CS 220: Survey of Programming Languages

Lecture Slides

Object Oriented Programming Languages

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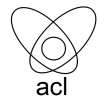
Session 5



Object Oriented Programming Languages

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C++

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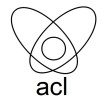

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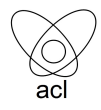
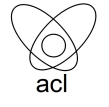
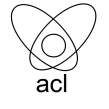


Characteristics of an object-oriented PL



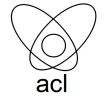
Characteristics of an object-oriented PL

- Classes as objects



Characteristics of an object-oriented PL

- Classes as objects
  - Variables as properties
  - Procedures/functions as methods



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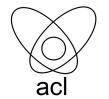

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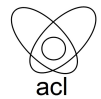

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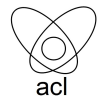

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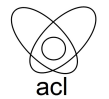
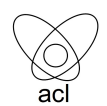
- Deeply rooted from imperative PLs



The "birth" of OO according to Alan Kay



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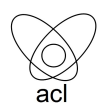

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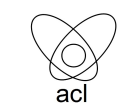

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- "I recalled the monads of Leibniz, the "dividing nature at its joints" discourse of Plato, and other attempts to parse complexity."

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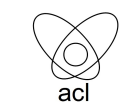
By the way...



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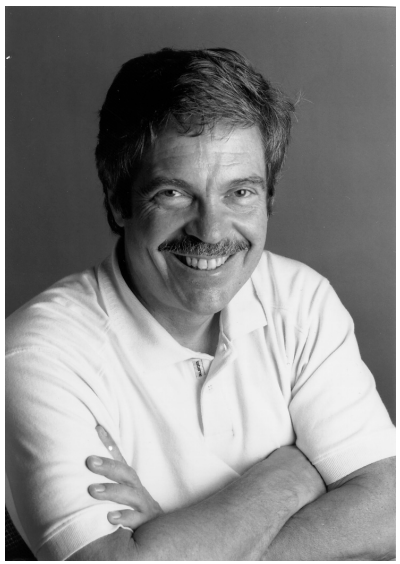

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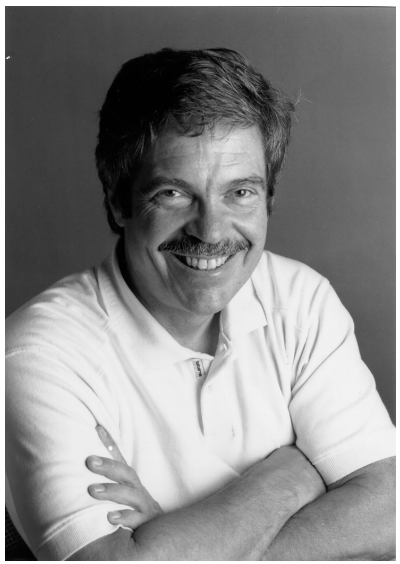

