Flexible sets of distinctions for multiple paradigms

-A means of constructing ontologies for knowledge representation
-In domain of Chinese Medicine and Orthodox Medicine

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Agenda

☐ Introduction of Domain (2-5)

☐ Introduction of Ontology and examples (6-13)

☐ Problems with Distinctions, KR and Terminology (14-22)

☐ Introduction of flexible sets of distinctions (23)

☐ Comparing approaches with distinctions (24-26)

☐ Summary (27)

Modelling Domain Knowledge into ontologies

☐ Ontologies are recognized as a key technology for knowledge sharing

☐ Ontologies have been developed for domain knowledge, especially in the medical domain
- ☐ UMLS - Medline
- ☐ GALEN – Prodigy Drug NHS
- ☐ Anatomy ontology
- ☐ UTCMLS

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Constructing ontologies for multiple paradigms

☐ It is necessary to deal with heterogeneous knowledge, information, data resources and multiple paradigms in health care domain

- ■ Broad background knowledge is essential for health care service providers

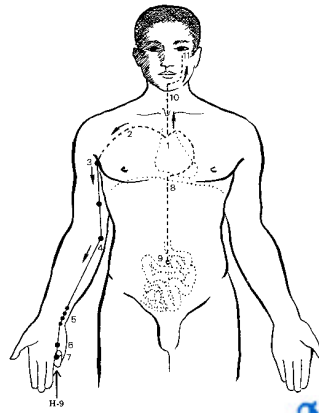- ■ Life long health records involve all aspects of health conditions

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Human body
– Orthodox or Chinese Medicine

Adopt from http://www.bartleby.com/107/214.html   Adopt from http://www.acupuncture.com

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What is ontology?

☐ Definition

☐ Principle & Criteria

☐ Contents

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What is the definition of ontology ?

☑ Gruber's (1993) for Informatics
   ☑ A specification of a conceptualization

☑ Philosopher Quine
   ☑ "What is there? To be is to be the value of quantified variable"

What are the principles and criteria ?

☑ Completeness (in terms of the partitions – disjoint and exhaustive)
☑ Coherence (consistency)
☑ Expressiveness (the ability to represent formally the concepts)
☑ Minimal ontological commitments

☑ Abstraction (to define generic categories of concepts, the relations between them and to organise them reliably)
☑ Reusability
☑ Reliability
☑ Clarity and Objectivity

☑ Standardization of names
☑ Minimization of the semantic distance between sibling concepts.
☑ Maximum monotonic extendibility

What are the contents of ontology?

- ☑ Thing
    - ☑ Objects
    - ☑ Concepts
    - ☑ Classes
    - ☑ Categories
    - ☑ Types
    - ☑ Physics
    - ☑ Metaphysics

- ☐ Distinction

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# What are the contents of ontology?

- ☐ Thing
- ☑ Distinction (or gradation)
    - ☑ Two-way distinction (Sowa)
        - ☑ Physical and abstract; Pathological and Physiological; Yin and Yang
        - ☑ Range of pressure; degree of sweetness

    - ☑ Three-way distinction (Peirce, Sowa)
        - ☑ Independent, (Monadic predicate, P(x))
        - ☑ Relative, (Dyadic relation, R(x, y))
        - ☑ Mediating, (Triadic relation M(x,y,z))

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Hierarchy of Sowa's Top-Level Categories
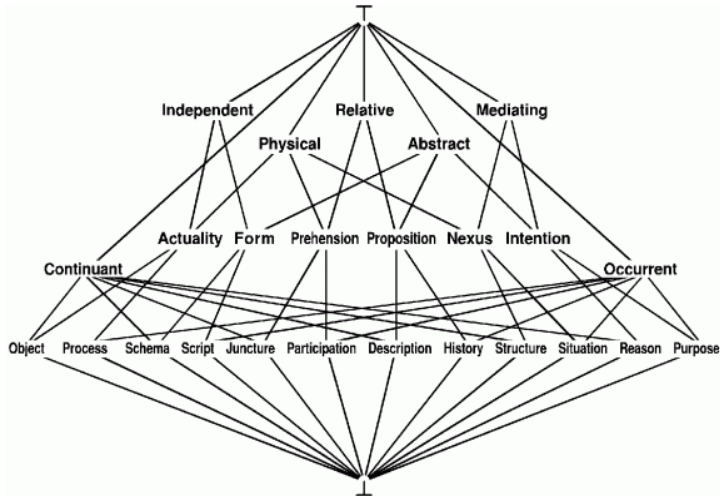
Adopt from Sowa(2000)

