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Scientific DataLink's Artificial Intelligence Classification Scheme

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About a year ago, I was approached by Phoebe Huang of Comtex Scientific Corporation who hoped that I would help devise a dramatically expanded index for topics in AI, to aid Comtex in indexing the series of AI memos and reports that they had been gathering. Comtex had tried to get the ACM to expand and update its classification, but was told that ACM had just revised the listing two years or so ago, and did not intend to revise it again for a while; even if they did, the revision might require a year or more to complete. Comtex wanted the new classification within six to eight weeks. I agreed to take on the task, thinking it wouldn't be too hard.

The major decision I had to make was whether to use the existing ACM index scheme and add to it, or to start with a fresh sheet of paper and devise my own. I thought that the ACM's placement of expert systems and application in the same major category was inappropriate—some expert systems work is quite theoretical and experimental, and many applications (e.g., robotics) have nothing to do with expert systems. On the other hand, many articles have been classified using the ACM scheme over the years, and there is value in continuity. Nevertheless, I felt it was time to devise a fresh scheme. I went through all the other index schemes I could find, including an IEEE list and the indices of several texts. I also looked through several *IJCAI* and *AAAI Proceedings* for topics. I tried to keep each topic that was mentioned several times, and to put each topic in a natural place in a hierarchy of topics; if there was no single suitable place, I placed topics in more than one place and kept cross-references. When I finished a rough layout, I found that for the most part, it really didn't differ much from the ACM index at the top levels (only on some terminology and on the expert systems-applications issue). On reflection, I decided to stick with ACM's top two levels, only adding, not modifying, major headings. My main reasons were 1) that there really is value in continuity, and 2) that the most important function of an index is to allow someone reasonably knowledgeable in the field to locate the index numbers and literature references for a topic without too much difficulty. By these criteria, I think the index is adequate.

The classification is certainly not adequate as a reflection of the organization of AI as a field, and it will also become rapidly dated. Whether it can even accommodate AI for the next five years or beyond is a difficult question to answer. My feeling is that it probably doesn't matter, largely because of work now being done in AI within five years, I suspect we will have much smarter on-line index and retrieval systems, and that there will be little need for an index of the sort I've produced, a last vestige of the era of paper-oriented information.

0 General

1 Applications and Expert Systems
- 1.0 Cartography
- 1 1 Games
  - 1 1 0 Chess
    - 1 1 0 0 Plausible Move Generators
    - 1.1.0.1 Static Evalution
    - 1.1.0.2 Horizon Effect
    - 1 1 0.3 Chunking Methods
  - 1 1 1 Checkers
  - 1.1.2 Backgammon
  - 1 1 3 Bidding Games
  - 1.1 4 Wagering Games
  - 1.1.5 War Games
  - 1 1 6 Games, Other
- 1 2 Industrial Applications (9)
  - 1 2 0 Automatic Assembly
  - 1.2.1 Parts Handling
  - 1.2.2 Inspection
  - 1.2 3 Welding
  - 1 2 4 Planning for Production
  - 1.2.5 Inventory
- 1 3 Law

1.4 Medicine and Science (1.15, 4 4 1, 6 3, 6.4)
1.4.0 Medical Applications
1.4.1 Chemical Applications
1.4.2 Biological Applications
1.4.3 Geological Applications
1.4 3.0 Oil Well Log Interpretation
1.4.3.1 Mineral Recovery
1.4.3.2 Land Use Analysis
1.4.4 Social Science Applications
1.5 Natural Language Interfaces (7.10)
1.6 Office Automation
1.7 Military Applications (1.17)
1.7.0 Autonomous Vehicles (9.1)
1.7.1 Integration of Information (9 2 5, 10 4.4)
1.7 2 Decision Aids
1.7.3 Target Tracking (10.3.2)
1 7.4 Communication
1.8 Business and Financial
1.8.0 Tax Experts (1.15)
1.8.1 Investment
1.8 2 Financial Planning
1.8.3 Information Storage and Retrieval
1.9 Natural Language Processing Applications
1.9.0 Spelling and Style Checkers
1.9.1 Machine Translation (7.3)
1 9.2 Speech Recognition and Generation (7.0, 7.4)
1 9.3 Text Processing (7.5)
1.10 Mathematical Aids (3)
1.11 Education
1 11.0 Tutoring Systems
1.11.1 Intelligent Computer-Aided Instruction
1.11.2 Aids to Learning Programming
1.11.3 Curriculum Design
1.12 Library Applications
1.13 Engineering Automation
1.13.0 Computer System Design
1.13 1 VLSI Design Aids
1.13.2 CAD/CAM (Computer-Aided Design/ Computer-Aided Manufacturing)
1.13.3 Programming Aids (5 6)
1.14 System Troubleshooting
1.15 Expert Systems
1.15.0 Expert System Languages and Aids for Building Expert Systems
1 15.1 Acquisition of Expert Knowledge
1.15.2 Plausible Reasoning
1.15.3 Representation of Expert Knowledge
1.15.4 Generation of Explanations
1.15.5 Expert Systems Based on Simulations and Deep Models
1.15.6 User Interfaces for Expert Systems
1.15.7 Validation of Expert systems
1.16 Prosthetics
1.17 Aviation Applications (1.7)
1.17.0 Pilot Aids
1.17.1 Air Traffic Control
1.18 Applications, Other (10.9)

2 Automatic Programming

2.0 Automatic Analysis of Algorithms
2 1 Program Modification
2.2 Program Synthesis
2 3 Program Transformation
2.3.0 Recursive to Iterative Transformations
2 3.1 Conditional Branch Ordering
2.4 Programming Verification
2 5 Programming Assistants

3 Deduction and Theorem Proving

3.0 Answer/Reason Extraction
3.1 Deduction (e.g. natural, rule-based)
3 2 Logic Programming (4.1.0)
3 2.0 Logic Programming Theory
3 2 1 Logic Programming Applications
3.2.2 Logic Programming Languages (5 1)
3 2 2.0 Horn Clauses
3 2 2.1 Cuts and Control Mechanisms
3.2.2.2 Logic Programming Implementation Issues, Other
3.3 Mathematical Induction
3.4 Metatheory
3.5 Nonmonotonic Reasoning and Belief Revision
3.5.0 Circumscription
3.5.1 Data Dependencies
3.5 2 Belief Revision Methods (11 2)
3 5 2.0 Dependency-Directed Backtracking (8.2.9)
3.6 Resolution
3.6.0 Unification Algorithms
3.6.1 Resolvents and Resolvent Selection
3 6.2 Termination
3 6.3 Implementation and Methodology for Resolution Methods
3.6.4 Theoretical Issues

4 Knowledge Representation

4 0 Frames and Scripts
4.0 0 Defaults
4.0.1 Stereotypes and Prototypes
4.0.2 Generation of Expectations
4.0.3 Frame Languages (5.4.0)
4 0 4 Frame-Driven Systems (7.2.1.1)
4.0.5 Inheritance Hierarchy (5 4.2)
4.1 Predicate Logic
4.1.0 First Order Predicate Calculus (3.2)
4.1.1 Skolem Functions
4.1.2 Second Order Logic
4 1.3 Modal Logics
4.1.4 Fuzzy Logic
4.2 Relational Systems
4.2.0 Relational Data Bases
4 2.1 Associative Memory
4.3 Representation Languages
4.4 Representations (Procedural and Rule-Based)
4.4.0 Production Rule Systems
4 4 0 0 Analysis of Protocols
4 4.0.1 Production Rule Ordering and Conflict Resolution
4.4.0 2 Agendas (5.4.4)
4.4.0 3 Blackboards (5.4.4)
4.4.1 Knowledge Bases (6.3, 6 4)