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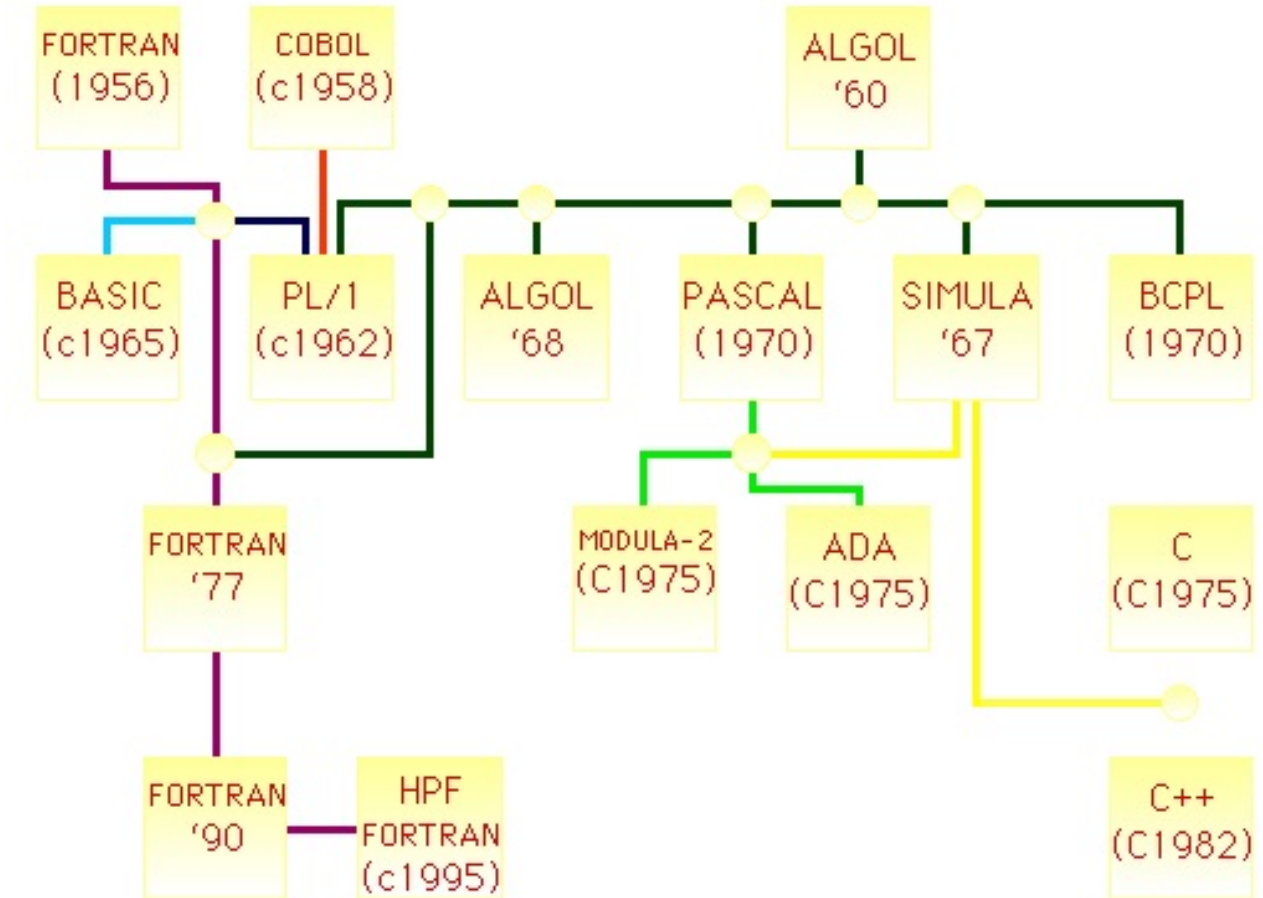
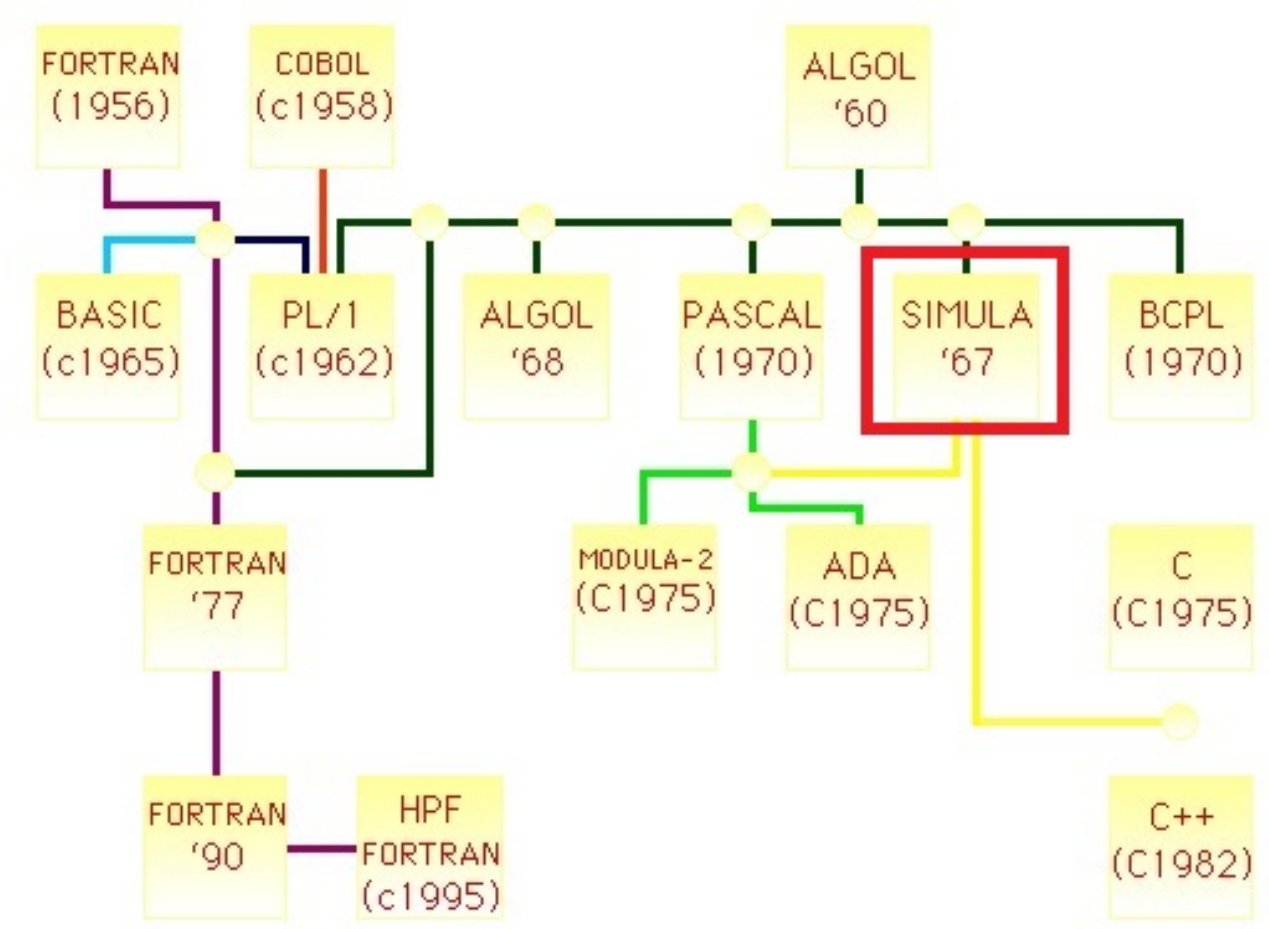
Imperative PL"lineage" redux



