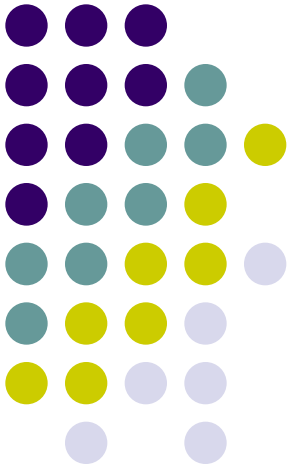
CS 460

Programming Languages

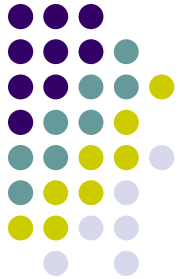
Fall 2023

Dr. Watts

(23 August 2023)



Course Administration



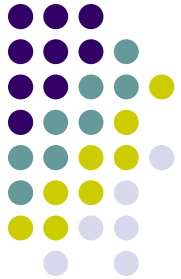
- Survey
- Course website
  http://watts.cs.sonoma.edu/cs460f23/

- BASIC
- FORTRAN
- Pascal
- COBOL
- BPL
- Audit Reporter
- RPG
- JCL
- SNOBOL
- APL

- ALGOL
- BAL
- SAS
- SPSS
- Ada
- LISP
- C
- Logo
- QBasic
- C++

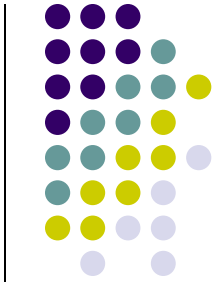
- MFC
- HTML
- Scheme
- Java
- Action Script
- C#
- XNA
- Objective C
- SVG
- Python

Why do we study Programming Languages?



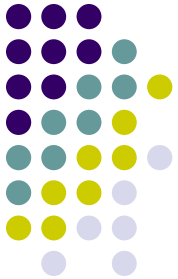
- Choosing languages
- Learning languages
- Efficient program implementation
- Designing and implementing new languages
- Expressing ideas
- Overall understanding

Influences on Language Design



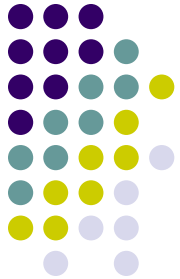
- Architectures
- Domains
- Paradigms

Programming Domains



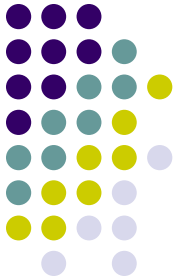
- Science and Mathematics
  - FORTRAN – FORmula TRANslator
- Business
  - COBOL – Common Business Oriented Language
- Education
  - BASIC – Beginners All-purpose Symbolic Instruction Code
- Artificial Intelligence
  - LISP, Scheme
- Systems
  - Assembly languages, C
- Interactive
  - Java, VB, C#
- Web
  - HTML, XML, CSS, SVG

Programming Paradigms



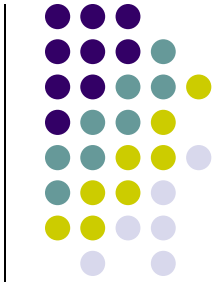
- Procedural
  - FORTRAN, COBOL, BASIC, Pascal
- Functional
  - LISP, Scheme
- Logical
  - Prolog
- Object Oriented
  - Smalltalk, Java
- Scripting
  - RPG, Java Script
- Hybrid
  - C++

Language Design Factors



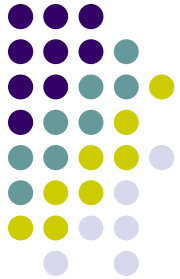
- Readability
- Simplicity
- Orthogonality
- Control Structures
- Data Types/Structures
- Writability
- Reliability
- Cost

Influences on Language Design



- Architectures
  - Single CPU – single processor
  - Single CPU – multiple processors
  - Multiple CPUs
- Domains
  - Calculating devices - ForTran
  - Business applications – COBOL
  - AI - Lisp
  - Education - BASIC
- Paradigms – way in which programs are written
  - Spaghetti code – lots of GOTOs!
  - Structured programming – ALGOL
  - Procedural Programming
  - Object Oriented Programming
  - Functional Programming
  - GUI / Web Programming
  - Parallel Programming

