A Granular Computing Paradigm for Concept Learning

Xiaofei Deng
Ph.D. Candidate
Department of Computer Science

University of Regina

Outline

- Concept learning
- Granular computing
- A model for concept learning
- Applications

What is concept learning?

- What is a concept?
  - Basic unit of human thought
  - The classical view: intension & extension
- A concept is a triplet:
  - (name, intension, extension),
  - (natural language, description, example)

$$(c, i(c), e(c)) \quad \text{or} \quad (g, i(g), e(g))$$

University of Regina

"intension" comes from logic, it indicates the internal content of a term or concept that constitutes its formal definition

The classical view of concepts

name: "dog"

A concept

descriptions of "dog"

intension:

bites

barks

four legs

loyalty

man's best friend

extension:

How do humans learn a concept?

- Two tasks of concept learning
  - Describe a concept by its intension
  - Derive relations between concepts
- An example:

Intension of known concept ➔ Intension of new concept

http://www.shutterstock.com

University of Regina

How do machines learn a concept?

- Learn classification rules
- An example:

Weekend=Yes and Raining=No ➔ Canoeing = Yes

Weekday=Yes ➔ Canoeing = No

○ ○ ○

- A classification tree:

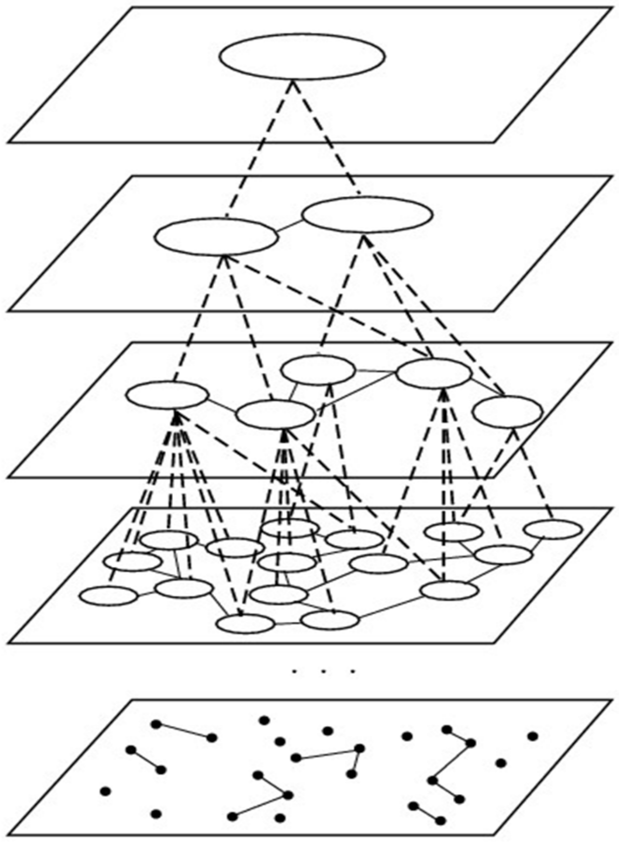
http://www.shutterstock.com

University of Regina

Granular computing

- Multi-level, multi-view granular structures

- Why do we need it?
  - Construct a set of granules with meaningful structures for learning effective rules

