Programming

What is Language?

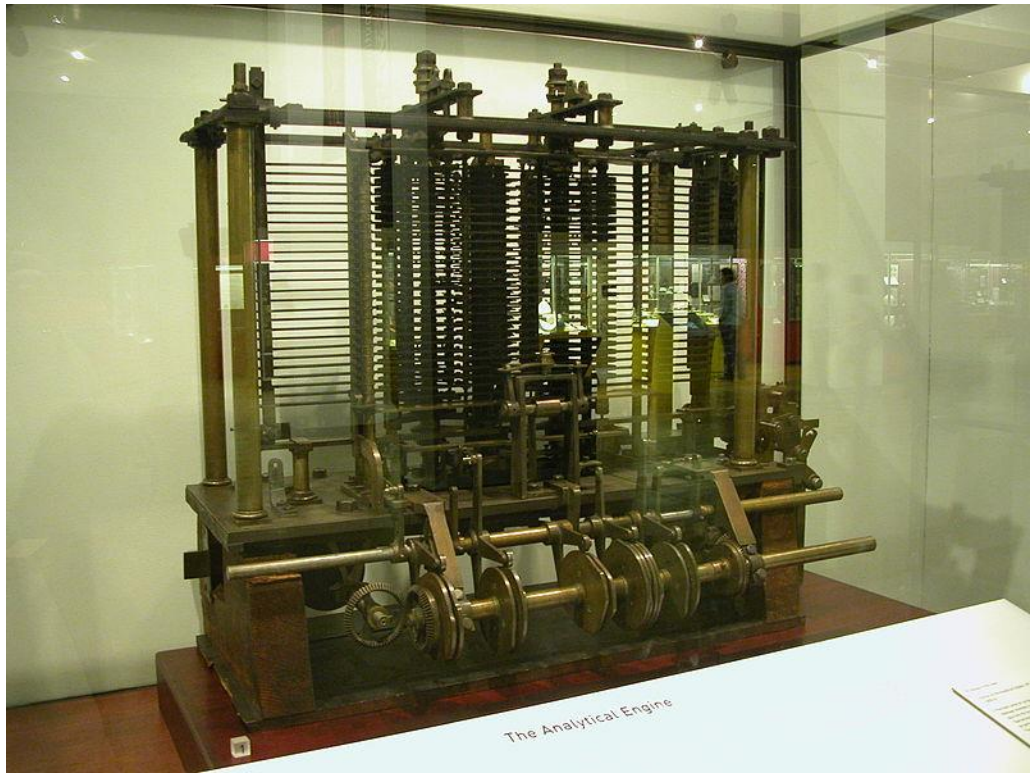
Buenos Días bon Matin goeie môre goedemorgen guten Morgen おはようございます	print ‘Good morning!’ print(“Good morning!”) printf(“Good morning!”) System.out.println(“Good morning!”) console.log(‘Good morning!’) println!(" Good morning!")

Ada Lovelace

- aka Augusta Ada (Byron) King, Countess of Lovelace
- *"that Enchantress who has thrown her magical spell around the most abstract of Sciences and has grasped it with a force few masculine intellects … could have exerted over it"*
  - Letter from Charles Babbage to Michael Faraday, September 9, 1843

Ada and the Analytical Engine

- Visited Babbage frequently and became intrigued by his difference engine
- In 1842, she began translating an Italian memoir on the analytical engine