Matrix of Top-Level Categories

	Physical		Abstract	
	Continuant	Occurrent	Continuant	Occurrent
Independent	Object	Process	Schema	Script
Relative	Juncture	Participation	Description	History
Mediating	Structure	Situation	Reason	Purpose

Adopt from Sowa(2000)

Top level ontology represent into protégé 2000
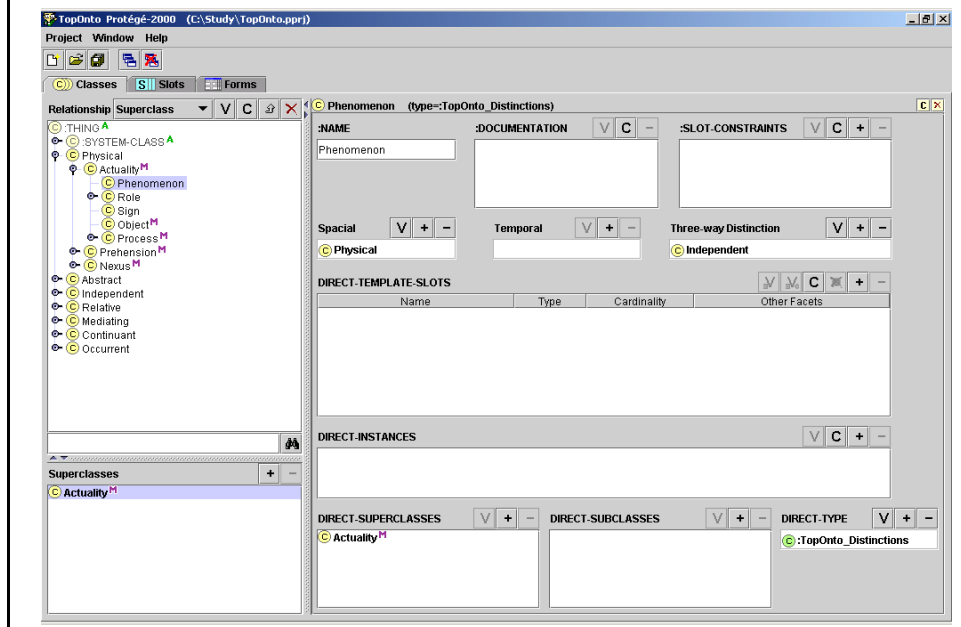
The problems of distinctions

☐ No fixed collection of distinctions or categories is likely to be adequate for describing all things for all time

☐ It is difficult to remain consistent even when we do our best

☐ We need to present distinctions in ontology. But how?

(much literature mentions "distinctions", so we call it the "distinction approach")

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Issues about ontology - distinctions

☑ Is-a (Taxonomic relationships - *generalization*)

☑ Part-of (Part-whole relationships - *aggregation*)

☑ Member-of (Membership relationships -*association*)

☑ Transitive (and override)

☑ Disjoint

☑ Axiom

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How distinctions are presented by protégé

■ The underpinning knowledge model OKBC and frame based system

■ The distinctions exist in protégé:

  □ Class vs.. subclass present "thing" in generalization and specialization - "is-a" taxonomy
  □ Class vs. Instance present "thing" can be divide to entity and individual
  □ Class vs. Slot present "thing" and its attribute or even more constrain, axiom
  □ Instance vs. Facet present individual and its constrain

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Difficulties of representing philosophy and knowledge

☐ The differences of understanding and choosing of distinctions exist between domain experts and knowledge engineers

☐ The expressiveness of techniques we use to build ontologies

☐ Ontologies designed for one paradigm are difficult to plug-in and play into different paradigms

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Resolve difficulties by flexible sets of distinctions

☐ Flexible sets of distinctions describe the complex world and incomplete knowledge of universal as much as we can

☐ Flexible sets of distinctions provide dynamic and tolerable meaning of "thing"

☐ Flexible sets of distinctions provide the ground for different purpose, and application, and paradigms, even belief

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# Difficulties of resolving terminology conflicts

- □ Some terms are same but have different meanings compared to orthodox medicine

- ■ Organ, Heart, Spleen, Liver, Lung, Kidney etc.

- □ Some terms only exist in Chinese Medicine

- ■ Yin, Yang, Qi etc.

- □ Some are common terms in daily life but have greater meanings in Chinese Medicine

- ■ Cold, Wind, Dampness etc.