7.2.1.4 Context for Understanding
7.2.1.5 Quantification
7.3 Machine Translation
7.3.0 Automatic Translation
7.3.1 Machine-Aided Translation
7.4 Speech Recognition and Understanding (1.9.2)
7.4.0 Acoustic Analysis
7.4.0.0 Formant Extraction
7.4.0.1 Allophonic and Phonotactic Constraints
7.4.1 Phonological Analysis
7.4.2 Isolated Word Recognition
7.4.3 Continuous Speech Recognition
7.4.4 Speaker Recognition
7.4.5 Training of Speech Systems for Individual Speakers
7.5 Text Analysis (1.9.3)
7.5.0 Text Summarizing
7.5.1 Question Answering
7.5.2 Automatic Indexing
7.5.3 Information Storage and Retrieval
7.6 Lexicology and Lexicography (1.9.3)
7.6.0 Machine-Readable Dictionaries
7.6.1 Thesauri
7.7 Discourse and Dialogue Understanding (11.1)
7.7.0 Speech Acts
7.7.1 Context and Focus
7.7.2 Corrective Dialogues
7.8 Story Understanding (4.0, 4.10, 4.11, 4.12, 7.2.1)
7.8.0 Story Grammars
7.8.1 Story Points and Morals
7.8.2 Narrative Units
7.9 Models Relating Language with Perception and Action (4.11)
7.9.0 Robot Control via Natural Language (9.5.0)
7.9.1 Scene and Event Description Generation (10.4.1)
7.9.2 Mental Image Models for Language Understanding
7.10 Natural Language Interfaces (1.5)
7.10.0 Natural Language Interfaces for Data Bases
7.10.1 Natural Language Interfaces for Expert Systems (1.15)
7.10.2 Natural Language Interfaces for Robots (9.5.0)
7.10.3 Portability of Natural Language Interfaces
7.10.4 Graceful Interactions

8 Problem Solving, Control Methods and Search

8.0 Backtracking
8.1 Dynamic Programming
8.2 Graph and Tree Search Strategies
8.2.0 Depth First Search
8.2.1 Breadth First Search
8.2.2 Best First Search
8.2.3 Branch and Bound
8.2.4 Hill-Climbing
8.2.5 Minimax
8.2.6 Alpha-Beta Algorithm
8.2.7 A* Algorithm
8.2.8 Beam Search
8.2.9 Dependency-Directed Backtracking (3.5.2.0)
8.2.10 Constraint Propagation (4.8)
8.2.11 Relaxation Methods
8.2.12 Marker Passing
8.2.13 Bidirectonal Search
8.2.14 Data-Driven or Top-Down Search
8.3 Heuristic Methods
8.3.0 Nature of Heuristics
8.3.1 Heuristic Control of Search
8.3.2 Strategies
8.3.3 Default Reasoning
8.3.4 Closed World Heuristics
8.3.5 Induction and Evaluation of Heuristics
8.3.6 Qualitative Reasoning and Envisionment
8.4 Plan Execution, Formation, Generation
8.4.0 Means-Ends Analysis
8.4.1 Forward Chaining
8.4.2 Backward Chaining
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8.4.4 Generate and Text
8.4.5 Hierarchical Planning
8.4.6 Metaplanning and Multiple Goals
8.4.6.0 Goal Selection
8.4.6.1 Opportunistic Planning
8.4.6.2 Goal Protection
8.4.6.3 Planning in Uncertain Situations
8.4.6.4 Conflict Resolution
8.4.7 Plan Verification
8.4.8 Plan Modification
8.5 Matching

9 Robotics

9.0 Manipulator
9.0.0 Arms
9.0.1 Hands
9.0.2 Tools and Special Purpose Effectors
9.1 Propelling Mechanisms
9.1.0 Wheeled Vehicles
9.1.1 Walkers
9.1.2 Underwater Vehicles
9.1.3 Airborne Vehicles
9.2 Sensors
9.2.0 Vision (10)
9.2.1 Tomography
9.2.2 Tactile Sensors
9.2.3 Kinesthetic Sensing
9.2.4 Proximity Sensors
9.2.4.0 Acoustic Proximity Sensors
9.2.4.1 Optical Proximity Sensors
9.2.4.2 Capactive Proximity Sensors
9.2.5 Integration of Sensor Information (1.7.1, 10.4.4)
9.3 Autonomous Robots (1.7.0)
9.3.0 Control Policies for Autonomous Robots
9.3.1 Route Finding and Planning
9.3.2 Obstacle Avoidance
9.3.3 Terrain Following
9.3.4 Robot Guidance
9.4 Manipulator Planning, Tracking, and Control (8.4, 10.3, 10.4)
9.4.0 Hand-Eye Coordination
9.4.1 Multiple Arm Coordination
9.4.2 Collision Avoidance

- 9.4.3 Error Recovery
- 9.4.4 Compliant Motion
- 9.4.5 Control via Servomechanisms
- 9.4.6 Control via Processors
- 9.5 Robot Control Languages
  - 9.5.0 High-level Languages for Robot Assembly Tasks (7.9.0)
  - 9.5.1 Constraint Languages (5.4.3)
  - 9.5.2 Findspace Problem
- 9.6 Cybernetics (12.4)