Number of Operation	Nature of Operation	Variables acted upon	Variables receiving results	Indication of change in the value on any Variable	Statement of Results	Data			Working Variables									Result Variables			
						$^1V_1$	$^1V_2$	$^1V_3$	$^0V_4$	$^0V_5$	$^0V_6$	$^0V_7$	$^0V_8$	$^0V_9$	$^0V_{10}$	$^0V_{11}$	$^0V_{12}$	$^0V_{13}\cdots$	$^1V_{21}$	$^1V_{22}$	$^1V_{23}$	$^0V_{24}\cdots$
						○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
						0	0	0	0	0	0	0	0	0	0	0	0	0	B in a dec. fract.	B in a dec. fract.	B in a dec. fract.	0
						0	0	0	0	0	0	0	0	0	0	0	0	0				0
						1	2	4	0	0	0	0	0	0	0	0	0	0				0
						1	2	n											B_1	B_3	B_5	B_7
1	×	$^1V_2 \times {}^1V_3$	$^1V_4, {}^1V_5, {}^1V_6$	$\left\{\begin{matrix} {}^1V_2 = {}^1V_2 \\ {}^1V_3 = {}^1V_3 \end{matrix}\right\}$	$= 2n$	.....	2	n	$2n$	$2n$	$2n$											
2	−	$^1V_4 - {}^1V_1$	$^2V_4$	$\left\{\begin{matrix} {}^1V_4 = {}^2V_4 \\ {}^1V_1 = {}^1V_1 \end{matrix}\right\}$	$= 2n - 1$	1	.....	.....	$2n-1$													
3	+	$^1V_5 + {}^1V_1$	$^2V_5$	$\left\{\begin{matrix} {}^1V_5 = {}^2V_5 \\ {}^1V_1 = {}^1V_1 \end{matrix}\right\}$	$= 2n + 1$	1	.....	.....	.....	$2n+1$												
4	÷	$^2V_5 \div {}^2V_4$	$^1V_{11}$	$\left\{\begin{matrix} {}^2V_5 = {}^0V_5 \\ {}^2V_4 = {}^0V_4 \end{matrix}\right\}$	$= \frac{2n-1}{2n+1}$	.....	.....	.....	0	0	.....	.....	.....	.....	.....	$\frac{2n-1}{2n+1}$						
5	÷	$^1V_{11} \div {}^1V_2$	$^2V_{11}$	$\left\{\begin{matrix} {}^1V_{11} = {}^2V_{11} \\ {}^1V_2 = {}^1V_2 \end{matrix}\right\}$	$= \frac{1}{2} \cdot \frac{2n-1}{2n+1}$	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	$\frac{1}{2} \cdot \frac{2n-1}{2n+1}$						
6	−	$^0V_{13} - {}^2V_{11}$	$^1V_{13}$	$\left\{\begin{matrix} {}^2V_{11} = {}^0V_{11} \\ {}^0V_{13} = {}^1V_{13} \end{matrix}\right\}$	$= -\frac{1}{2} \cdot \frac{2n-1}{2n+1} = A_0$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0						
7	−	$^1V_3 - {}^1V_1$	$^1V_{10}$	$\left\{\begin{matrix} {}^1V_3 = {}^1V_3 \\ {}^1V_1 = {}^1V_1 \end{matrix}\right\}$	$= n - 1 (= 3)$	1	.....	n	.....	.....	.....	.....	.....	.....	$n-1$							
22	+	$^2V_{12} + {}^2V_{13}$	$^3V_{13}$	$\left\{\begin{matrix} {}^2V_{12} = {}^0V_{12} \\ {}^2V_{13} = {}^3V_{13} \end{matrix}\right\}$	$= A_0 + B_1A_1 + B_3A_3$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0	$\{A_0 + B_1A_1 + B_3A_3\}$				
23	−	$^2V_{10} - {}^1V_1$	$^3V_{10}$	$\left\{\begin{matrix} {}^2V_{10} = {}^3V_{10} \\ {}^1V_1 = {}^1V_1 \end{matrix}\right\}$	$= n - 3 (= 1)$	1	.....	.....	.....	.....	.....	.....	.....	.....	$n-3$							

Here follows a repetition of Operations thirteen to twenty-three

24	+	$^4V_{13} + {}^0V_{24}$	$^1V_{24}$	$\left\{\begin{matrix} {}^4V_{13} = {}^0V_{13} \\ {}^0V_{24} = {}^1V_{24} \end{matrix}\right\}$	$= B_7$	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	B_7
25	+	$^1V_1 + {}^1V_3$	$^1V_3$	$\left\{\begin{matrix} {}^1V_1 = {}^1V_1 \\ {}^1V_3 = {}^1V_3 \\ {}^5V_6 = {}^0V_6 \\ {}^5V_7 = {}^0V_7 \end{matrix}\right\}$	$= n + 1 = 4 + 1 = 5$ by a Variable-card. by a Variable-card.	1	.....	$n+1$	.....	.....	0	0											

"[The Analytical Engine] might act upon other things besides number, were objects found whose mutual fundamental relations could be expressed by those of the abstract science of operations, and which should be also susceptible of adaptations to the action of the operating notation and mechanism of the engine

Supposing, for instance, that the fundamental relations of pitched sounds in the science of harmony and of musical composition were susceptible of such expression and adaptations, the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent."
- Ada Lovelace

