CS 220: Survey of Programming Languages

Lecture Slides

Imperative Programming Languages

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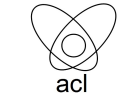
Session 4



Imperative Programming Languages

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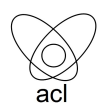
FORTRAN

Ada

Pascal

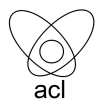
Imperative Programming Languages

Characteristics of an imperative PL



Characteristics of an imperative PL

- Statements are executed in a step-wise, sequential, manner



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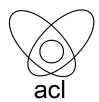
  - Order of execution is crucial



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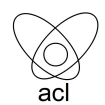
- Destructive assignment



Characteristics of an imperative PL

- Statements are executed in a step-wise, sequential, manner
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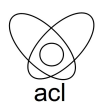
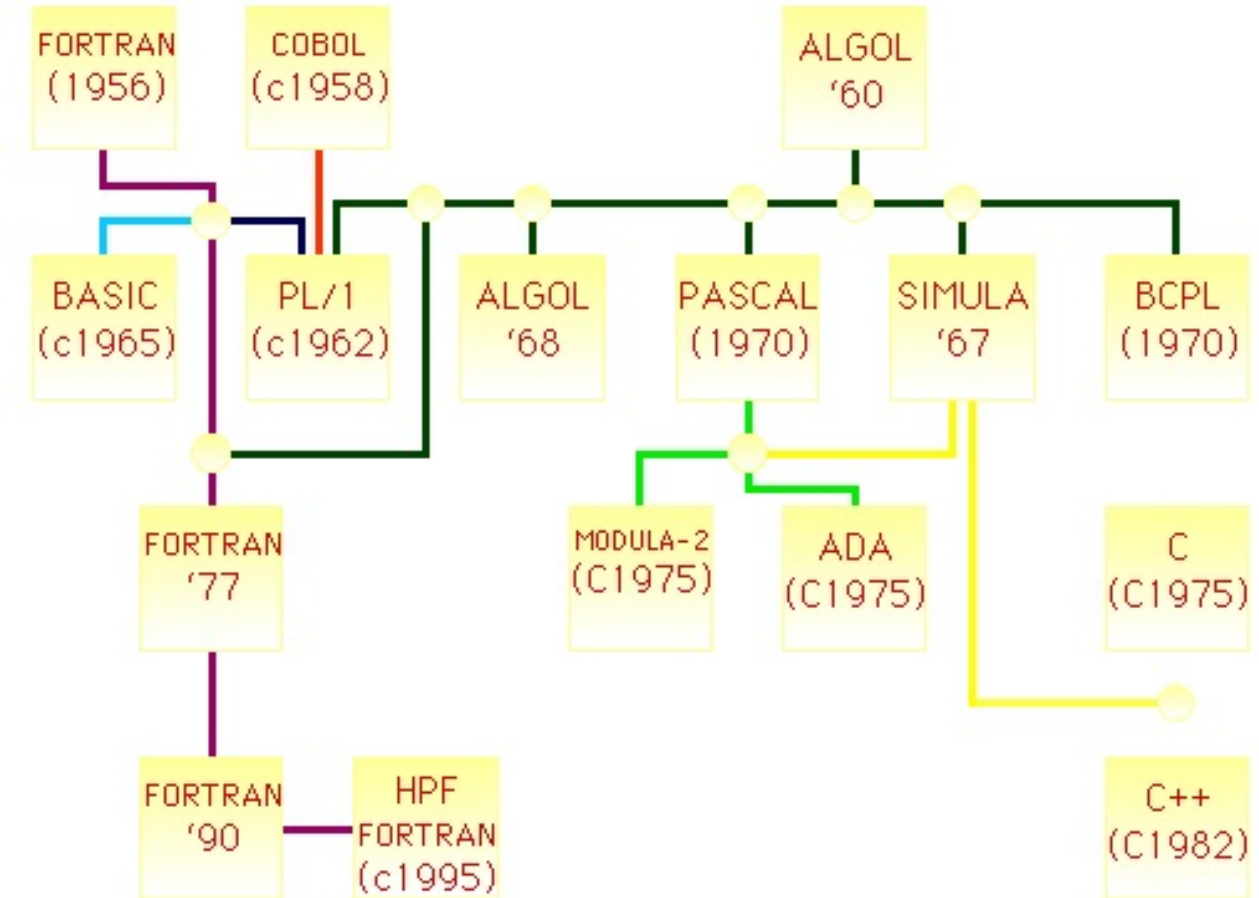
- Destructive assignment
- Control is the responsibility of the programmer

