

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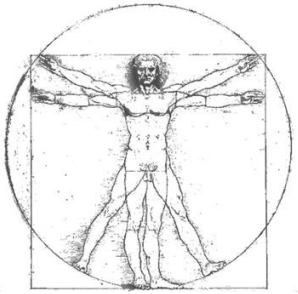
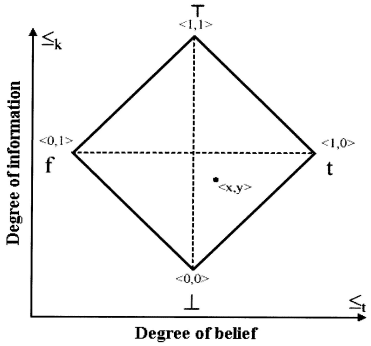
Idée générale



Domain Knowledge

Rule and fact

" If … then "
A <- B,C,D



Pattern Grammars

Bilattice

Human ?
Where ?
Why ?

human() <- head()
human() <- torso()
human() <- legs()

head()
torso()
legs()

<0.90,0.10>
<0.50,0.50>
<0.80,0.20>

Result

Input Image

Low Level Features

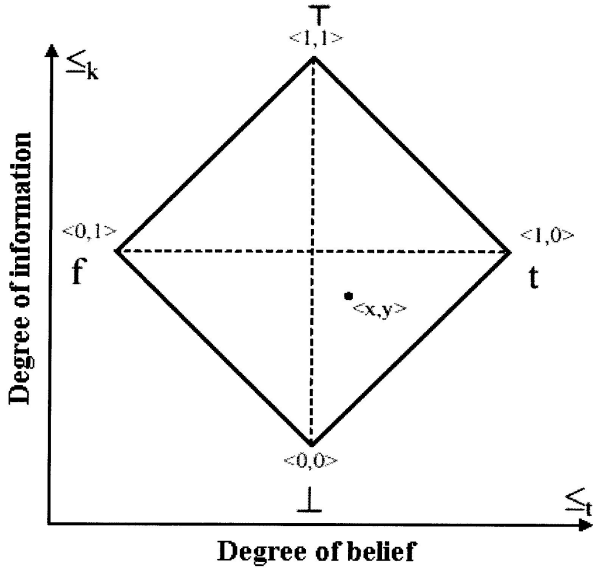
Rules and Facts

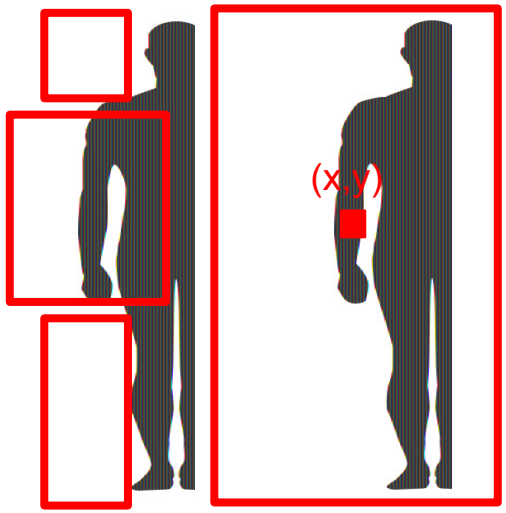
Weight

Rule Weight Learning

Reasoning framework

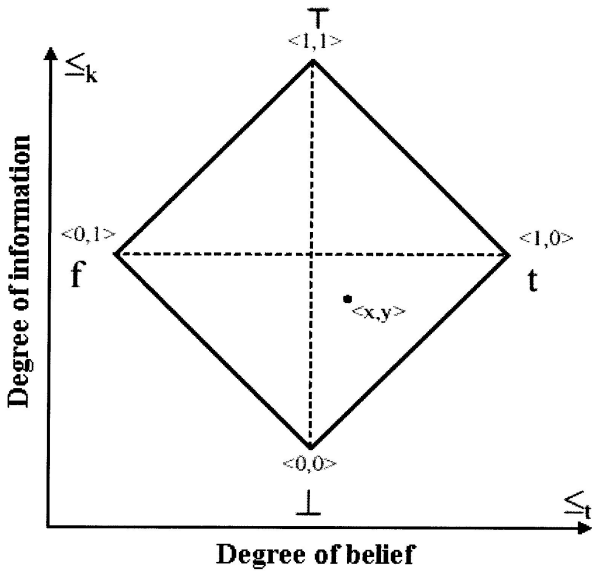
- **Logic Based Reasoning:**
  - Rule: “If … then …” = “human() <- head(), torso(), legs()”
  - Fact: A(X, Y, S) = head(location(x,y) and scale)
- **Bilattice Square** -> uncertainty