Ada Lovelace

aka The First Computer Programmer and Debugger

Rear Admiral Grace Hopper

Margaret Hamilton

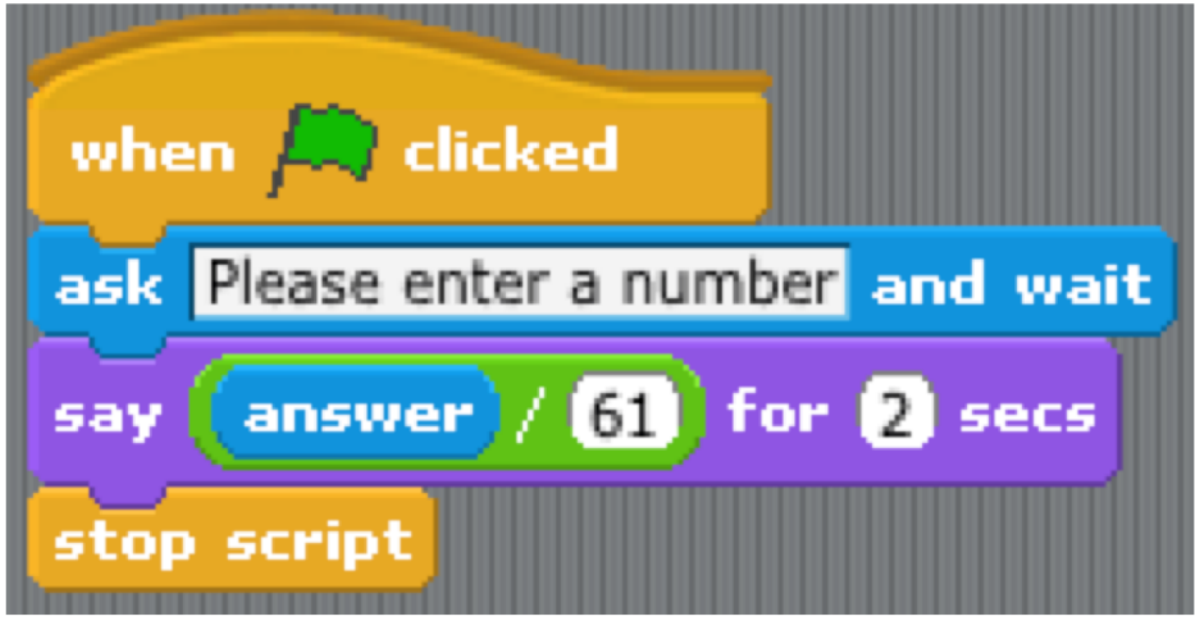
- Director of Software Engineering at the MIT instrumentation lab
- Responsible for developing on-board flight software for the Apollo space program
- Prevented a mission abort during the Apollo 11 moon landing

What is Programming?

Source Code

- We want to write a program that takes input from the user and prints the result of that input divided by 61.
- What would that program look like?

Scratch


when clicked
ask Please enter a number and wait
say answer / 61 for 2 secs
stop script

Language Hierarchy

High Level

Assembly

Machine

Hardware

High Level – C/C++

```c
#include <stdio.h>

int main(){
  printf("Enter a number: ");
  float x = 0.0;
  scanf("%f", &x);
  float y = x / 61;
  printf("%f\n", y);
  return 0;
}
```

High Level – Java

```
import java.io.*;
import java.util.*;

public class div{
  public static void main(String[] args){
    System.out.print("Enter a number: ");
    Scanner scanner = new Scanner(System.in);
    float x = scanner.nextFloat();
    float y = x / 61;
    System.out.println(y);
  }
}
```

High Level – C#

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;

namespace div
{
    class Program
    {
        static void Main(string[] args)
        {
            Console.WriteLine("Enter a number: ");
            double x = Double.Parse(Console.ReadLine());
            double y = x / 61.0;
            Console.WriteLine(y);
        }
    }
}
```

High Level - Python

```
x = int(input("Enter a number: "))
print(x / 61)
```

Other Languages

- Perl
- OCaml
- Lisp
- R
- PHP
- Fortran
- COBOL
- Ada
- Pascal
- Visual Basic

Assembly - Compilers

A program that takes source code written in a high level language and converts it into another language, usually one easier for a computer to understand.

Assembly Language