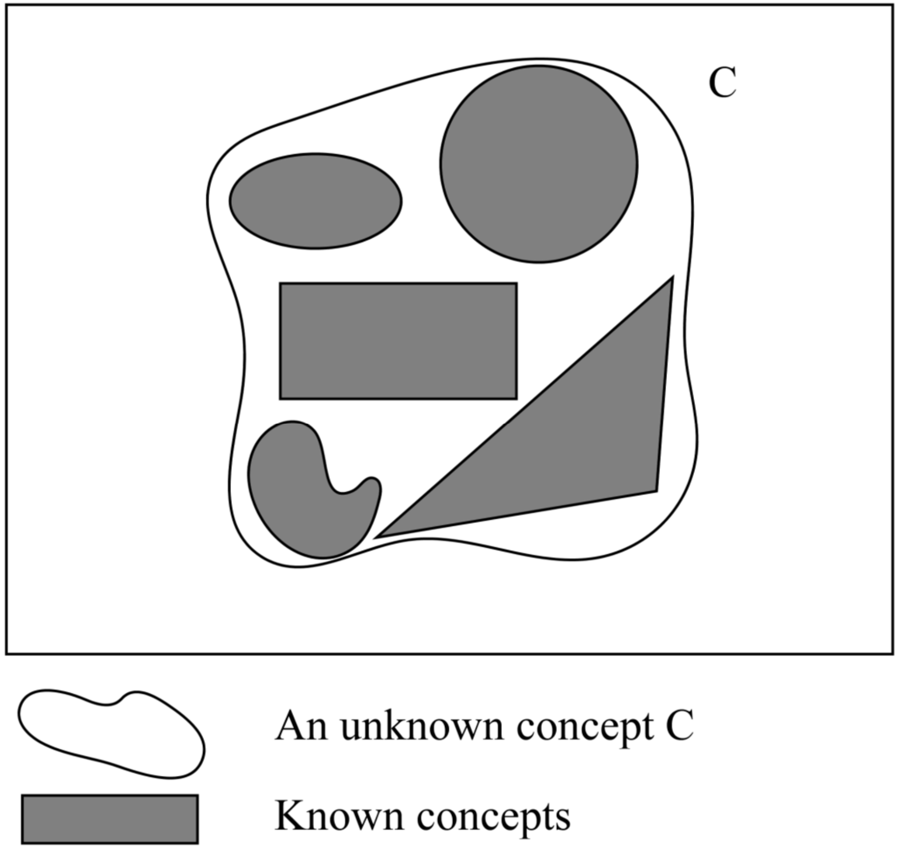


University of Regina

A model for concept learning

- Main idea: Using known concepts to approximate the unknown concept
- Three basic steps:
  1. Construct a family of known concepts
  2. Construct a good partition or covering for approximation
  3. For a known concept $\big(c, i(c), e(c)\big)$ and
     an unknown concept $(g, i(g), e(g))$,
     if $e(c) \subseteq e(g)$ then $i(c) \Longrightarrow i(g)$

How do machines learn a single concept?



A partition-based learning strategy

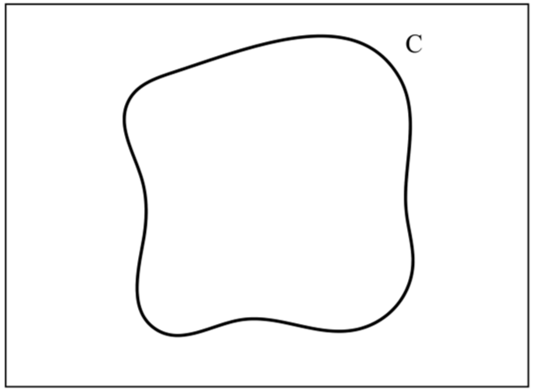


Fig. (1) Learning the unknown concept

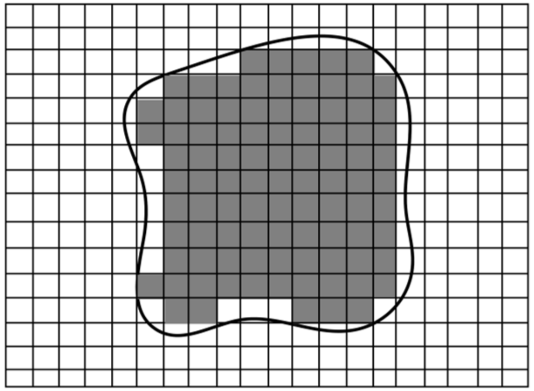


Fig. (2) A partition with finner granules

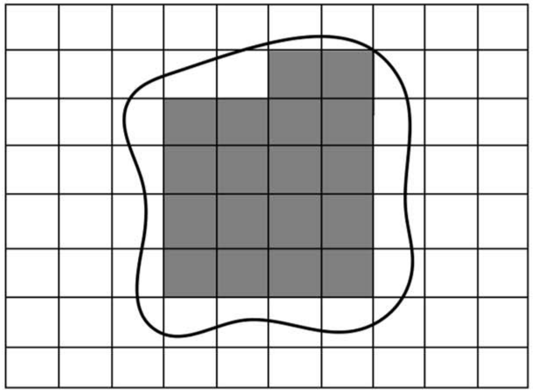


Fig. (3) A partition with coaser granules

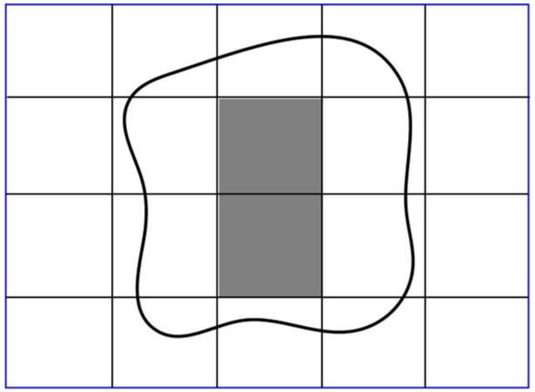


Fig. (4) The maximal general solution

A covering-based learning strategy

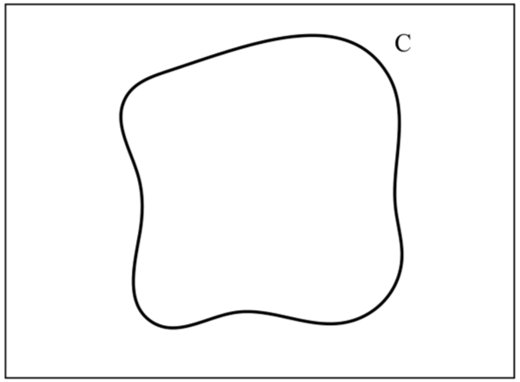


Fig. (1) Learning the unknown concept

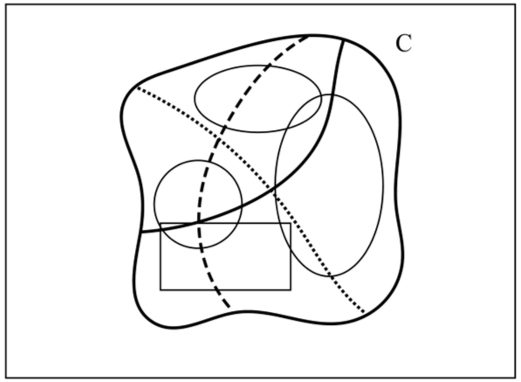


Fig. (2) A covering with finner granules

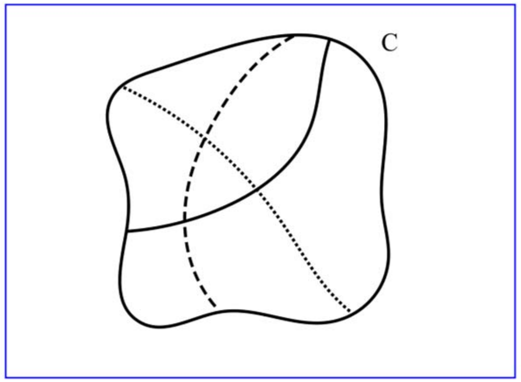


Fig. (3) The maximal general solution

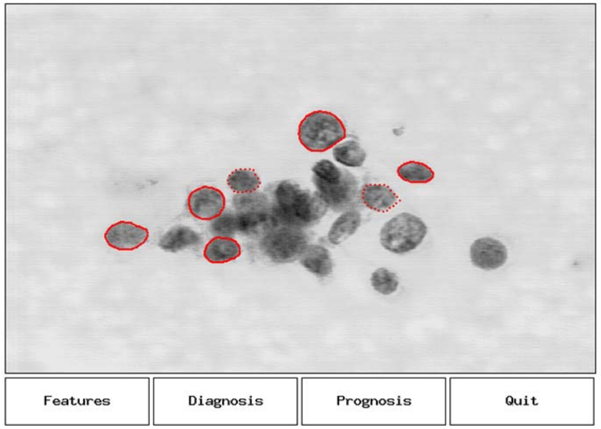
University of Regina

Applications

A dancing spider robot,
University of Arizona

http://hplusmagazine.com/2010/02/15/can-he-make-dancing-hexapod-robot-happy/

Cancer diagnosis,
University of Wisconsin



http://pages.cs.wisc.edu/~olvi/uwmp/cancer.html

Reference

- **X.F. Deng**, Yao, Y.Y. (2012) An information-theoretic interpretation of thresholds in probabilistic rough sets, RSKT'12.
- Yao, Y.Y., **X.F. Deng**. (2012). Granular Computing Paradigm for Concept Learning. In: Ramanna, S., Jain, L., Howlett, R.J. (Eds.), Emerging Paradigms in Machine Learning, Springer, London, pp. 307-326.
- Ross, B. H., Spalding, T. L. (1994). Concepts and Categories. Academic Press, New York.
- Yao, Y.Y. (2008). A unified framework of granular computing. In: Pedrycz W, Skowron A and reinovich V (eds.) Handbook of Granular Computing, pp. 401-410. Wiley, New York.

Questions?

Thank you

Xiaofei Deng

Department of Computer Science

deng200x@cs.uregina.ca

University of Regina

Realize. It starts with you.