http://cgi.csc.liv.ac.uk/~grant/Teaching/COMP205/intro.html

Simula as the progenitor of OOPLs



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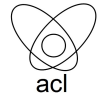

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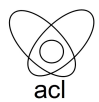

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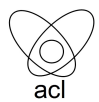

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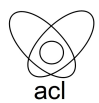

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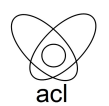

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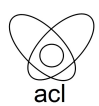

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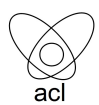

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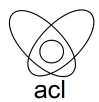

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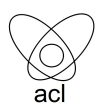

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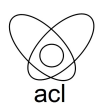

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  - "The class holds the shared behavior for its instances"
  - "To eval[uate] a program list, control is passed to the first object and the remainder is treated as its message"

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Evaluation

- Data types[1,2]

[1] http://people.cs.clemson.edu/~turner/courses/cs428/current/webct/content/st/stbasics.html

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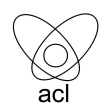

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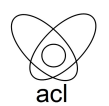

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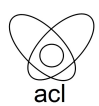

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  - Support for multidimentional arrays, which can be unbounded
  - Pointers are implicit objects

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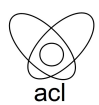

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- Syntax design (Redline[3,4])

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- Syntax design (Redline[3,4])
  - Production rules: 131
  - Number of top alternatives: 51
  - Number of symbols: (unaccounted)
  - Vocabulary
    - Nonterminal symbols: 80
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  - Everything is a class, even primitive data types
  - Too orthogonal for an OOPL, that programming tends to create Ravioli Codes[5]

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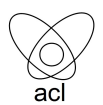

Evaluation

- Abstraction

[6] http://pharo.gforge.inria.fr/PBE1/PBE1ch6.html
[7] http://java.ociweb.com/mark/programming/Smalltalk.html
[8] http://www.mimuw.edu.pl/~sl/teaching/00_01/Delfin_EC/Overviews/ExceptionHandling.htm

Evaluation

- Abstraction
  - Methods are public and instance variables are private (to the instances that own it) [6]

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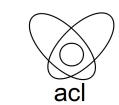

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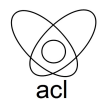

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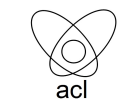

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  - Modern versions
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    - Signal classes (e.g. VisualWorks)

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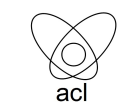

Evaluation

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    - Dynamic typing
  - Interpreter executes bytecode to evaluate expressions and methods
  - Primitive methods implemented directly in machine language