Reasoning framework

- **Bilattice Square:**
  - <x,y> = <evidence for, evidence against>
  - Two axis: Source ‘s degree of information and degree of belief
  - Four points: true, false, contradiction, unknown
  - Line of indifference and of consistency



- **Operations:** Conjunction - Disjunction, Combination of evidence from different sources - Consensus, Negation -> Closure

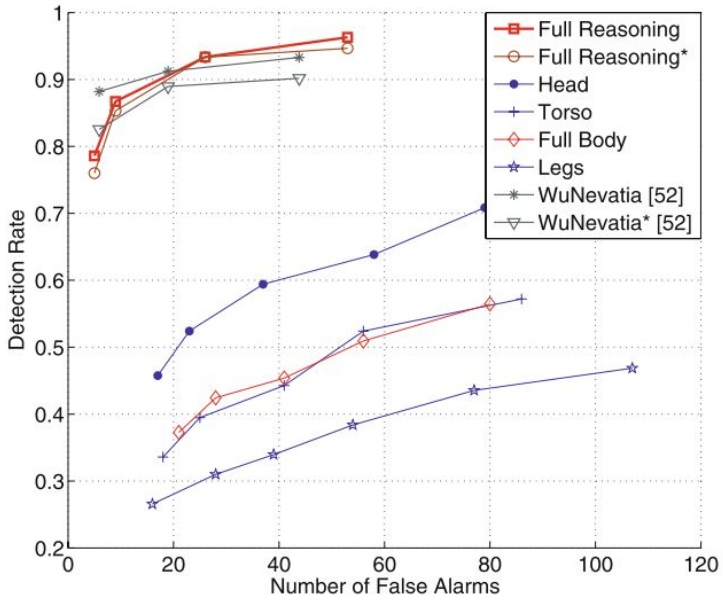
RULE WEIGHT LEARNING

Positive Predictive Value Based Learning (PPV)

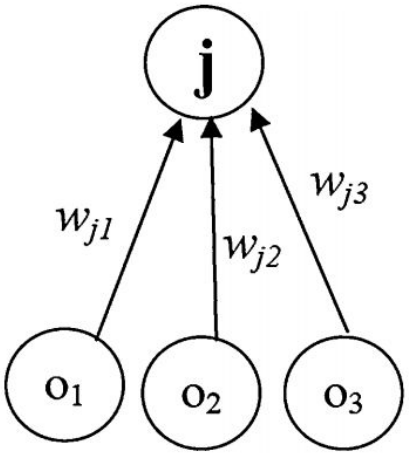
This measure is learnt individually for each rule

- Full reasoning
- Head
- Torso

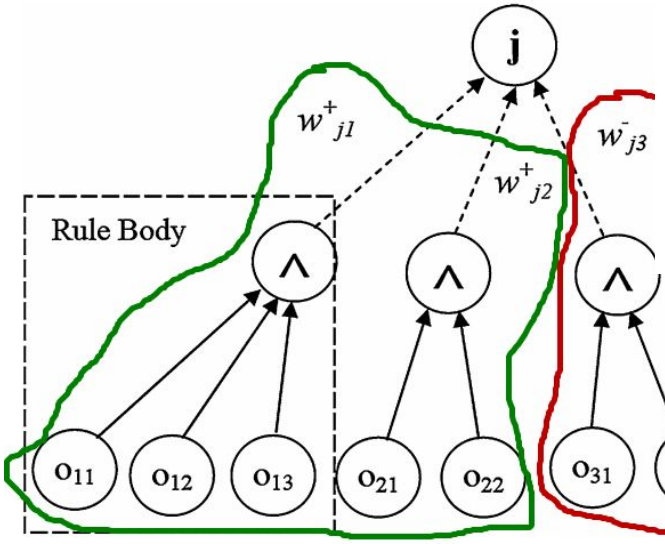
ROC Curve



Knowledge Based Artificial Neural Networks (KBANN)



Traditional Back-propagation



$$\phi(j \leftarrow o_{11}, o_{12}, o_{13}) = w^+_{j1}$$

$$\phi(j \leftarrow o_{21}, o_{22}) = w^+_{j2}$$

$$\phi(\neg j \leftarrow o_{31}, o_{32}) = w^-_{j3}$$

Modified Back-propagation

$$z_j = \phi(j) = \sum_i w_{ji}\sigma(\phi(o_i))$$

σ is the sigmoid function (activation function)

$$z_j = \phi(j)$$

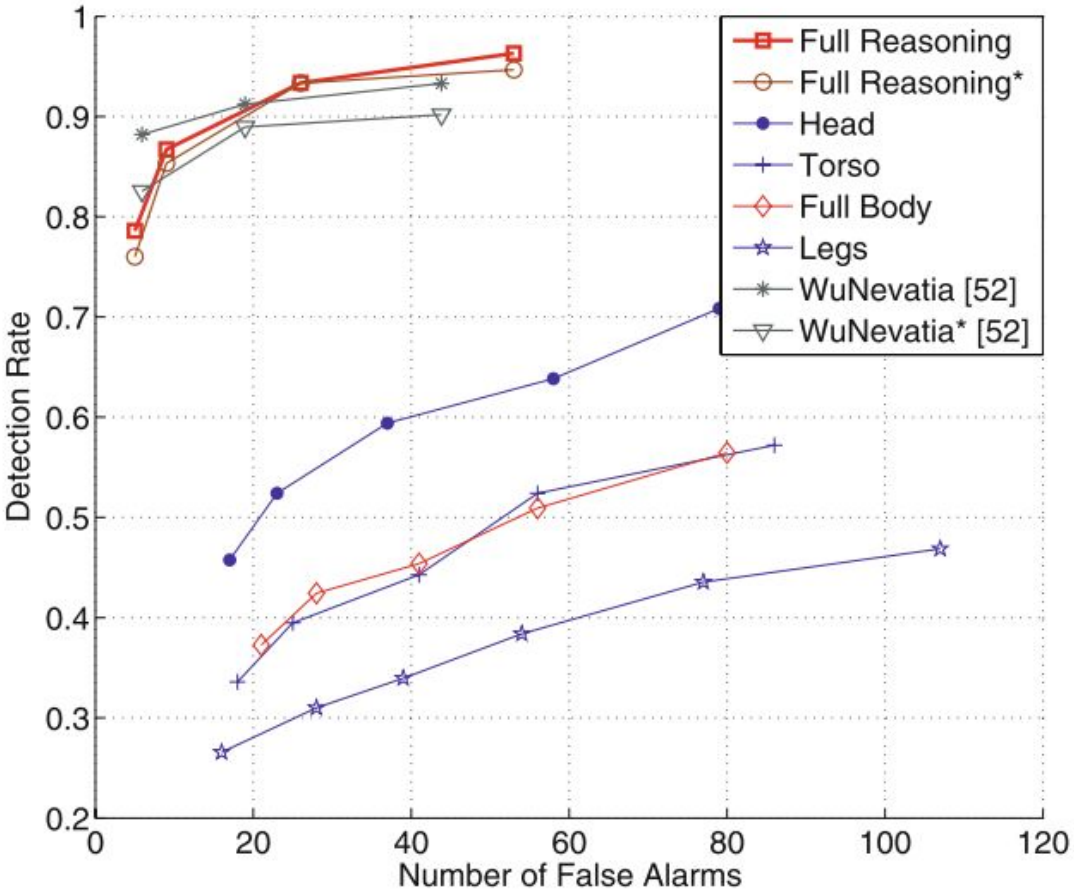
$$= \bigoplus_i^{+ve} w^+_{ji} \wedge \left[\bigwedge_l \phi(o_{il})\right] \oplus \neg \bigoplus_i^{-ve} w^-_{ji} \wedge \left[\bigwedge_l \phi(o_{il})\right]$$

So on => error, update rule weight, etc.