```
0000000000400564 <main>:
  400564: 55                    push   %rbp
  400565: 48 89 e5              mov    %rsp,%rbp
  400568: 48 83 ec 10           sub    $0x10,%rsp
  40056c: b8 00 00 00 00        mov    $0x0,%eax
  400571: 89 45 f8              mov    %eax,-0x8(%rbp)
  400574: b8 bc 06 40 00        mov    $0x4006bc,%eax
  400579: 48 8d 55 f8           lea    -0x8(%rbp),%rdx
  40057d: 48 89 d6              mov    %rdx,%rsi
  400580: 48 89 c7              mov    %rax,%rdi
  400583: b8 00 00 00 00        mov    $0x0,%eax
  400588: e8 e3 fe ff ff        callq  400470 <__isoc99_scanf@plt>
  40058d: f3 0f 10 45 f8        movss  -0x8(%rbp),%xmm0
  400592: f3 0f 10 0d 2a 01 00 movss  0x12a(%rip),%xmm1
          # 4006c4 <_IO_stdin_used+0xc>
  400599: 00
  40059a: f3 0f 5e c1           divss  %xmm1,%xmm0
  40059e: f3 0f 11 45 fc        movss  %xmm0,-0x4(%rbp)
  4005a3: f3 0f 10 45 fc        movss  -0x4(%rbp),%xmm0
  4005a8: 0f 5a c0              cvtps2pd %xmm0,%xmm0
  4005ab: b8 bf 06 40 00        mov    $0x4006bf,%eax
  4005b0: 48 89 c7              mov    %rax,%rdi
  4005b3: b8 01 00 00 00        mov    $0x1,%eax
  4005b8: e8 93 fe ff ff        callq  400450 <printf@plt>
  4005bd: b8 00 00 00 00        mov    $0x0,%eax
  4005c2: c9                    leaveq
  4005c3: c3                    retq
```

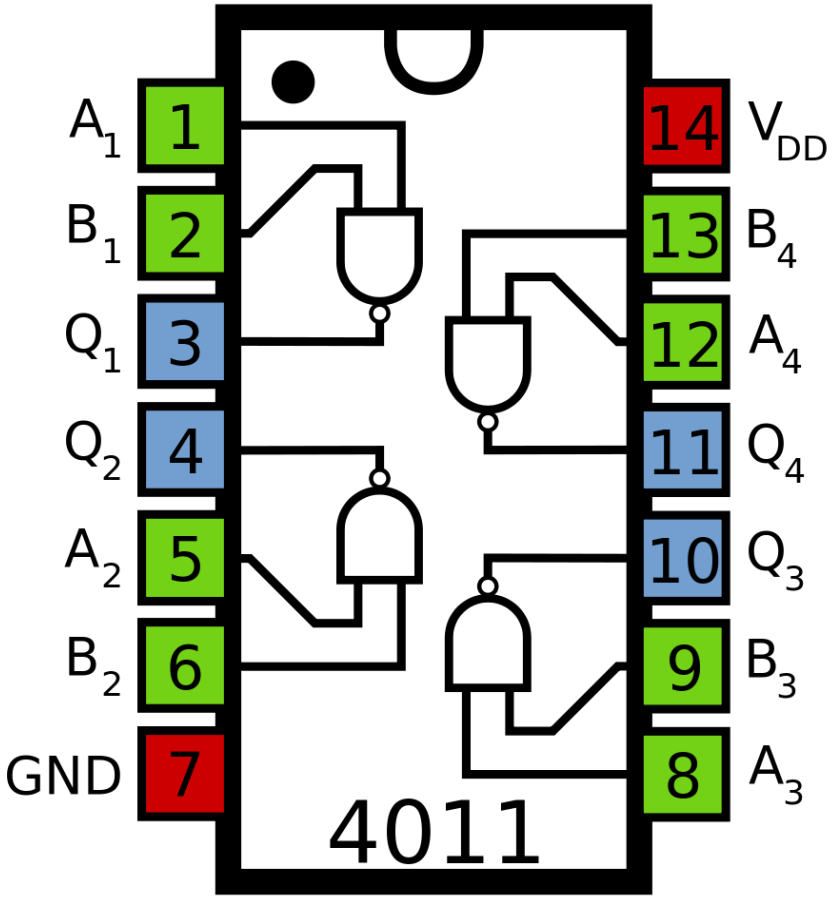
Assembler

A program that takes assembly language code and converts it into executable machine language code that can be directly read by a computer.

Machine Language

```
0000330: 00000000 01011111 01011111 01100111 01101101 01101111  .__gmo
0000336: 01101110 01011111 01110011 01110100 01100001 01110010  n_star
000033c: 01110100 01011111 01011111 00000000 01101100 01101001  t__.li
0000342: 01100010 01100011 00101110 01110011 01101111 00101110  bc.so.
0000348: 00110110 00000000 01011111 01011111 01101001 01110011  6.__is
000034e: 01101111 01100011 00111001 00111001 01011111 01110011  oc99_s
0000354: 01100011 01100001 01101110 01100110 00000000 01110000  canf.p
000035a: 01110010 01101001 01101110 01110100 01100110 00000000  rintf.
0000360: 01011111 01011111 01101100 01101001 01100010 01100011  __libc
0000366: 01011111 01110011 01110100 01100001 01110010 01110100  _start
000036c: 01011111 01101101 01100001 01101001 01101110 00000000  _main.
0000372: 01000111 01001100 01001001 01000010 01000011 01011111  GLIBC_
0000378: 00110010 00101110 00110111 00000000 01000111 01001100  2.7.GL
000037e: 01001001 01000010 01000011 01011111 00110010 00101110  IBC_2.
0000384: 00110010 00101110 00110101 00000000 00000000 00000000  2.5...
000038a: 00000010 00000000 00000010 00000000 00000000 00000000  ......
```

Hardware


A1
1
B1
2
Q1
3
Q2
4
A2
5
B2
6
GND
7
14
VDD
13
B4
12
A4
11
Q4
10
Q3
9
B3
8
A3
4011

Programming