SRL: Markov Logic

• A unified language for AI/ML
• Special cases:
  – First-order logic
  – Probabilistic models
• Syntax: Weighted first-order formulas
• Semantics: Templates for Markov nets
• Inference: Logical and probabilistic
• Learning: Statistical and ILP
Sample Applications

• Information extraction
• Entity resolution
• Link prediction
• Collective classification
• Web mining
• Natural language processing

• Computational biology
• Social network analysis
• Robot mapping
• Activity recognition
• Personal assistants
• Probabilistic KBs
• Etc.
Overview of the Class

• Background
• Markov logic
• Inference
• Learning
• Extensions
• Your projects
Background

• Markov networks
  – Representation
  – Inference
  – Learning

• First-order logic
  – Representation
  – Inference
  – Learning (a.k.a. inductive logic programming)
Markov Logic

• Representation
• Properties
• Relation to first-order logic and statistical models
• Related approaches
Inference

• Graphical models inference

• Lifted Inference
  – Exact Algorithms
  – Belief Propagation Algorithms
  – Sampling Algorithms
  – MAP inference
Learning

• Weight learning
  – Generative
  – Discriminative
  – Incomplete data

• Structure learning and theory revision

• Statistical predicate invention

• Transfer learning
Extensions

• Continuous domains
• Infinite domains
• Recursive MLNs
• Relational decision theory
AI: The First 100 Years

IQ

Human Intelligence

1956

2006

2056

Artificial Intelligence

Graph showing the comparison of Human Intelligence and Artificial Intelligence over 100 years (1956 to 2056).
AI: The First 100 Years

IQ

Human Intelligence

Artificial Intelligence

1956
2006
2056
AI: The First 100 Years

IQ

Artificial Intelligence

Human Intelligence

1956
2006
2056
The Interface Layer

Applications

Interface Layer

Infrastructure
Databases

Applications

Interface Layer

Relational Model

Infrastructure

Query Optimization

Transaction Management

ERP

CRM

OLTP
Programming Systems

Applications

Interface Layer

High-Level Languages

Compilers

Infrastructure

Code Optimizers
Hardware

Applications

Computer-Aided Chip Design

Interface Layer

VLSI Design

Infrastructure

VLSI modules
Artificial Intelligence

- Applications
- Robotics
- Vision
- NLP
- Planning
- Multi-Agent Systems
- First-Order Logic?

- Interface Layer
- Representation
- Inference
- Learning
- Infrastructure
Artificial Intelligence

Applications

Robotics

NLP

Planning

Multi-Agent Systems

Vision

Interface Layer

Graphical Models?

Representation

Infrastructure

Inference

Learning
# Logical and Statistical AI

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We Need to Unify the Two

- The real world is complex and uncertain
- Logic handles complexity
- Probability handles uncertainty
Artificial Intelligence

Applications

Robotics

Planning

NLP

Multi-Agent Systems

Vision

Interface Layer

Markov Logic

Representation

Infrastructure

Inference

Learning