10 Vision (9.2.0)

- 10.0 Architecture and Control Structure
  - 10.0.1 Pyramid Architecture
  - 10.0.2 Heterarchical Models
  - 10.0.3 Hierarchical Models
    - 10.0.3.0 Model-Driven Vision (10.4.2)
    - 10.0.3.1 Bottom-up Vision Models
  - 10.0.4 Perceptrons
- 10.1 Intensity, Color, Photometry and Thresholding
  - 10.1.0 Segmentation
    - 10.1.0.0 Edge Detection
    - 10.1.0.1 Region Grouping
  - 10.1.1 Zero Crossings
  - 10.1.2 Color Identification
  - 10.1.3 Feature Extraction
  - 10.1.4 Template Matching
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  - 10.2.0 Depth Maps
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    - 10.2.0.1 Depth from Motion
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    - 10.2.0.3 Direct Ranging
  - 10.2.1 Intrinsic Images
    - 10.2.1.0 Reflectance Maps
  - 10.2.2 Subjective Contours
  - 10.2.3 Occluding Contours
  - 10.2.4 Shadows
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  - 10.2.6 Surface Albedo
- 10.3 Motion
  - 10.3.0 Optical Flow
  - 10.3.1 Shape from Motion (10.6.4)
  - 10.3.2 Motion Tracking
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- 10.4 Perceptual Reasoning (4.11)
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  - 10.4.1 Scene Description Generation (7.9.1)
    - 10.4.1.0 Judgment of Perceptual Salience
  - 10.4.2 Model-Driven Vision (10.0.3.0)
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  - 10.5.4 Quadtrees
  - 10.5.5 Octrees
  - 10.5.6 Primal Sketch
  - 10.5.7 Line Drawings
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  - 10.6.4 Shape from Motion (10.3.1)
  - 10.6.5 Labeling of Line Drawings
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  - 10.7.1 Textons
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  - 10.7.3 Mosaic-Models of Texture
- 10.8 Object Shape Representation
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  - 10.8.3 Volumetric Models
  - 10.8.4 Fractal-Based Descriptions
  - 10.8.5 Hierarchical Object Representations
- 10.9 Systems and Applications (1.18)
  - 10.9.0 Handwriting Recognition

11 Cognitive Modeling and Psychological Studies of Intelligence

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  - 11.0.0 Primitives for Emotion Modeling
  - 11.0.1 Relationships of Situations to Affect
  - 11.0.2 Relationships of Affect to Action
- 11.1 Reasoning about Beliefs and Motives of Others (7.7)
  - 11.1.0 Mutual Knowledge
  - 11.1.1 Speech Act Planning
  - 11.1.2 Speech Act Interpretation
- 11.2 Belief Revision (3.5)
- 11.3 Nature of Expertise (1.15)
- 11.4 Reasoning about Events and Actions (4.11)
  - 11.4.0 Common Sense Physics
  - 11.4.1 Mechanism Modelling
- 11.5 Decision Making
- 11.6 Models of Memory
  - 11.6.0 Semantic Memory
  - 11.6.1 Episodic Memory and Reminding
  - 11.6.2 Skill Memory
- 11.7 Models of Consciousness and Phenomenology (13.0.3)
- 11.8 Protocol Analysis

12 Specialized AI Architectures

- 12.0 Programming Language-Oriented Architectures
- 12.1 Connectionist Architectures
- 12.2 Image and Speech Processing Architectures
- 12.3 Architectures, Other
- 12.4 Cybernetics (9.6)

13 Social and Philosophical Issues

13.0 Theoretical Foundations and Philosophical Issues
- 13 0.0 AI Paradigms
- 13 0 1 Nature of Intelligence
- 13.0.2 Theoretical Limitations of Computational Models
- 13.3.3 Phenomenology (11.7)
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- 13.0.5 Hermeneutics
- 13.0.6 Epistemology
- 13.0.7 Intentions
- 13.0.8 Self-Organization
- 13.0.9 Self-Reference
- 13.0.10 Self-Replication
- 13.0.11 Common Sense

13.1 Social Impact
13.2 History
13.3 Funding
13.4 Research Methodology

MOVING?

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