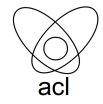


"Lineage" of imperative PLs



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

Imperative Programming Languages



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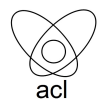

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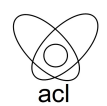

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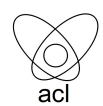

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Background

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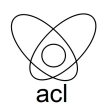
- FORTRAN was the first high-level language, using the first compiler ever developed
  - Credited for giving rise to compiler theory



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Evaluation

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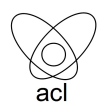

[1] http://cs.ubishops.ca/ljensen/fortran/pointer.htm

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- Data types[1]
  - Integers, real single and double precision floating point numbers, complex numbers, characters, logical as primitive types

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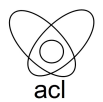

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  - Integers, real single and double precision floating point numbers, complex numbers, characters, logical as primitive types
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  - Pointers are derived types

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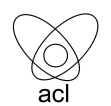

Evaluation

- Data types[1]
  - Integers, real single and double precision floating point numbers, complex numbers, characters, logical as primitive types
  - Support for multidimensional arrays, which can be unbounded
  - Pointers are derived types
  - Allows for derived structures using the `TYPE - END TYPE` declaration

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Evaluation

- Syntax design (Fortran 90[2])

[2] http://slebok.github.io/zoo/fortran/f90/derricks/extracted/index.html
[3] http://p.web.umkc.edu/pgd5ab/www/fortran_abstraction_and_encapsul.htm

Evaluation

- Syntax design (Fortran 90[2])
  - Number of production rules: 331
  - Number of top alternatives: 751
  - Number of symbols: 3,718
  - Vocabulary
    - Nonterminal symbols: 345
    - Terminal symbols: 173

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- Abstraction[3]
  - References to non-local variables were through `COMMON` blocks
  - `MODULE` to allow blocks of parameters, variables, and subprograms to be both shared and re-used.

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Evaluation

- Expressivity

[4] http://www.southampton.ac.uk/~fangohr/randomnotes/iop_cpg_newsletter/2007_1

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Evaluation

- Expressivity
  - On its own, it isn't as expressive as modern imperative language (e.g. no shortcut operators)

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Evaluation

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  - There are some efforts to improve expressiveness, albeit through modules[4]
- Exception handling: No exception handling in pure Fortran 95, but an attempt was made although never standardized[5]

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Evaluation

- Restricted aliasing: Uses the `in`, `out`, and `inout` keywords to control aliasing in parameter passing

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http://cs.txstate.edu/~ch04/webtest/teaching/courses/5318/lectures/slides2/s3-criteria.pdf

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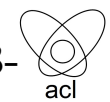
- Efficiency



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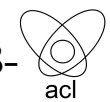

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- Restricted aliasing: Uses the `in`, `out`, and `inout` keywords to control aliasing in parameter passing
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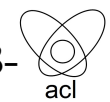
  - Static type checking



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- Restricted aliasing: Uses the `in`, `out`, and `inout` keywords to control aliasing in parameter passing
- Efficiency
  - Static type checking
  - Portable



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Evaluation

- Restricted aliasing: Uses the `in`, `out`, and `inout` keywords to control aliasing in parameter passing
- Efficiency
  - Static type checking
  - Portable
  - No recursion

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- Efficiency
  - Static type checking
  - Portable
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  - No array bounds checking

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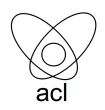
Imperative Programming Languages



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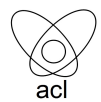

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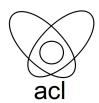
- The Ada language is the result of the US Army, Navy, and Air Force proposed to develop a high-level language for embedded systems



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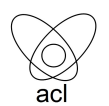

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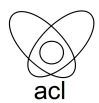

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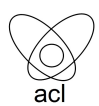

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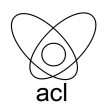

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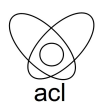