Name space or package for Terminology conflicts
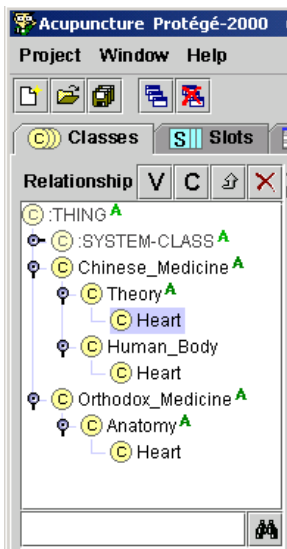
- ■ In Acupuncture.pont

```
"(defclass %3ACLIPS_TOP_LEVEL_SLOT_CLASS
    (is-a USER)
    (role concrete))
….

(defclass
    uk.ac.salford.SHIRE.Chinese_Medicine.Theory.Heart
    (is-a Theory)
    (role concrete))
…..
(defclass
uk.ac.salford.SHIRE.Chinese_Medicine.Human_Body.Heart
    (is-a Human_Body)
    (role concrete))
…
(defclass
    uk.ac.manchester.Orthodox_Medicine.Anatomy.Heart
    (is-a Anatomy)
    (role concrete)) "
```
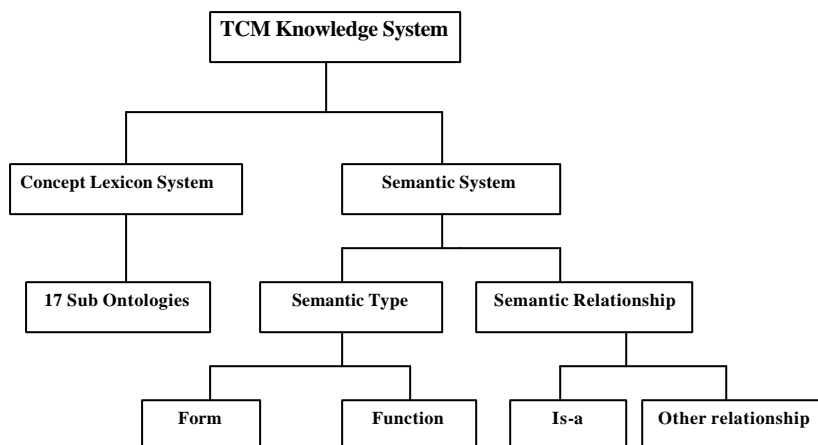
Chinese Medicine Knowledge System - UTCMLS

- UTCMLS project - funded by the China Science & Technology department

- Aim: standard terminology, concept and knowledge acquisition, information retrieval

- 5 top level classes

- 17 sub-ontologies

- About 100 TCM oriented semantic types plus UMLS semantic type

- Defined 57 kinds of semantic relationships plus UMLS

UTCMLS Architecture

```
                    TCM Knowledge System
                    ┌─────────┴─────────┐
          Concept Lexicon System    Semantic System
                  │              ┌──────┴──────┐
          17 Sub Ontologies   Semantic Type   Semantic Relationship
                          ┌──────┴──────┐   ┌──────┴──────┐
                        Form      Function  Is-a   Other relationship
```

Flexible sets of distinctions vs. multiple perspectives

- Multiple perspective
  - higher level distinction of view point

- Flexible distinction
  - Distinguish the difference inside perspective and between perspective

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Flexible sets of distinctions vs. categories, sets, types, collections

- Categories, sets, types, collections are high level distinctions of classification (or specification or arrangement)

- Distinctions could be more fundamental and at lower level. Combined distinctions can generate the categories, sets, types, collections

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Flexible sets of distinctions vs. Logical

"At the ontological level, a central issue is the distinction between the logical relations which contribute to the taxonomic structure of the domain and those which do not, providing instead additional information on already identified objects."

- Nicola Guarino (1995)
  Formal ontology, conceptual analysis and knowledge representation

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Flexible sets of distinctions for constructing ontologies for KR

☐ The meanings of thing are different for different paradigms based on different sets of distinctions

☐ Differences of meaning could be represented by sets of distinctions

☐ Clearly defined sets of distinctions could be reusable for other purpose or application

☐ It could be shared cross paradigms

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Summary

- ☐ Describe difficulties of designing ontology for multiple paradigms

- ☐ Explore how distinctions approach works in Sowa's top level ontology, one domain ontology and protégé

- ☐ Briefly compare the differences between this approach and multiple perspective, sets, category, type, and collections, and logic

- ☐ Propose flexible sets of distinctions as a means for constructing ontology

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