2. ML ("Meta Language")

- Strong, compile-time type checking.
- Types are determined by inference rather than declaration.
- Naturally polymorphic (one function declaration can be used with many different types).
- Pattern-directed programming (you define patterns that are automatically matched during a call).
- Typed exceptions are provided.
- Abstract data types, with constructors, are included.

3. Prolog (Programming in Logic)

- Programs are Facts and Rules.
- Programmers are concerned with definition, not execution.
- Execution order is automatically determined.

4. Pizza

- Extends a popular Object-oriented language, Java, to include
  - Parametric polymorphism (similar to C++'s templates).
  - First-class functional objects.
  - Algebraic data types, including patterns.

5. C#

- This is Microsoft's answer to Java. In most ways it is very similar to Java, with some C++ concepts reintroduced and some useful additions.
  - Events and delegates are included to handle asynchronous actions (like keyboard or mouse actions).
  - Properties allow user-defined read and write actions for fields.
  - Indexers allow objects other than arrays to be indexed.
  - Collection classes may be directly enumerated:
    ```foreach (int i in array) ...```
  - Structs and classes co-exist and may be inter-converted (boxed and unboxed).
Enumerations, operator overloading and rectangular arrays are provided.
Reference, out and variable-length parameter lists are allowed.

6. Python
A simple, efficient scripting language that quickly builds new programs out of existing applications and libraries.
Cleanly includes objects.
Scales nicely into larger applications.

Evolution of Programming Languages
In the beginning, ...
programs were written in absolute machine code—a sequence of bits that encode machine instructions.

Example:

```
34020005
0000000c
3c011001
ac220000
```

This form of programming is
- Very detailed
- Very tedious
- Very error-prone
- Very machine specific

Symbolic Assemblers
Allow use of symbols for operation codes and labels.
Example:

```
li     $v0,5
syscall
sw     $v0,a
```

Far more readable, but still very detailed, tedious and machine-specific.
Types are machine types.
Control structures are conditional branches.
Subprograms are blocks of code called via a “subroutine branch” instruction.
All labels are global.

Fortran (Formula Translator)
Example:

```
do 10 i=1,100
10 a(i)=0
```

Developed in the mid-50s.
A major step forward:
- Programming became more “problem oriented” and less “machine oriented.”
- Notions of control structures (ifs and do loops) were introduced.
- Subprograms, calls, and parameters were made available.
- Notions of machine independence were introduced.
- Has evolved into many new variants, including Fortran 77, Fortran 90 and HPF (High Performance Fortran).
**Cobol (Common Business Oriented Language)**

Example:

- multiply i by 3 giving j.
- move j to k.
- write line1 after advancing 1 lines.

Developed in the early 60s.
The first widely-standardized programming language.
Once dominant in the commercial world; still important.
Wordy in structure; designed for non-scientific users.
Raised the issue of who should program and how important readability and maintainability are.

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**Algol 60 (Algorithmic Language)**

Example:

```plaintext
real procedure cheb(x,n);
value x,n;
real x; integer n;
cheb := if n = 0 then 1
  else if n = 1 then x
  else 2 × x ×
      cheb(x,n-1)−cheb(x,n-2);
```

Developed about 1960.
A direct precursor of Pascal, C, C++ and Java.
Introduced many ideas now in wide use:
- Blocks with local declarations and scopes.
- Nested declarations and control structures.

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- Parameter passing
- Automatic recursion.

But,
- I/O wasn’t standardized.
- IBM promoted Fortran and PL/I.

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**Lisp (List Processing Language)**

Example:

```plaintext
((lambda (x) (* x x)) 10)
```

Developed in the early 60s.
A radical departure from earlier programming languages.
Programs and data are represented in a uniform list format.
Types are a property of data values, not variables or parameters.
A program can build and run new functions as it executes.
Data values were not fixed in size.
Memory management was automatic.
A formal semantics was developed to define precisely what a program means.