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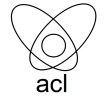
Object Oriented Programming Languages

Object Oriented Programming Languages

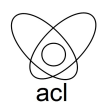
Smalltalk

C++

Java



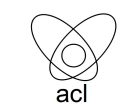
Background



http://groups.engin.umd.umich.edu/CIS/course.des/cis400/cpp/cpp.html

Background

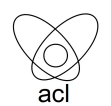
- C++ is an "upgrade" of C to handle object-oriented programming.



http://groups.engin.umd.umich.edu/CIS/course.des/cis400/cpp/cpp.html

Background

- C++ is an "upgrade" of C to handle object-oriented programming.
- Developed by Bjarne Stroustrup at Bell Laboratories and published initially in 1983



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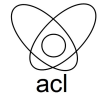
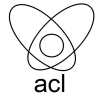


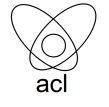
Evaluation

- Data types



Evaluation

- Data types
  - Integers, floating and fixed point real numbers, characters, enumerations as primitive types



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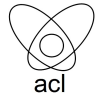

Evaluation

- Data types
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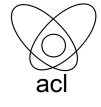
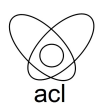
  - Support for multidimentional arrays
  - Explicit pointers
  - Allows for derived structures using `struct` and `typedef` declarations apart from class declarations



Evaluation

- Syntax design (C++ 0x[13])



[13] http://slebok.github.io/zoo/cpp/cpp0x/n2723/extracted/index.html

Evaluation

- Syntax design (C++ 0x[13])
  - Production rules: 159
  - Number of top alternatives: 449
  - Number of symbols: 1,835
  - Vocabulary
    - Nonterminal symbols: 162
    - Terminal symbols: 119

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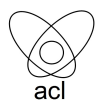
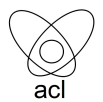


Evaluation

- Syntax design (Continuation)



[14] RA Sebesta, Chapter 1.3

Evaluation

- Syntax design (Continuation)
  - Orthogonality[14]

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    - Primitive types and `structs` can be returned from functions, but cannot (technically) be done for arrays.

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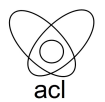

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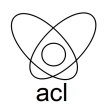

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  - "I made up the term 'object-oriented', and I can tell you I didn't have C++ in mind" - Alan Kay
  - "C++ would make a decent teaching language if we could teach the ++ part without the C part." - Michael B. Feldman.

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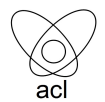
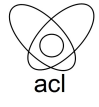


Evaluation

- Abstraction



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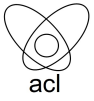

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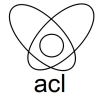
  - `namespace` declarations allow additional scoping of variables



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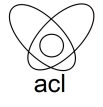
- Expressivity: Rich standard library allows for easier coding of fundamental algorithms and data structures



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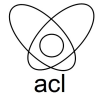
- Exception handling: `try`, `catch`, and `throw` keywords



Evaluation

- Restricted aliasing

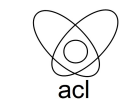
acl

[15] http://www.drdobbs.com/cpp/comparing-cc-compilers/184405450

[16] http://scienceblogs.com/goodmath/2006/11/02/the-c-is-efficient-language-fa/

Evaluation

- Restricted aliasing
  - Explicit pointers



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Evaluation

- Restricted aliasing
  - Explicit pointers
  - Methods allow pass-by-reference

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Evaluation

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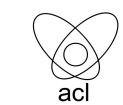
- Efficiency:



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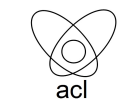
Evaluation

- Restricted aliasing
  - Explicit pointers
  - Methods allow pass-by-reference
- Efficiency:
  - Type checking: Employs both static (compile time) and dynamic (runtime) type checking



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Evaluation

- Restricted aliasing
  - Explicit pointers
  - Methods allow pass-by-reference
- Efficiency:
  - Type checking: Employs both static (compile time) and dynamic (runtime) type checking
  - C++ compilers are known for their efficiency in terms of memory and compilation time[15] (but of course, there are those that are more efficient especially when heavy number-crunching is involved[16])

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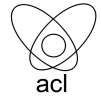
Object Oriented Programming Languages

Object Oriented Programming Languages

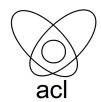
Smalltalk

C++

Java



Background



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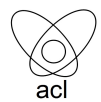
http://oracle.com.edgesuite.net/timeline/java/