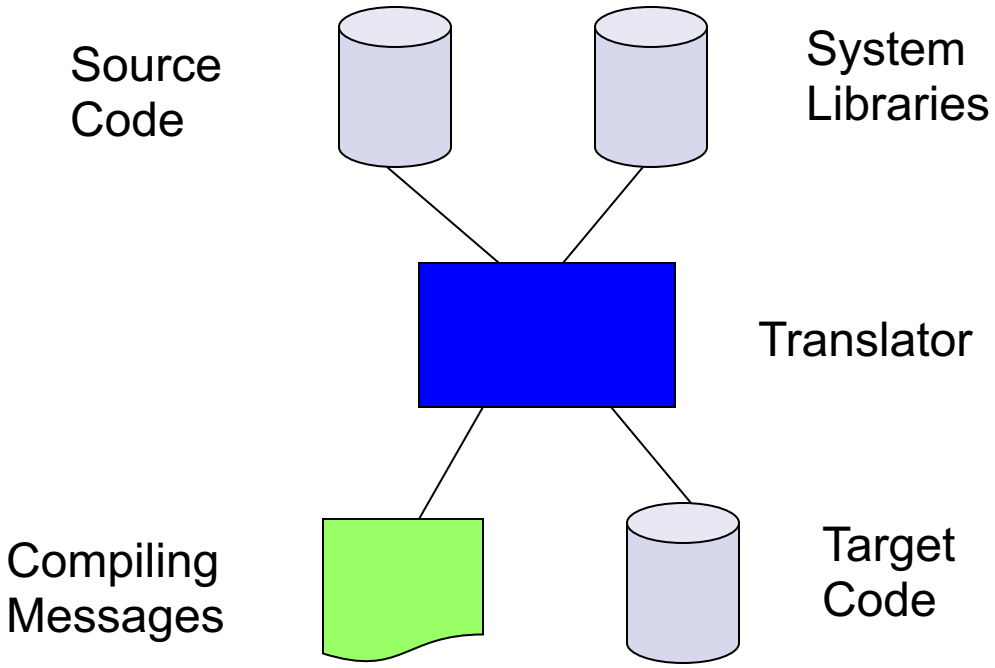
The compilation process



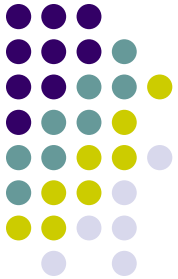
- Input – a human readable source program
  - Text file
  - Conforms to a specific programming language
- Output – a machine readable target program
  - A “binary” file
  - Conforms to a specific machine architecture

Language Translation

System Libraries



Phases of Compilation

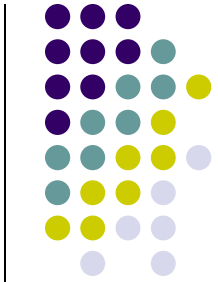


- Lexical analysis
- Syntactical analysis
- Semantic analysis
- Intermediate code generation
- Optimization
- Target code generation

Lexical Analysis

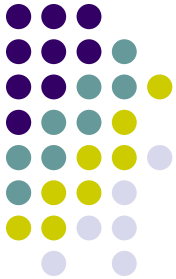
```
int
25.5
;
```

Language Design



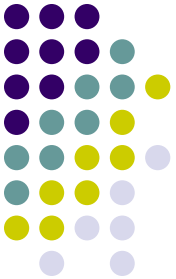
- Key (reserved) words (K)
- Symbols (S)
- Literals (L)
- User defined names (U)

Lexical Analysis Exercise 1



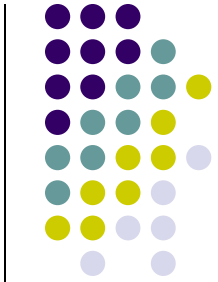
```
#include <iostream>
using namespace std;

int main (int argc, char * argv [])
{
        if (argc < 3)
             exit (1);
        string cat = argv[1];
        cat += argv[2];
        cout << cat << endl;
        return 0;
}
```

Lexical Analysis Exercise 2



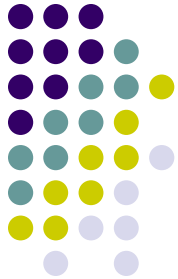
```
#include <iostream>
using namespace std;

int main ()
{
      int abc123, xyz;
      cout << &abc123*.0123 << endl;
      cout << -123+456 << endl;
      cout << +123.-45.67/.89 << endl;
      cout << abc123+++xyz << endl;
      return 0;
}
```

C++ User defined names



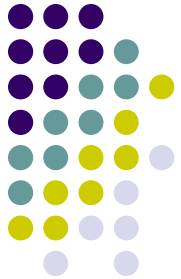
- Uses?
- Rules?
- Regular expression

Regular Expressions



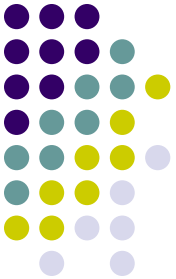
- Alphabet – the symbols that actually appear in the lexeme
- Special symbols to define the regular expression
  - ( ) : grouping
  - * : 0 or more occurrences of a pattern
  - $^{+}$: 1 or more occurrences of a pattern
  - | : indicates alternatives
  - λ : indicates nothing (lambda)

Regular Expression for User Defined Names



- Alphabet = {_, a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z, A, B, C, D, E, F, G, H ,I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9}
- Regular expression?
  - (_|a|b|c|d|e|f|g|h|i|j|k|l|m|n|o|p|q|r|s|t|u|v|w|x|y|z|A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z)(_|a|b|c|d|e|f|g|h|i|j|k|l|m|n|o|p|q|r|s|t|u|v|w|x|y|z|A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z|0|1|2|3|4|5|6|7|8|9)*

Use of Underscore (_) in User Defined Names



```
#include <iostream>
using namespace std;

int main ()
{
      int _;
      float __;
      string ___;
      char ____;
      bool _____;
      cout<<_<<__<<___<<____<<_____<<endl;
      return 0;
}
```