Wide-Area Knowledge Representation: A Foundation for The Noosphere

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Overview

- Annotation, Indexation & Retrieval
- Distributed Knowledge Representation
- Constraint-Guided Systems
- Ternary Relation Representations
  - Bi-Directional Ternary Relations
  - Self-Indexation
  - Completeness
  - Time & Space Complexity
  - Equality

Background

- Natural Language Understanding
  - Syntactic Parsing & Generation
  - Semantic Representation
- Open Meeting System
  - Hypertext based on Persistent Ternary Relations
  - Light-Weight Semantics
  - Taxonomic Information Access
  - Email & Web Form Processing Interfaces

Annotation, Indexation & Retrieval

- Information Access
  - Current, Complete, Correct, Felicitous
- Challenges
  - Hierarchical Walkers take Geologic Time
  - Resources & Data Streams are Opaque
  - High Latency, Intermittent Availability
- Solution
  - Assertional Substrate with Caching
  - Indexation in the Infrastructure

Distributed Knowledge Representation

- Interlinked Assertions
- Build on Distributed Object System
- Terms Resolved by Low Latency Name Service
- Relations Served by Owners
- Contexts for Different Link Semantics
- Infrastructure Caches
  - Indices
  - Predication Information

Constraint-Guided Systems

- Reference System
  - Complete, Efficient Graph Matching
- Semantic Inversion
  - Induction of Constraint Descriptions
  - Graphical Displays
  - Sentence Generation
- Lexical Classification
  - Hierarchical Recognition

Ternary Relation Representations

- First Class Relations
- Bi-Directional Interpretation
- Pervasive Symmetries
- Arbitrarily Expressive
- Encodes & Decodes Natural Language
- No Epistemic Pre-commitments

Bi-Directional Ternary Relation

- Components
  - Subject
  - Relation Type
  - Object
- Constraints
  - Subject Relation <--> Object Relation
  - Subject <-> Object
  - Relation Type

Self-Indexation

- Ternary Relations
  - Determinate Inverse
  - Objects Cache Relation Type Count
- Token Universals
  - Track Token Instances
  - Maintain Token Instance Count
- Context Unions
  - Abstract Space & Time

Completeness

- All First Order Structures Indexed
  - Enter via Token Universal
  - Traversal via Bi-Directional Relations
- No Holes in Index
  - Representation is the Index
- Extending Indexation
  - By New Assertions
  - By Lexical Classification

Time & Space Efficiency

- Time Complexity for Reference
  - Smallest Accessible Possibility Space
  - Constraint Ordering
    - By Complexity Class
    - By Bounded Possibility Count
  - Reformulation of Reference Specifications
- Space Complexity ~ = 2x Relations
  - Actual Relation
  - Instance Relation to Token Universal

Equality

- Lexicalist, Surface Semantics
- Meaning Postulates Map Equivalences
- Context Organize
  - Regions Conforming to Specific Semantics
  - Temporal Structures
  - Belief Structures (e.g.., counterfactuals)
  - Semantic Transfer Postulates

Middleware Requirements

- Low Latency Name Service
- Exporting Index Data
  - Token Instance Counts
  - Relation Inverse Counts
- Hierarchical Caching
  - Down to address space level
- Meaning Negotiation Protocol

Middleware Services

- Reference (Name Service)
  - by Constraints
  - by Generating Constraints from an Example
- Walking Structures under Constraints
  - Mapping Actions over Network Regions
  - Cache Prefetch
- Notification, Alerting, Pattern-Action Rules
- Translation Across Semantic Contexts

Conclusions

- Ternary Relations Preferred
  - Simplest Invertible Representation
  - Complete Self-Indexation
  - Excellent Computational Properties
  - Arbitrarily Expressive
  - No Epistemic Pre-commitment
- Simple Initial Usage as Property Lists
- Incremental Evolution of Services

Epilogue

- *Differentiate the implementation from the representation*
- *Name service is the starting point for assertional substrate.*
- *Constraint-guided retrieval*