Background

- Developed in 1991 by the Green Team led by ~~Ryan~~ James Gosling under the defunct Sun Microsystems



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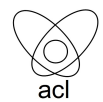
Background

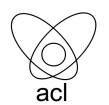
- Developed in 1991 by the Green Team led by ~~Ryan~~ James Gosling under the defunct Sun Microsystems
- Initially called Oak



http://oracle.com.edgesuite.net/timeline/java/

Background

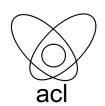
- Developed in 1991 by the Green Team led by ~~Ryan~~ James Gosling under the defunct Sun Microsystems
- Initially called Oak
- The main target of Java was to enhance Web experience



http://oracle.com.edgesuite.net/timeline/java/

Background

- Developed in 1991 by the Green Team led by ~~Ryan~~ James Gosling under the defunct Sun Microsystems
- Initially called Oak
- The main target of Java was to enhance Web experience
  - In 1994, Java (Oak) was used to develop WebRunner (now known as HotJava), a web browser that supports dynamic elements (e.g. video, reactive input-output mechanisms)
  - Achieved mainstream popularity in 1995



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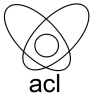
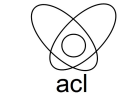
Evaluation

- Data types



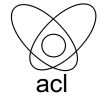
Evaluation

- Data types
  - Integers, floating and fixed point real numbers, characters, enumerations as primitive types



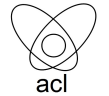
Evaluation

- Data types
  - Integers, floating and fixed point real numbers, characters, enumerations as primitive types
  - Support for multidimentional arrays



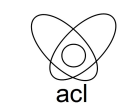
Evaluation

- Data types
  - Integers, floating and fixed point real numbers, characters, enumerations as primitive types
  - Support for multidimentional arrays
  - Allows for derived structures via class declarations



Evaluation

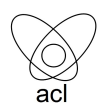
- Syntax design (Java 5.0[17])



[17] http://slebok.github.io/zoo/java/java-5/landman/extracted/index.html

Evaluation

- Syntax design (Java 5.0[17])
  - Production rules: 302
  - Number of top alternatives: 302
  - Number of symbols: 1,782
  - Vocabulary
    - Nonterminal symbols: 110
    - Terminal symbols: 265



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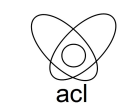
Evaluation

- Syntax design (Java 5.0[17])
  - Production rules: 302
  - Number of top alternatives: 302
  - Number of symbols: 1,782
  - Vocabulary
    - Nonterminal symbols: 110
    - Terminal symbols: 265
  - Grammar is similar to C++, but difference is that it was built primarily as an OOPL rather than something that was built on top of a PL with a different paradigm



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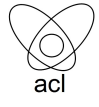
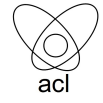
Evaluation

- Abstraction



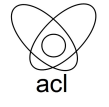
Evaluation

- Abstraction
  - Access grants to variables and procedures can be declared via `public`, `private`, and `protected`



Evaluation

- Abstraction
  - Access grants to variables and procedures can be declared via `public`, `private`, and `protected`
  - `package` declaration for grouping together related classes



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- Abstraction
  - Access grants to variables and procedures can be declared via `public`, `private`, and `protected`
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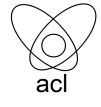
- Expressivity: Rich core API set allows for easier coding of fundamental algorithms and data structures



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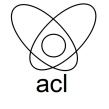
  - Access grants to variables and procedures can be declared via `public`, `private`, and `protected`
  - `package` declaration for grouping together related classes
- Expressivity: Rich core API set allows for easier coding of fundamental algorithms and data structures
- Exception handling: `try`, `catch`, and `throw` keywords



Evaluation

- Restricted aliasing: Everything is pass-by-value[18,19]

[18] http://jonskeet.uk/java/passing.html
[19] http://javadude.com/articles/passbyvalue.htm
[20] http://www.csi.ucd.ie/staff/jmurphy/publications/1681.pdf
[21] http://www.ibm.com/developerworks/library/j-codetoheap/
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Evaluation

- Restricted aliasing: Everything is pass-by-value[18,19]
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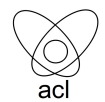

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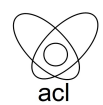

Evaluation

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  - Memory inefficiency[20,21]
  - Security vulnerabilities[22]

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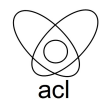

END OF SESSION 5