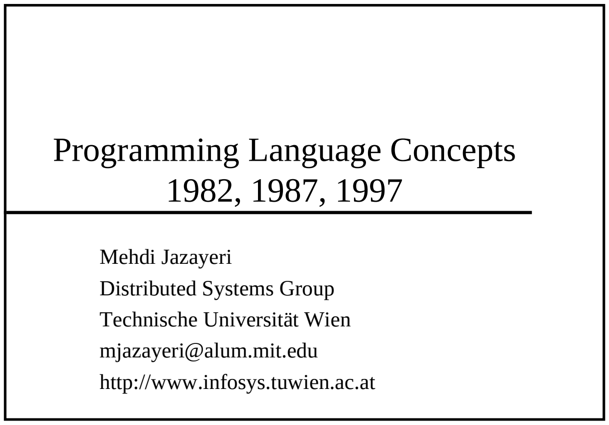
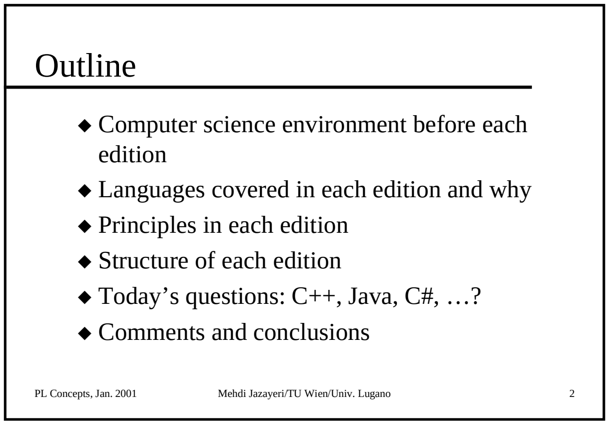


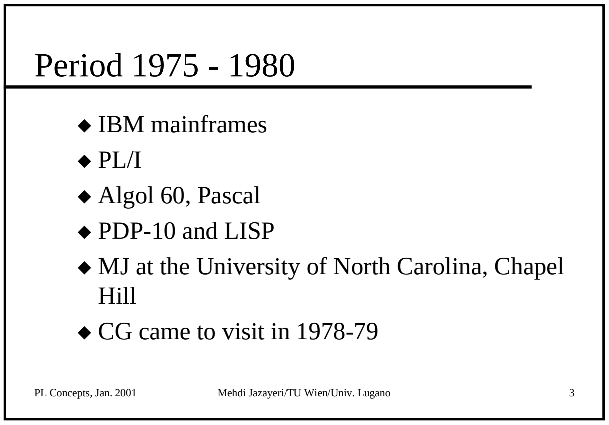
Programming Language Concepts 1982, 1987, 1997

Mehdi Jazayeri
Distributed Systems Group
Technische Universität Wien
mjazayeri@alum.mit.edu
http://www.infosys.tuwien.ac.at



Outline

- Computer science environment before each edition
- Languages covered in each edition and why
- Principles in each edition
- Structure of each edition
- Today’s questions: C++, Java, C#, …?
- Comments and conclusions



Period 1975 - 1980

- IBM mainframes
- PL/I
- Algol 60, Pascal
- PDP-10 and LISP
- MJ at the University of North Carolina, Chapel Hill
- CG came to visit in 1978-79

Environment before first edition (1980)

- Excitement about functional programming
- Excitement and apprehension about Ada
- C versus Pascal debates
- Unix and available computing (moving away from mainframes)
- Surprise: PROLOG

Environment before second edition (1985)

- Japanese Fifth Generation Project
  - Logic programming
  - PROLOG
- Acceptance of multiple paradigms
- Lowered expectation of formal methods
  - formal semantics
- Widespread unix
- Surprise: C++

Environment before third edition (1997)

- Dominance of object orientation
  - C++, Ada 95
- More functional programming
  - ML
- Excitement about Internet
  - Java, Java, Java, Java, Java, …
  - PCs, WWW, language implementations
- Surprise: ?

Today’s environment

- Domination of marketing
- Short term focus (time-to-market)
- ...

