

Introduction and Paradigms

Programming Language Concepts Lecture 1

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Course Goals

1. Expose students to the four major programming paradigms: imperative, object-oriented, functional, and logic.
2. Cover programming language specification: syntax and semantics
3. Discuss language constructs, design goals, run-time structures, and implementation techniques.

Course Goals (cont'd)

- Not merely a tour of programming languages.
- The goal is to study the LINGUISTICS of programming. An analogy: a linguist has more knowledge than merely speaking a few languages.

Course Topics

1. Paradigms.
2. Evolution of Programming Languages (postpone?)
3. Compiling.
4. Lexical and Syntax Analysis (parsing)
5. Names, Scopes and Bindings.
6. Data Types.
7. Expressions and Assignment.
8. Control flow.
9. Subprograms.
10. Object-oriented programming (C++)

Course Topics

11. Concurrency.
12. Functional Programming Languages.
13. Logic Programming Languages.

Paradigms

- Paradigms
 - Paradigm definition
 - The paradigm shift
 - Paradigm blindness and paralysis
 - Examples

Definition of Paradigm

- Thomas Kuhn (The Structure of Scientific Revolutions): "... accepted samples of practical methods in science."
- Adam Smith (Powers of the Mind): "A shared set of assumed facts. Water to the fish, a paradigm explains the world and allows us to predict its behavior. When in the middle of a paradigm, it is difficult to imagine any other."

Definition of Paradigm (cont'd)

- Willis Hartman (An Incomplete Guide to the Future): "... a basic way of perceiving, thinking, valuing and doing things that are associated with a particular vision of reality."
- Marilyn Ferguson (The Aquarian Conspiracy): "... a framework for thought... a scheme for understanding and explaining certain aspects of reality."

Definition of Paradigm (cont'd)

- Joel Barker (Discovering the Future: The Business of Paradigms): " ... a set of rules that define limits, and establish what's necessary to be successful within those limits."
- **NOTE:** We humans subscribe to paradigms composed of a **SMALL** set of rules, and we have a **STRONG** tendency to resist letting them go.

The Paradigm Shift

- A change in rules: old rules not only stop being useful, but they **GET IN THE WAY**.
- Examples (in general):
 - Rise(and then fall) of Japan as a economical superpower.
 - Fall of the Soviet Union.
 - South Africa abolishes apartheid without bloodshed.

The Paradigm Shift (cont'd)

- College degree no longer a guarantor of economic success.
- Computers (and Internet) for everyone.
- Offshoring of IT jobs (IT skills as a commodity).
- And, of course, 9/11/2001.

The Paradigm Shift (cont'd)

- Examples (specific to computing):
 - Structured programming.
 - Object oriented programming.
 - The WWW.
 - “Towers of Hanoi”
 - The .com boom (and bust).
 - Computing in Astronomy.
- NOTES:
 - Paradigm shifts occur suddenly.
 - Their timing is **VERY** difficult to predict.

The Paradigm Shift (cont'd)

- Change is instigated by an “outsider.”
 - The new college graduate, or a scientist moving from one discipline to another:
 - Unfamiliar with the established paradigm.
 - Not “vested” in the old paradigm.

The Paradigm Shift (cont'd)

- Example:

“If I had thought about it, I wouldn't have done it. The literature is full of examples that show that this cannot be done” -- (Spencer Silver of 3M, inventor of Post-it notes).

Paradigm Blindness and Paralysis

- The mortal disease of certainty.
- Paradigms act as physiological filters; a colored filter before the eyes.
- The rules for the new paradigm are often completely **INVISIBLE** to those still subscribing to the old paradigm.

Paradigm Blindness and Paralysis (cont'd)

- Example: In the late 1930's, Chester Carlson showed Kodak, IBM and 41 other companies his new "photographic system":
 - a steel plate, some black powder, a piece of cat fur, a piece of amber, some wax paper, and an iron.
 - Only the Halloid Corporation adopted the new system. They later became ???

Paradigm Blindness and Paralysis (cont'd)

- Example: Who invented the quartz clock?
 - The swiss!
- Characteristics of paradigm blindness:
 - “That’s not the way we do it.”
 - “It is not going to work.”
 - “That’s impossible.”
 - “If you had my years of experience, you would know you are wrong.”

Paradigm Blindness and Paralysis (cont'd)

- Examples . . .

Programming (Language) Paradigms

- FOUR PARADIGMS OF COMPUTING
 - Imperative:
 - WHAT DO WE DO NEXT ?
 - Functional:
 - WHAT IS THE FUNCTION'S VALUE ?
 - Object-Oriented:
 - WHAT ARE THE TERMS OF THE CONTRACT ?
 - Logic:
 - WHEN IS IT TRUE THAT ... ?

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