APPLICATION

Human Detection

Aerial Object Detection



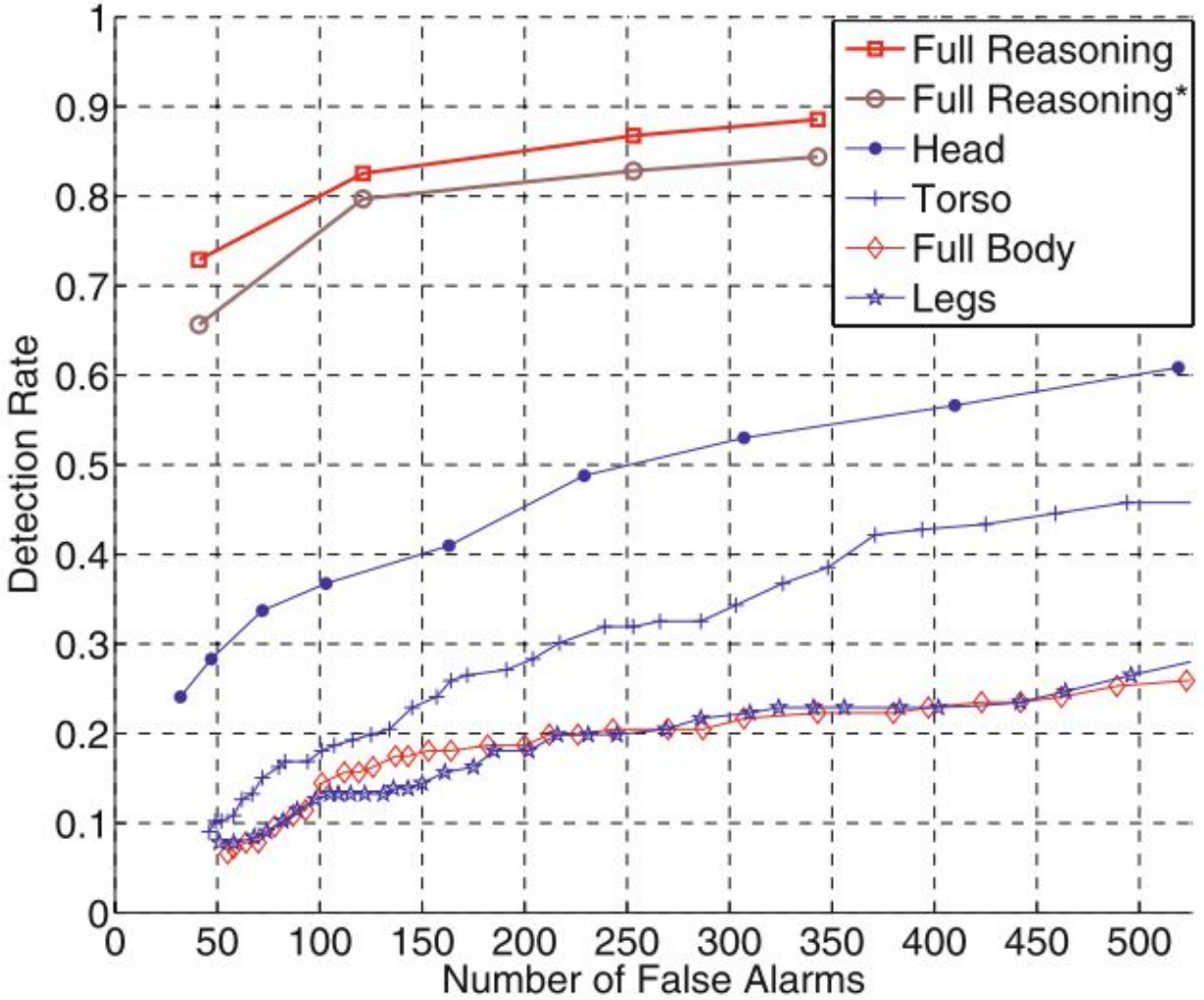
ROC Curve

Human Detection

Component based rules

Geometry based rules

Context based rules



Aerial Object Detection

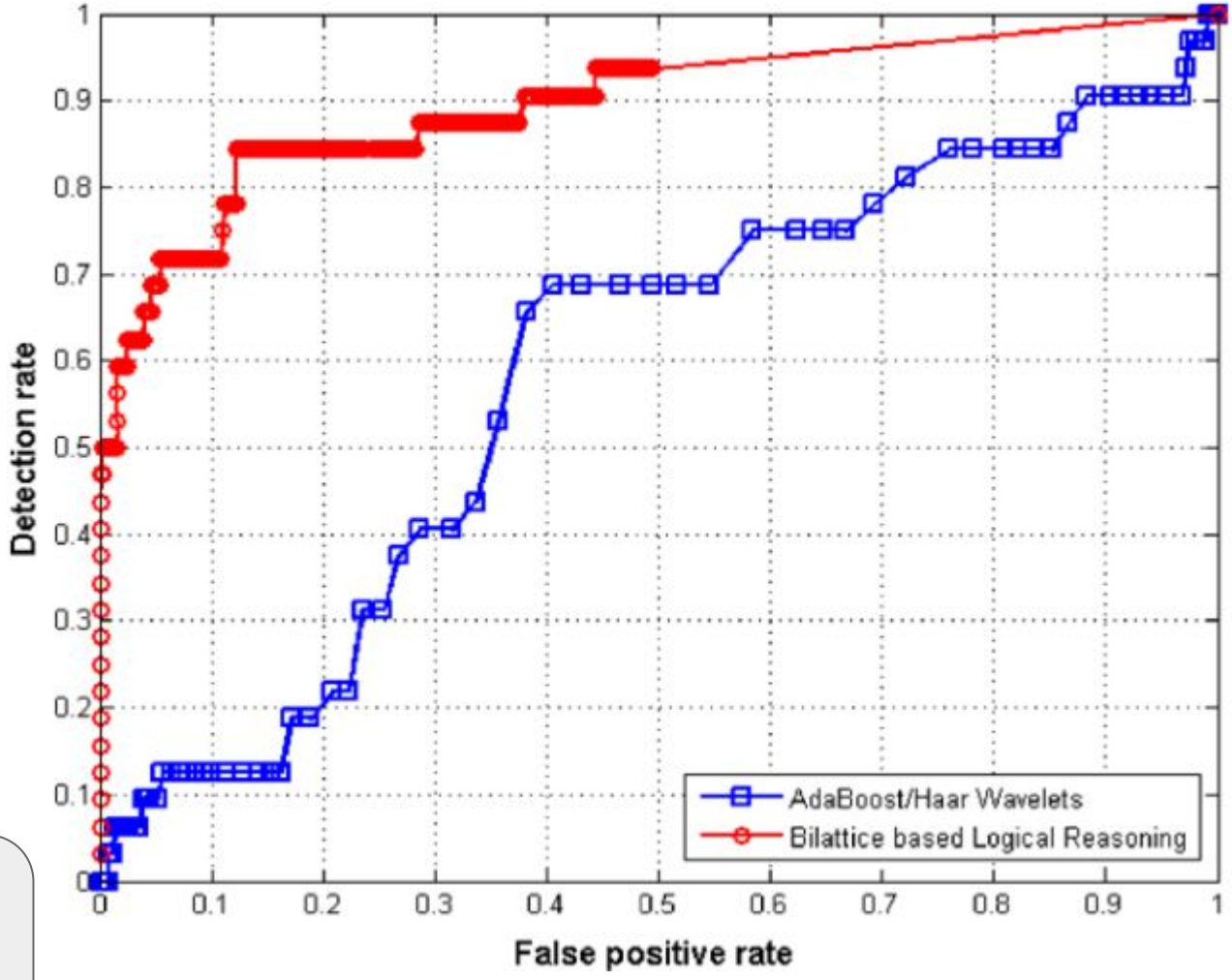
Geometry Features

Extract: line, cercle. conet...

Contextual Features

Discriminate terrain textures in aerial scenes.

oceans, forest, urban,..



ROC Curves for SAM site detection problem

Conclusion

Capable of predicting the presence of a specific pattern and its location

It provides a capable to synthesize a many information of object. (head, torso, leg…)

It provides the proof in linguistic form
by Using facts inferred and level of uncertainty