Choice of languages
First Edition

- Pascal
  - beauty and simplicity
  - teaching value
- Algol 68
  - blind adherence to language design principles
- Simula 67
  - fundamental support for abstraction through the class concept
- But not Ada -- why not?

Glossary of selected languages
First Edition

- Ada
- ALGOL 60
- ALGOL 68
- APL
- Bliss
- C
- CLU
- Concurrent Pascal
- COBOL
- Euclid
- FORTRAN
- Gypsy
- LISP
- Mesa
- Modula
- Pascal
- PL/I
- PLZ
- SIMULA 67
- SNOBOL4

Glossary of selected languages Second Edition

◆ Ada
◆ ALGOL 60
◆ ALGOL 68
◆ APL
◆ BASIC (added)
◆ Bliss
◆ C
◆ CLU
◆ COBOL
◆ Concurrent Pascal
◆ Euclid

◆ FORTRAN
◆ Gypsy
◆ LISP
◆ Mesa
◆ Modula-2 (repl. Modula)
◆ Pascal
◆ PL/I
◆ PROLOG (repl. PLZ)
◆ SIMULA 67
◆ Smalltalk
◆ SNOBOL4

Glossary of selected languages Third Edition

◆ Ada
◆ ALGOL 60
◆ ALGOL 68
◆ APL
◆ BASIC
◆ C
➨ C++
➨ CLIPS
➨ CLOS
◆ CLU

◆ COBOL
◆ Concurrent Pascal
➨ Eiffel
◆ Euclid
◆ FORTRAN
➨ Icon
➨ Java
◆ LISP
◆ Mesa
➨ ML

◆ Modula-2
➨ Modula-3
➨ Oberon-2
➨ OPS5
◆ Pascal
➨ Perl
◆ PL/I
◆ PROLOG
➨ Python
➨ Scheme
➨ SETL

◆ SIMULA 67
◆ Smalltalk
◆ SNOBOL4
➨ Tcl/Tk

➨ indicates addition

removed: Bliss, Gypsy

Glossary of selected languages additions in Third Edition

➨ C++
➨ CLIPS
➨ CLOS

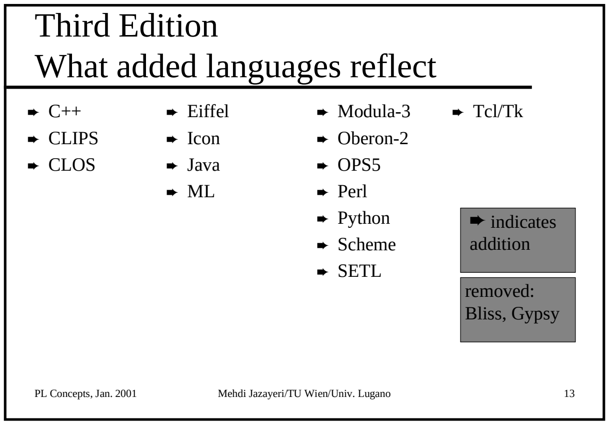
➨ Eiffel
➨ Icon
➨ Java
➨ ML

➨ Modula-3
➨ Oberon-2
➨ OPS5
➨ Perl
➨ Python
➨ Scheme
➨ SETL

➨ Tcl/Tk

➨ indicates addition

removed: Bliss, Gypsy

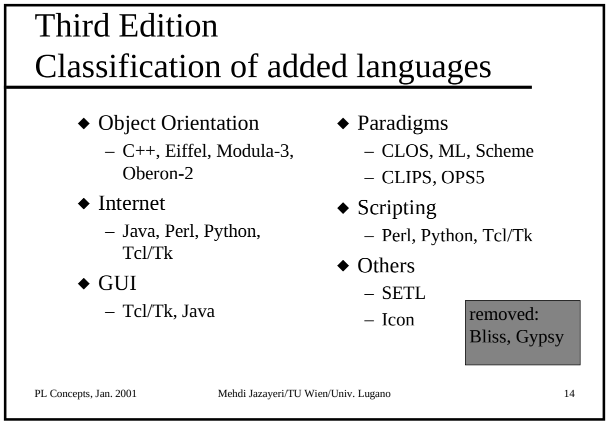


Third Edition
What added languages reflect

- ➨ C++
- ➨ CLIPS
- ➨ CLOS
- ➨ Eiffel
- ➨ Icon
- ➨ Java
- ➨ ML
- ➨ Modula-3
- ➨ Oberon-2
- ➨ OPS5
- ➨ Perl
- ➨ Python
- ➨ Scheme
- ➨ SETL
- ➨ Tcl/Tk

➨ indicates addition

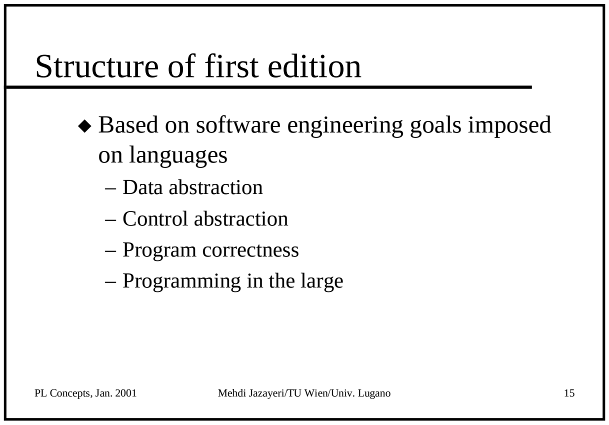
removed: Bliss, Gypsy



Third Edition
Classification of added languages

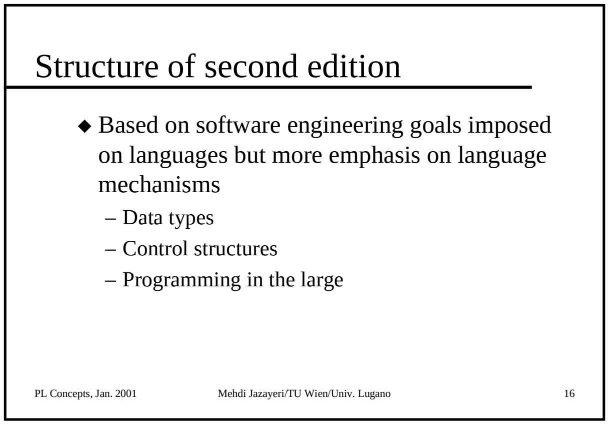
- ◆ Object Orientation
  - C++, Eiffel, Modula-3, Oberon-2
- ◆ Internet
  - Java, Perl, Python, Tcl/Tk
- ◆ GUI
  - Tcl/Tk, Java
- ◆ Paradigms
  - CLOS, ML, Scheme
  - CLIPS, OPS5
- ◆ Scripting
  - Perl, Python, Tcl/Tk
- ◆ Others
  - SETL
  - Icon

removed: Bliss, Gypsy



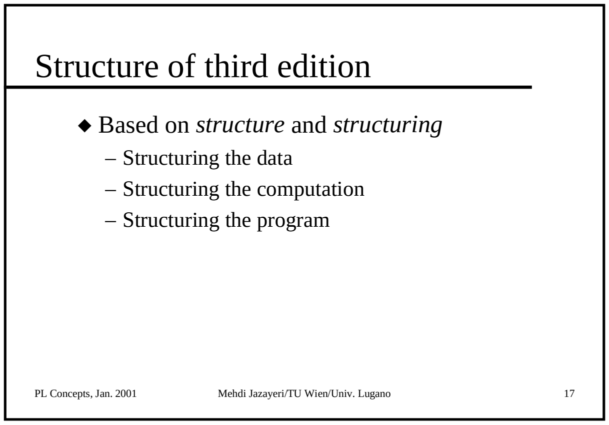
Structure of first edition

- ◆ Based on software engineering goals imposed on languages
  - Data abstraction
  - Control abstraction
  - Program correctness
  - Programming in the large



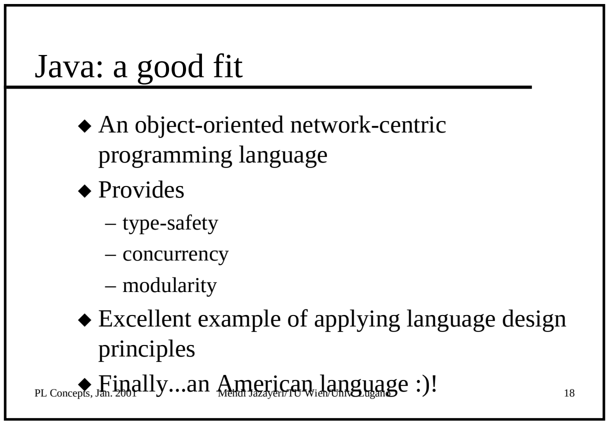
Structure of second edition

- Based on software engineering goals imposed on languages but more emphasis on language mechanisms
  - – Data types
  - – Control structures
  - – Programming in the large



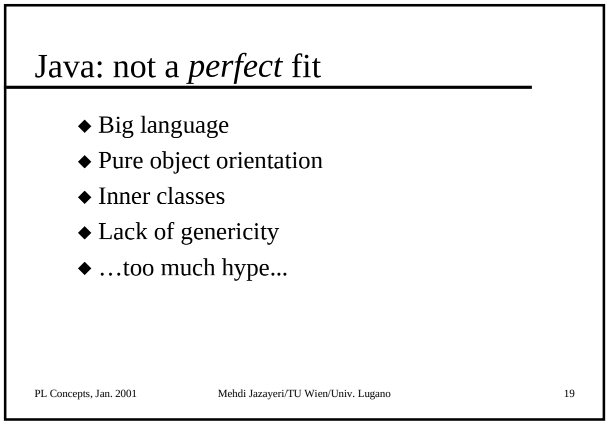
Structure of third edition

- Based on *structure* and *structuring*
  - – Structuring the data
  - – Structuring the computation
  - – Structuring the program



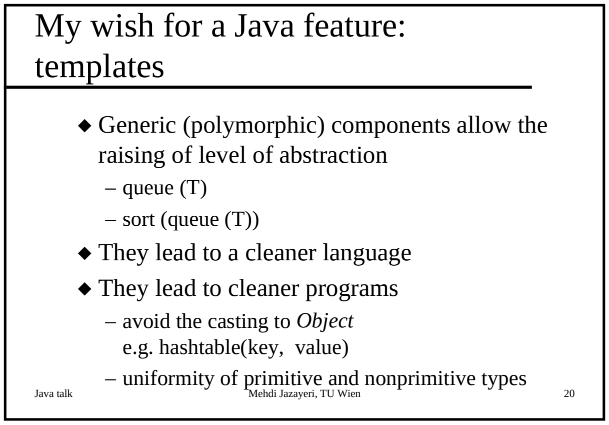
Java: a good fit

- An object-oriented network-centric programming language
- Provides
  - – type-safety
  - – concurrency
  - – modularity
- Excellent example of applying language design principles
- Finally...an American language :)!



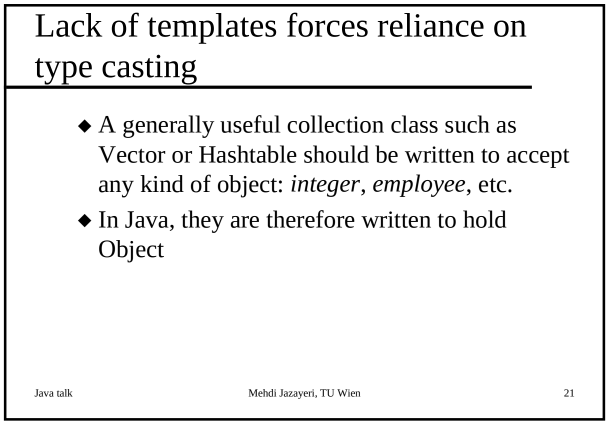
Java: not a *perfect* fit

- ◆ Big language
- ◆ Pure object orientation
- ◆ Inner classes
- ◆ Lack of genericity
- ◆ …too much hype...



My wish for a Java feature: templates

- ◆ Generic (polymorphic) components allow the raising of level of abstraction
  - – queue (T)
  - – sort (queue (T))
- ◆ They lead to a cleaner language
- ◆ They lead to cleaner programs
  - – avoid the casting to *Object*
    e.g. hashtable(key, value)
  - – uniformity of primitive and nonprimitive types



Lack of templates forces reliance on type casting

- ◆ A generally useful collection class such as Vector or Hashtable should be written to accept any kind of object: *integer*, *employee*, etc.
- ◆ In Java, they are therefore written to hold Object

Vector class

- Some methods of Vector:
  public void addElement(Object)
  public Object firstElement()
  pubic int capacity()
  public int size()
- What if we want to insert a *Point p* into vector *v*?

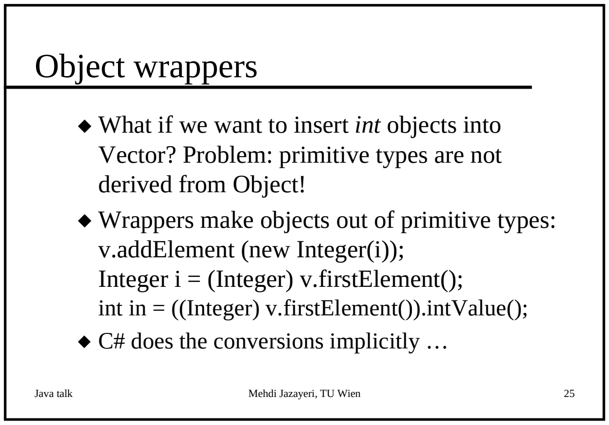
Need for casts with Vector

- To insert Point p in Vector v:
  v.addElement (p);
- What about getting an element out?
  p = v.firstElement(); XXX No! XXX
- We must use a cast:
  p = (Point) v.firstElement();

More problems:

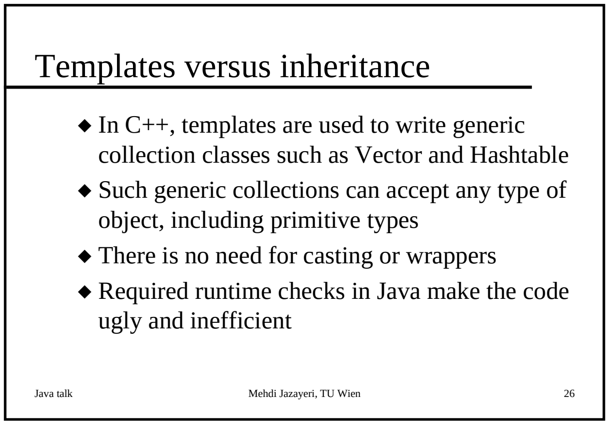
- What if the vector may contain objects of different types: Points, Pixels, Boxes…?
- Need runtime checks:

```
Object o = v.firstElement();
if (o instanceof Point) {
     // code to process Point object
}
if (o instanceof Pixel) { ...
```



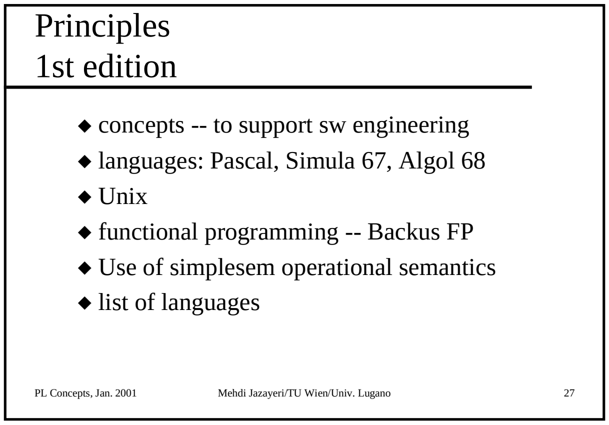
Object wrappers

- What if we want to insert *int* objects into Vector? Problem: primitive types are not derived from Object!
- Wrappers make objects out of primitive types:
  v.addElement (new Integer(i));
  Integer i = (Integer) v.firstElement();
  int in = ((Integer) v.firstElement()).intValue();
- C# does the conversions implicitly …



Templates versus inheritance

- In C++, templates are used to write generic collection classes such as Vector and Hashtable
- Such generic collections can accept any type of object, including primitive types
- There is no need for casting or wrappers
- Required runtime checks in Java make the code ugly and inefficient



Principles
1st edition

- concepts -- to support sw engineering
- languages: Pascal, Simula 67, Algol 68
- Unix
- functional programming -- Backus FP
- Use of simplesem operational semantics
- list of languages