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  - Based on these reports, a revised language design was published in February of 1980
  - The final official version of the language was settled upon a few years after

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Evaluation

- Data types[6]

acl

[6] http://www.adaic.org/learn/materials/intro/part2

Evaluation

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

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Evaluation

- Data types[6]
  - Integers, floating and fixed point real numbers, complex numbers, characters, enumerations as primitive types
  - Support for multidimensional arrays

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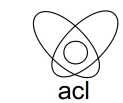


Evaluation

- Data types[6]
  - Integers, floating and fixed point real numbers, complex numbers, characters, enumerations as primitive types
  - Support for multidimensional arrays
  - Allows for derived structures using the `record` type declaration

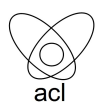
[6] http://www.adaic.org/learn/materials/intro/part2

Evaluation

- Syntax design (Ada 2005[7])
  - Number of production rules: 394
  - Number of top alternatives: 621
  - Number of symbols: 2,973
  - Vocabulary
    - Nonterminal symbols: 405
    - Terminal symbols: 101

[7] http://slebok.github.io/zoo/ada/ada2005/txl/lehyaric-cordy/extracted/index.html

[8] http://www.infres.enst.fr/~pautet/Ada95/chap06.htm



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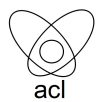

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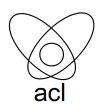
- Abstraction[8]
  - Access grants to variables and procedures can be declared via `public` and `private`

[7] http://slebok.github.io/zoo/ada/ada2005/txl/lehyaric-cordy/extracted/index.html

[8] http://www.infres.enst.fr/~pautet/Ada95/chap06.htm



Evaluation

- Syntax design (Ada 2005[7])
  - Number of production rules: 394
  - Number of top alternatives: 621
  - Number of symbols: 2,973
  - Vocabulary
    - Nonterminal symbols: 405
    - Terminal symbols: 101
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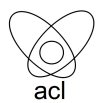

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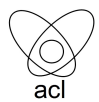
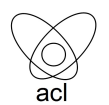


Evaluation

- Exception handling: Has a `exception-when` statement to perform in-program exception handling

[9] http://www.infres.enst.fr/~pautet/Ada95/chap06.htm
[10] http://www.adaic.org/community/compilers-conformity





Evaluation

- Exception handling: Has a `exception-when` statement to perform in-program exception handling
- Restricted aliasing: Uses the `IN` and `OUT` keywords to control aliasing in parameter passing

[9] http://www.infres.enst.fr/~pautet/Ada95/chap06.htm
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- Efficiency:
  - Known to be a language with strong (static) type-checking (The '95 version, at least) [9]

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Evaluation

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- Restricted aliasing: Uses the `IN` and `OUT` keywords to control aliasing in parameter passing
- Efficiency:
  - Known to be a language with strong (static) type-checking (The '95 version, at least) [9]
  - Compilers and dialects must conform to the standards set by the Ada Conformity Assessment Authority (ACAA) to "to be dependable, reusable, portable, maintainable, and legible", and in the case of Ada 95 and Ada 2005, "highly reliable"[10]

[9] http://www.infres.enst.fr/~pautet/Ada95/chap06.htm
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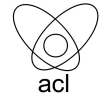
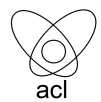
Imperative Programming Languages



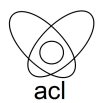
Background



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

Background

- Pascal programming language was originally developed by Niklaus Wirth, the original published definition of which appeared in 1971



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Background

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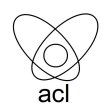
- Pascal aimed to provide features that were lacking in other languages of the time



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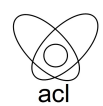

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Background

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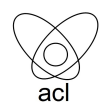
- Pascal aimed to provide features that were lacking in other languages of the time
  - Efficiency in implementation and execution
  - Allows for development of well-structured and well-organized programs



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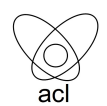
Background

- Pascal programming language was originally developed by Niklaus Wirth, the original published definition of which appeared in 1971
- Pascal aimed to provide features that were lacking in other languages of the time
  - Efficiency in implementation and execution
  - Allows for development of well-structured and well-organized programs
  - Served as a vehicle for teaching computer programming



