Logic Notations

• Frege’s Begriffsschrift (concept writing) - 1879:

assert $P$
not $P$
if $P$ then $Q$
for every $x$, $P(x)$
Logic Notations

• Frege’s Begriffsschrift (concept writing) - 1879:

Every ball is red

\[ \forall x \text{ ball}(x) \rightarrow \text{red}(x) \]

Some ball is red

\[ \exists x \text{ ball}(x) \land \text{red}(x) \]
Logic Notations

• Algebraic notation - Peirce, 1883:
  – Universal quantifier: $\Pi_x P_x$
  – Existential quantifier: $\sum_x P_x$
Logic Notations

• Algebraic notation - Peirce, 1883:

Every ball is red:

$$\Pi_x (\text{ball}_x \rightarrow \text{red}_x)$$

Some ball is red:

$$\Sigma_x (\text{ball}_x \cdot \text{red}_x)$$
Logic Notations

• Peano’s and later notation:

Every ball is red:

\[ \forall x \ (\text{ball}(x) \supset \text{red}(x)) \]

Some ball is red:

\[ \exists x \ (\text{ball}(x) \land \text{red}(x)) \]
Logic Notations

- **Existential graphs** - Peirce, 1897:
  - **Existential quantifier**: a link structure of bars, called line of identity, represents $\exists$
  - **Conjunction**: the juxtaposition of two graphs represents $\land$
  - **Negation**: an oval enclosure represents $\neg$
Existential Graphs

If a farmer owns a donkey, then he beats it:
Existential Graphs

- **EG’s rules of inferences:**
  - **Erasure:** in a positive context, any graph may be erased.
  - **Insertion:** in a negative context, any graph may be inserted.
  - **Iteration:** a copy of a graph may be written in the same context or any nested context.
  - **Deiteration:** any graph may be erased if a copy of its occurs in the same context or a containing context.
  - **Double negation:** two negations with nothing between them may be erased or inserted.
Existential Graphs

Prove: \(((p \Rightarrow r) \land (q \Rightarrow s)) \Rightarrow ((p \land q) \Rightarrow (r \land s))\) is valid
Existential Graphs

Prove: \(((p \Rightarrow r) \land (q \Rightarrow s)) \Rightarrow ((p \land q) \Rightarrow (r \lor s))\)

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Existential Graphs

- $\alpha$-graphs: propositional logic
- $\beta$-graphs: first-order logic
- $\gamma$-graphs: high-order and modal logic
Semantic Networks

• Since the late 1950s dozens of different versions of semantic networks have been proposed, with various terminologies and notations.

• The main ideas:
  – For representing knowledge in structures
  – The meaning of a concept comes from the ways it is connected to other concepts
  – Labelled nodes representing concepts are connected by labelled arcs representing relations
Semantic Networks

Mammal isa Person

Person has-part Nose

Nose instance team Liverpool

Red uniform color Owen

Owen instance team Liverpool
Semantic Networks

![Semantic Network Diagram]

- **John**
  - **Height**: H1
  - **Value**: 1.80
- **Bill**
  - **Height**: H2

The relationship between John and Bill is defined by the `greater-than` relation with a value of 1.80.
Semantic Networks

The dog bit the mail carrier

![Diagram showing semantic network with nodes and arrows indicating relationships between dog, bite, mail carrier, assailant, and victim.]
Every dog has bitten a mail-carrier
Conceptual Graphs


• CG = Perice’s EGs + semantic networks
Conceptual Graphs

- **1968**: term paper to Marvin Minsky at Harvard.
- **1970's**: seriously working on CGs
- **1976**: first paper on CGs
- **1981-1982**: meeting with Norman Foo
- **1984**: the book coming out
Simple Conceptual Graphs

CAT: tuna

relation

MAT: *

On

concept type (class)

concept

relation type

individual referent

generic referent

09 November 2009
Ontology

• **Ontology**: the study of "being" or existence

• **An ontology** = "A catalog of types of things that are assumed to exist in a domain of interest" (Sowa, 2000)

• **An ontology** = "The arrangement of kinds of things into types and categories with a well-defined structure" (Passin 2004)
Ontology
Ontology

Aristotle's categories

- Being
  - Substance
  - Accident
    - Property
      - Inherence
        - Quality
        - Quantity
      - Directedness
        - Movement
        - Intermediacy
          - Activity
          - Passivity
          - Having
          - Situated
      - Containment
        - Spatial
        - Temporal
Ontology

Geographical categories

- Area
  - Block
  - Terrain
  - Country
  - Wetland
  - Mountain

- Point
  - Dam
  - Town
  - Bridge
  - Airstrip
  - Heliport

- Line
  - On-Land
    - Road
    - Border
    - Railroad
  - On-Water
    - River
  - Power-Line
Ontology

PERSON: john

Eat

CAKE: *

ANIMAL

FOOD

Eat
CG Projection

PERSON: john 1 Has-Relative 2 PERSON: *

PERSON: john 1 Has-Wife 2 WOMAN: mary
Nested Conceptual Graphs

It is not true that cat Tuna is on a mat.
Nested Conceptual Graphs

Every cat is on a mat.
Nested Conceptual Graphs

Julian could not fly to Mars.
Nested Conceptual Graphs

Tom believes that Mary wants to marry a sailor.
Homework

• Reading:
