

7th Annual IAS-STS Conference on "Critical Issues in Science and Technology Studies",

Graz, 8-9 May 2008

**THE SHIFT TO SOFT COMPUTING IN ARTIFICIAL  
INTELLIGENCE AND ITS RELATION TO ALTERNATIVE  
KINDS OF EPISTEMOLOGY**

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# 1. “Women *into* IT” Approach (Liberal Approach)

- Characteristic of studies within Computer Scientists and policy makers (Communication of the ACM, SIGSE: i.e. Camp, Pearl, Klawe, Frenkel). Share the general liberal discourse of “Gender Equity”.
- Two kind of analysis:
  - Statistical research about the under-representation of women in the field.
  - Analyses of structural barriers: in recruitment, education, training...
- **IT itself is not questioned:** Since IT is neutral the problem is located in women, they are expected to change to be educated and “adapted” to technology.
- There have been a lot of interventions from this perspective, though with very little impact.

## 2. Cyberfeminist Studies

- Centred more in the “Communication” part of ICTs (Internet)
- Posmodernist and Cultural Studies
- Not questioning technology: mostly Techno-optimists.
- Gender essentialist

### 3. *Gender Studies of IT* (Feminist Constructivist Approach) (I)

Turn from “Women and Technology” to “Gender and (Information) Technology”.  
**Thesis of the “Co-construction” or “Mutual Shaping” of Gender and Technology.**

**1. Analyses at a general level:** Using Harding’s Multi-level Model (Gender Structure, Gender Symbolism and Gender Identity) in relation to Technology

- **A) Studies of “Computer cultures”:** Technology as culture is seen as set of meanings attached to technology. These studies analyse the symbolic (gendered) meanings of IT such the masculine Images in “the hacker culture” and “the nerd image of computing” (*Turkle, Hapnes and Sorensen*). Other authors do semiotic studies through the analysis of language and metaphors (i.e. the “brain metaphor”). (*van Ost*)
- **B) Studies of Gender Identities in Computing:** Technology as culture is implicated in the construction of subjective gender identities. One paradigmatic case of identity related to Technology is that of the **Engineer**, which is related with (one type) of masculinity (*Faulkner, Mellström*). There are some studies about “Knowledge Engineers”, which is part of Artificial Intelligence (*Forsythe*)

### 3. *Gender Studies of IT* (Feminist Constructivist Approach) (II)

#### 2. Analyses of concrete technologies:

Using the concept/tool of “Gender-Script”: Gender is not only the meanings “associated” to artifacts in the realm of use but designers incorporate gender to the very materiality of artifacts. (*Oudshoorn, van Ost, Rommes’s case of Amsterdam’s Digital City*).

- **Critiques to Feminist Constructivist Studies of Technology:**
  - There exists an (unintended) tendency to gender essentialism (use of terms such “feminine skills”, “feminine connotated values”...) which at the end reinforce existing gender binary stereotypes (*Landström, 2007*).
  - Except for the analysis of cultural inscriptions in use and very concrete cases of shaping of IT through designer's representation of users, Computer Science and IT themselves are not questioned, nor deconstructed.

## 4. Analysis of the Discipline itself (Epistemological Approach)

- **Focused on the foundations** of Computer Science: fundamental concepts within the discipline.
- Björkman (2005) identifies **two ways of analyzing “Computer Science itself”**:
  - A) How paradigms (theories and methods) are constructed and maintained: which are the paradigmatic basis of Computer Science, whether exists other paradigms...
  - B) Epistemological Questions: How knowledge is constructed within the history of the discipline, why only certain ways of knowing are consider “valid”, who “has” or characterized that kind of knowledge....
- **Based on the insights of Feminist Epistemologies**

## Example of the Epistemological Approach: Artificial Intelligence

*“Artificial Intelligence is the science of making machines do things that would require intelligence if done by men” (Marvin Minsky, 1968)*

- **Symbolic AI** is the tradition in AI that emphasizes representation in symbolic form. It was the main paradigm in AI in the four decades after 1950. **Herbert Simon y Allen Newell (1955) presented the first AI system called Logical Theorist (LT)** which “reasoned logically”: a set of symbols represent concepts and a set of rules allow to manage the symbols to arrive deductively to conclusions. LT was able to demonstrate some theorems of Russel and Whitehead’s Principia Matemática.
- **There are other traditions in such Neural Networks, Expert Systems, Evolutionary Computing....**
- **Feminist Studies of AI** try to make explicit the implicit assumptions or “inscriptions” in the way knowledge is conceived and used in Artificial Intelligence (Adam 1998)

# Contrasting Epistemologies

## AI Classical Epistemology

1. “Objective” Knowledge
2. Propositional knowing  
(*knowing that*)
3. Logical and abstract reasoning
4. Rationalist and Procedural Epistemology
5. Lack of reflexivity

## Feminist Epistemology

1. Situated Knowledge
2. Other types of knowing:  
“*knowing how*”, bodily knowledge
3. Concrete reasoning
4. Epistemological Pluralism
5. Aimed to change and intervention

## The turn to Soft Computing (I)

- **Soft Computing / Computational Intelligence** is an interdisciplinary field that covers the theories of Fuzzy Sets and Systems, Artificial Neural Networks and Evolutionary Algorithms – scientific fields that arose from the 1940s to the 70s.
- The concept of **Fuzzy Set (also Fuzzy Logic)** was introduced by **Lotfi Zadeh** in **1965**, and it was defined as “a problem-solving and control system methodology which is empirically-based rather than a mathematical one, which provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise or missing input information”.
- Soft Computing differs from conventional (hard) computing in that it is tolerant of **imprecision, uncertainty, partial truth, and approximation**. It represents a significant paradigm shift in the aims and ways of doing computing,
- **Plurality of Methods:** All of these methods are complementary and not competitive in Soft computing. As Lotfi Zadeh says, the advantage comes from the combination of them (for example “neurofuzzy” consumer products and systems, that use a combination of fuzzy logic and neural network techniques).

## The turn to Soft Computing (II)

- **“Computing with Words”**: In May 1996 Zadeh coined the idea that the main contribution of Fuzzy Logic is *Computing with Words*. Fuzzy sets are able to make models of natural language’s concepts and these models can be used to compute directly with them.
- **Fuzzy sets models are dependent of the context**: They follow Wittgenstein’s idea that “the meaning of a word is its use in language”. In this way, previous empirical analysis of the context of use is an obligatory step for soft computing developments.
- **Fuzzy Engineering**: Soft Computing is not only a theoretical approach in Artificial Intelligence, it also has a **very important part of technical developments** (mainly in Japan, but now in many countries). Most of the developments are Domestic Technologies: washing and dryer machines, microwaves, refrigerators, “rice cookers”...

## Hard vs Soft as presented in Soft Computing

### Hard Computing

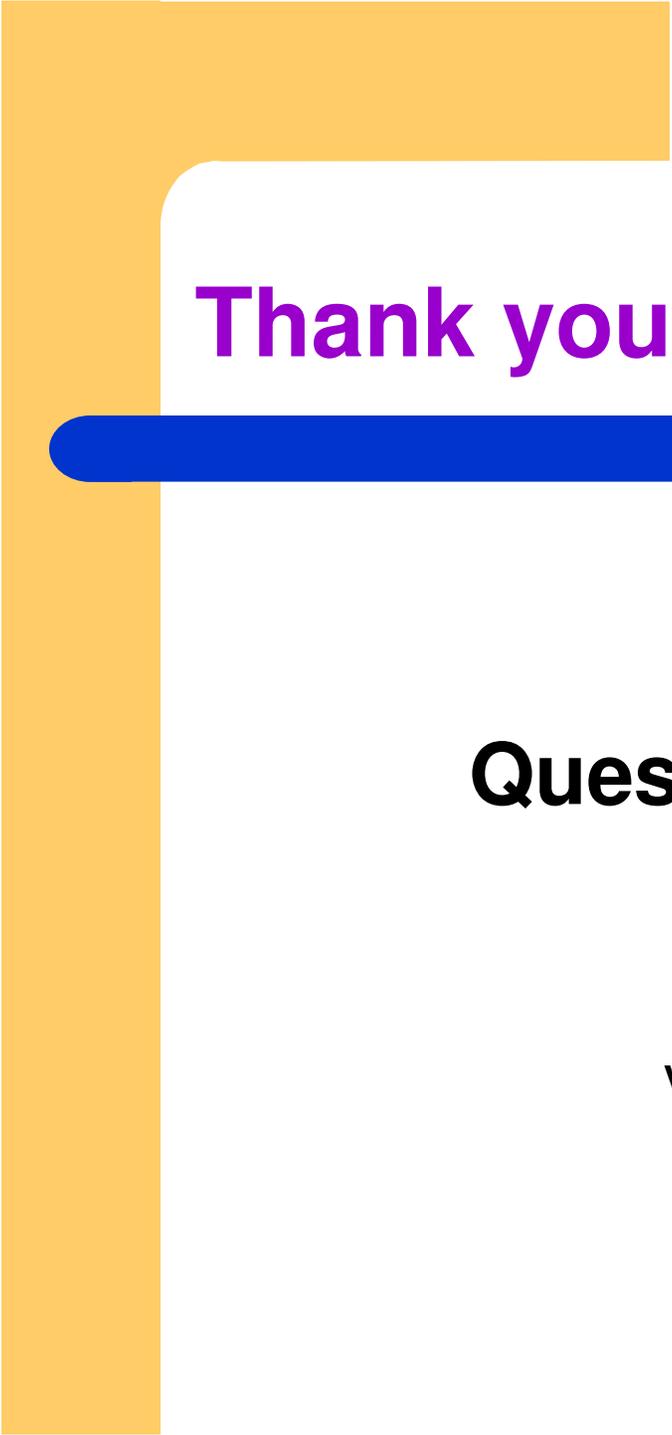
- **Rigid/Crisp/Precise**
- **Bi-valued**
- **Total order**
- **Abstract based**
- **Unique**
- **Numbers**

### Soft Computing

- **Flexible/Approximate**
- **Fuzzy-valued**
- **Partial order**
- **Empirically  
(Contextually) based**
- **Hybrid/Plural**
- **Words: “Computing  
with Words” Project**

# Some questions for future work

- The **paradigm shift** in AI of which Soft Computing is part includes also other approaches such **Situated Robotics, Sociable/Emotional Robotics and Affective Computing**. They try to model other types of knowledge: common sense, bodily skills, emotions...
- **Do these new approaches challenge the universality of the knower subject or support other ways of knowing in IT in general?** (i.e. taking into account the variability of common sense among different cultures in Soft Computing projects, or situating the robots not only physically but culturally)
- **Do these disciplines make any reference to the gendered feature of the knowledge they work on** (i.e. There are more women working on this approaches)? There is a risk of “assimilation” of this new-valued type of computing and just be “adapted” to the mainstream, as happened before with other paradigms.



**Thank you!**



**Questions or comments?**

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