# Multiplication of Two Complex Numbers – Lookup Table

## Algorithm

### Integer Multiplication

These are steps for multiplying two integer numbers:

* First ignore the sign of numbers
* Multiply the two numbers by “The Long (Grade-School/Standard) Multiplication Algorithm”
  + For multiplying each two digits use the predefined lookup table
* If just one of the original numbers is negative, negate the result

### Complex Multiplication

These are steps for multiplying two complex numbers:

* Multiplication of two complex numbers is a complex number
* Use the integer multiplication algorithm
  + For calculating the real part
    - Multiply the real of the first number by the real of the second number
    - Multiply the imaginary of the first number by the imaginary of the second number
    - Subtract the two results
  + For calculating the imagination part
    - Multiply the real of the first number by the imaginary of the second number
    - Multiply the imaginary of the first number by the real of the second number
    - Add the two results

## Analysis

### Integer Multiplication

|  |  |
| --- | --- |
| Step | Time Complexity |
| a = <the first integer number>;  b = <the second integer number>;  n = unsigned a;  m = unsigned b;  n\_len = number of digits of n;  m\_len = number of digits of m; | 1 |
| t = [m\_len][n\_len + m\_len]; // filled with zero | (log10(b))^2 + log10(a)\*log10(b) |
| for (i=0 to m\_len) {  c = 0; // Carry  u = digit of m at [m\_len - i - 1];  for (j=0 to n\_len) {  v = digit of n at [n\_len - j - 1];  p = lookup\_table[u][v] + c; // multiply u by v  t[i][n\_len + m\_len - j - i - 1] = p mod 10;  c = p / 10;  }  t[i][m\_len - i - 1] = c;  } | log10(a)\*log10(b) |
| s = ‘’; // Result  c = 0; // Carry | 1 |
| for (i=0 to n\_len + m\_len) {  p = c;  for (i=0 to m\_len) {  p += t[j][n\_len + m\_len - i - 1];  }  s = (p mod 10) + s;  c = p / 10;  } | (log10(b))^2 + log10(a)\*log10(b) |
| if (a is negative) or (b is negative) {  return -s;  } else {  return s;  } | 1 |
| END | O(2\*(log10(b))^2 + 3\*log10(a)\*log10(b)) |

### Complex Multiplication

|  |  |
| --- | --- |
| Step | Time Complexity |
| a = <the first complex number>;  b = <the second complex number>; | 1 |
| result.real = integer\_multiply(a.real, b.real) – integer\_multiply(a.imag, b.imag); | 2 \* (log10(b))^2 + log10(a)\*log10(b)) |
| result.imag = integer\_multiply(a.real, b.imag) + integer\_multiply(a.imag, b.real); | 2 \* (log10(b))^2 + log10(a)\*log10(b)) |
| END | O((log10(b))^2 + log10(a)\*log10(b))) |