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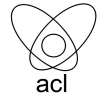
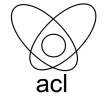
Evaluation

- Data types



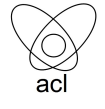
Evaluation

- Data types
  - Integers, real single and double precision floating point numbers, complex numbers, characters, logical as primitive types



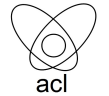
Evaluation

- Data types
  - Integers, real single and double precision floating point numbers, complex numbers, characters, logical as primitive types
  - Support for multidimensional arrays, and in later versions, a string type as a "special" kind of array



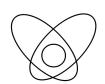
Evaluation

- Data types
  - Integers, real single and double precision floating point numbers, complex numbers, characters, logical as primitive types
  - Support for multidimensional arrays, and in later versions, a string type as a "special" kind of array
  - Allows for derived structures using the `Record` type declaration



Evaluation

- Syntax design (Delphi 2006[11])



[11] http://slebok.github.io/zoo/pascal/delphi/delphi2006/cangas/extracted/index.html

Evaluation

- Syntax design (Delphi 2006[11])
  - Number of production rules: 186
  - Number of top alternatives: 387
  - Number of symbols: 1,444
  - Vocabulary
    - Nonterminal symbols: 197
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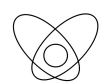
  - Number of production rules: 186
  - Number of top alternatives: 387
  - Number of symbols: 1,444
  - Vocabulary
    - Nonterminal symbols: 197
    - Terminal symbols: 184
  - Uniformity issues
    - Constants cannot be declared with values given by expressions, even though expressions are accepted in all other contexts when a value is needed
    - `if` and `while` need `begin-end` to take in multiple statements, but repeat loops do not

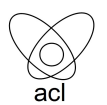
[11] http://slebok.github.io/zoo/pascal/delphi/delphi2006/cangas/extracted/index.html





Evaluation

- Abstraction



[12] http://www.freepascal.org/docs-html/ref/refse102.html

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- Abstraction
  - In Delphi and Object Pascal, access grants to variables and procedures can be declared via `public`, `private`, and `protected`

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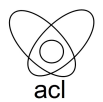

Evaluation

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  - In Delphi and Object Pascal, access grants to variables and procedures can be declared via `public`, `private`, and `protected`
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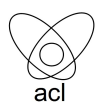

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  - In Delphi and Object Pascal, access grants to variables and procedures can be declared via `public`, `private`, and `protected`
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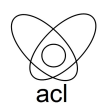

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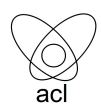
  - In Delphi and Object Pascal, access grants to variables and procedures can be declared via `public`, `private`, and `protected`
  - `program` declaration to allow blocks of parameters, variables, and subprograms to be both shared and re-used.
- Expressivity: At par with (most) imperative PLs
- Exception handling: Has a `try-except` statement to perform in-program exception handling in the Delphi version[12]

[12] http://www.freepascal.org/docs-html/ref/refse102.html

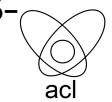


Evaluation

- Restricted aliasing[13]

[13] http://swinbrain.ict.swin.edu.au/wiki/Pass_by_Value_vs._Pass_by_Reference
[14] http://cs.txstate.edu/~ch04/webtest/teaching/courses/5318/lectures/slides2/s3-criteria.pdf
[15] http://www.cs.princeton.edu/courses/archive/spr96/cs441/notes/l16.html





Evaluation

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  - Pass-by-value parameter passing is done by default

acl

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Evaluation

- Restricted aliasing[13]
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  - Pass-by-reference can be done by adding the keyword `var` prior to the name of the formal parameter

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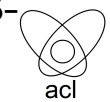

Evaluation

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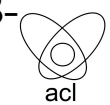
  - Pass-by-reference can be done by adding the keyword `var` prior to the name of the formal parameter
- Efficiency[14]



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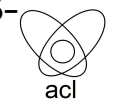

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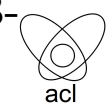
  - Pascal is known as a statically-typed language[15]
  - No forward references



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  - One-pass compiler

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[14] http://cs.txstate.edu/~ch04/webtest/teaching/courses/5318/lectures/slides2/s3-criteria.pdf

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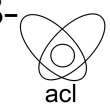

END OF SESSION 4