

Structure & Flow

Basic Program Structure

```
void setup() {
  // Runs once when sketch starts
}
void loop() {
  // Runs repeatedly
}
```

Control Structures

```
if (x < 5) { ... } else { ... }
while (x < 5) { ... }
for (int i = 0; i < 10; i++) { ... }
break; // Exit a loop immediately
continue; // Go to next iteration
switch (var) {
  case 1:
    ...
    break;
  case 2:
    ...
    break;
  default:
    ...
}
return x; // x must match return type
return; // For void return type
```

Function Definitions

```
<ret. type> <name>(<params>) { ... }
e.g. int double(int x) {return x*2;}
```

Operators

General Operators

```
= assignment
+ add - subtract
* multiply / divide
% modulo
== equal to != not equal to
< less than > greater than
<= less than or equal to
>= greater than or equal to
&& and || or
! not
```

Compound Operators

```
++ increment
-- decrement
+= compound addition
-= compound subtraction
*= compound multiplication
/= compound division
&= compound bitwise and
|= compound bitwise or
```

Bitwise Operators

```
& bitwise and | bitwise or
^ bitwise xor ~ bitwise not
<< shift left >> shift right
```

Pointer Access

```
& reference: get a pointer
* dereference: follow a pointer
```

Built-in Functions

Pin Input/Output

```
Digital I/O - pins 0-13 A0-A5
pinMode(pin,
  [INPUT, OUTPUT, INPUT_PULLUP])
int digitalRead(pin)
digitalWrite(pin, [HIGH, LOW])
```

Analog In - pins A0-A5

```
int analogRead(pin)
analogReference(
  [DEFAULT, INTERNAL, EXTERNAL])
```

PWM Out - pins 3 5 6 9 10 11

```
analogWrite(pin, value)
```

Advanced I/O

```
tone(pin, freq_Hz)
tone(pin, freq_Hz, duration_ms)
noTone(pin)
shiftOut(dataPin, clockPin,
  [MSBFIRST, LSBFIRST], value)
unsigned long pulseIn(pin,
  [HIGH, LOW])
```

Time

```
unsigned long millis()
// Overflows at 50 days
unsigned long micros()
// Overflows at 70 minutes
delay(msec)
delayMicroseconds(usec)
```

Math

```
min(x, y) max(x, y) abs(x)
sin(rad) cos(rad) tan(rad)
sqrt(x) pow(base, exponent)
constrain(x, minval, maxval)
map(val, fromL, fromH, toL, toH)
```

Random Numbers

```
randomSeed(seed) // long or int
long random(max) // 0 to max-1
long random(min, max)
```

Bits and Bytes

```
lowByte(x) highByte(x)
bitRead(x, bitn)
bitWrite(x, bitn, bit)
bitSet(x, bitn)
bitClear(x, bitn)
bit(bitn) // bitn: 0=LSB 7=MSB
```

Type Conversions

```
char(val) byte(val)
int(val) word(val)
long(val) float(val)
```

External Interrupts

```
attachInterrupt(interrupt, func,
  [LOW, CHANGE, RISING, FALLING])
detachInterrupt(interrupt)
interrupts()
noInterrupts()
```

Libraries

```
Serial - comm. with PC or via RX/TX
begin(long speed) // Up to 115200
end()
int available() // #bytes available
int read() // -1 if none available
int peek() // Read w/o removing
flush()
print(data) println(data)
write(byte) write(char * string)
write(byte * data, size)
SerialEvent() // Called if data rdy
```

```
SoftwareSerial.h - comm. on any pin
SoftwareSerial(rxPin, txPin)
begin(long speed) // Up to 115200
listen() // Only 1 can listen
isListening() // at a time.
read, peek, print, println, write
// Equivalent to Serial library
```

```
EEPROM.h - access non-volatile memory
byte read(addr)
write(addr, byte)
EEPROM[index] // Access as array
```

```
Servo.h - control servo motors
attach(pin, [min_uS, max_uS])
write(angle) // 0 to 180
writeMicroseconds(uS)
// 1000-2000; 1500 is midpoint
int read() // 0 to 180
bool attached()
detach()
```

```
Wire.h - I2C communication
begin() // Join a master
begin(addr) // Join a slave @ addr
requestFrom(address, count)
beginTransmission(addr) // Step 1
send(byte) // Step 2
send(char * string)
send(byte * data, size)
endTransmission() // Step 3
int available() // #bytes available
byte receive() // Get next byte
onReceive(handler)
onRequest(handler)
```

Variables, Arrays, and Data

Data Types

```
boolean true | false
char -128 - 127, 'a' '$' etc.
unsigned char 0 - 255
byte 0 - 255
int -32768 - 32767
unsigned int 0 - 65535
word 0 - 65535
long -2147483648 - 2147483647
unsigned long 0 - 4294967295
float -3.4028e+38 - 3.4028e+38
double currently same as float
void i.e., no return value
```

Strings

```
char str1[8] =
  {'A', 'r', 'd', 'u', 'i', 'n', 'o', '\0'};
// Includes \0 null termination
char str2[8] =
  {'A', 'r', 'd', 'u', 'i', 'n', 'o'};
// Compiler adds null termination
char str3[] = "Arduino";
char str4[8] = "Arduino";
```

Numeric Constants

```
123 decimal
0b01111011 binary
0173 octal - base 8
0x7B hexadecimal - base 16
123U force unsigned
123L force long
123UL force unsigned long
123.0 force floating point
1.23e6 1.23*10^6 = 1230000
```

Qualifiers

```
static persists between calls
volatile in RAM (nice for ISR)
const read-only
PROGMEM in flash
```

Arrays

```
int myPins[] = {2, 4, 8, 3, 6};
int myInts[6]; // Array of 6 ints
myInts[0] = 42; // Assigning first
// index of myInts
myInts[6] = 12; // ERROR! Indexes
// are 0 though 5
```