Principles
2nd edition

- paradigms -- more on functional but logic and rule-based also
- Fifth Generation
- formal semantics
- list of languages

Principles
3rd edition

- concepts -- structure
  - structuring the data
  - structuring the computation
  - structuring the program
- languages: C++, ML, Java, Ada 95
- paradigms: OO
- list of languages

New possibilities
Third edition

- Web site http://www.infosys.tuwien.ac.at/pl-book
- Simplesem interpreter in Java
  - first edition: concepts
  - second edition: more rigorous
  - third edition: supported by interpreter

Anticipating language developments

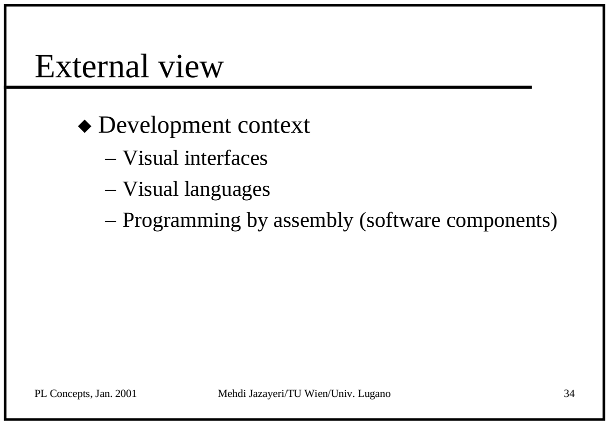
- Inside view
  - linguistic details such as control and data structure
  - drives some (research) languages
- Outside view
  - how is the language used?

External view

- External view determines development of languages
- Context of use
  - execution
  - development
- Successful languages take the external view into account

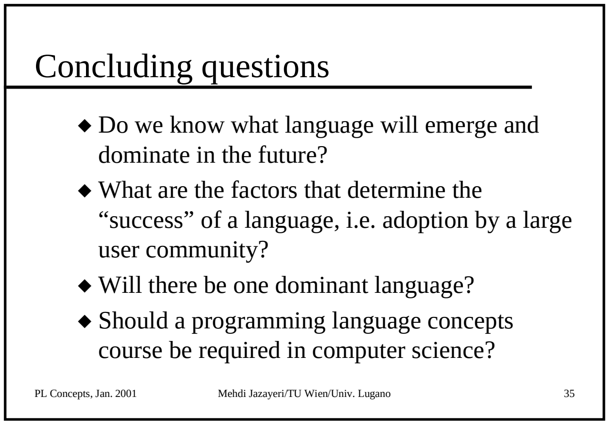
External view

- Execution context
  - user-interfaces
    - multimedia devices
  - computational model
    - Internet
    - middleware
  - database integration
  - dealing with time



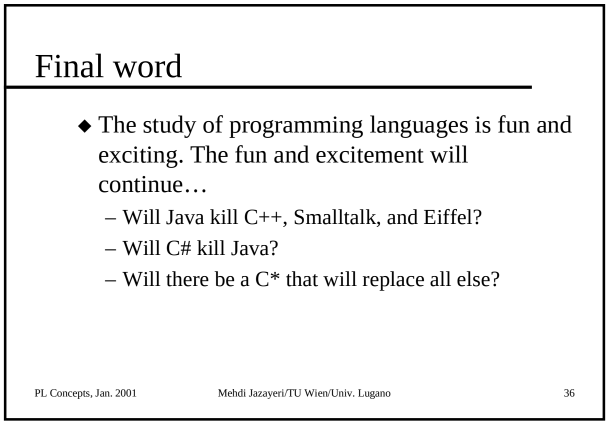
External view

- Development context
  - Visual interfaces
  - Visual languages
  - Programming by assembly (software components)



Concluding questions

- Do we know what language will emerge and dominate in the future?
- What are the factors that determine the “success” of a language, i.e. adoption by a large user community?
- Will there be one dominant language?
- Should a programming language concepts course be required in computer science?



Final word

- The study of programming languages is fun and exciting. The fun and excitement will continue…
  - Will Java kill C++, Smalltalk, and Eiffel?
  - Will C# kill Java?
  - Will there be a C* that will replace all else?