

# Install MPIR on Ubuntu and MacOS X

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## Introduction

MPIR (multiple precision integers and rationals) is a library for performing arbitrary-precision (“bignum”) arithmetic. See <http://mpir.org/index.html>. It is highly optimized code written in C and assembly language.

For example, using MPIR and an appropriate algorithm, you can write a C++ program to compute a million decimal digits of pi in under 3 seconds on a modern Linux laptop (Figure 1).

```
(base) ron@ubuntu-19-04:~/BigPi$ ./BigPi > BigPi.out
(base) ron@ubuntu-19-04:~/BigPi$
(base) ron@ubuntu-19-04:~/BigPi$ head BigPi.out
pi to 1000000 places:

3.1415926535 8979323846 2643383279 5028841971 6939937510 5820974944 5923078164 0628620899 8628034825 3421170679
8214808651 3282306647 0938446095 5058223172 5359408128 4811174502 8410270193 8521105559 6446229489 5493038196
4428810975 6659334461 2847564823 3786783165 2712019091 4564856692 3460348610 4543266482 1339360726 0249141273
7245870066 0631558817 4881520920 9628292540 9171536436 7892590360 0113305305 4882046652 1384146951 9415116094
3305727036 5759591953 0921861173 8193261179 3105118548 0744623799 6274956735 1885752724 8912279381 8301194912

9833673362 4406566430 8602139494 6395224737 1907021798 6094370277 0539217176 2931767523 8467481846 7669405132
(base) ron@ubuntu-19-04:~/BigPi$
(base) ron@ubuntu-19-04:~/BigPi$ tail BigPi.out
4477996748 7499697694 2713766869 5533195125 3377640985 8709668386 3263926164 9456086841 4037456842 0719405950
7017430354 6918215090 0466493998 5517413893 8519757312 1568261622 8622318810 9672974760 6013028331 1937161140

8747270676 2558567775 1199566674 8615196491 2970193318 0849941096 1813929649 2789360902 1253544332 7375064260
6242994120 3273625582 4417498345 0947309453 4366159072 8416319368 3075719798 0682315357 3715557181 6122156787
9364250138 8711702327 5555779302 2667858031 9993081083 0576307652 3320507400 1393909580 7901637717 6292592837
6487479017 7274125678 1905555621 8050487674 6991140839 9779193765 4232062337 4717324703 3697633579 2589151526
0315614033 3212728491 9441843715 0696552087 5424505989 5678796130 3311646283 9963464604 2209010610 5779458151

Elapsed time: 2.9057 seconds
```

Figure 1. The head and the tail of a listing of a million decimal digits of pi computed with MPIR on Ubuntu.

We will download, configure, build, and install MPIR on the Ubuntu distribution of the Linux operation system. See <https://www.ubuntu.com/>.

If you have not yet installed and configured Ubuntu, first read the following tutorials:

- “Install Ubuntu on Windows 10 and on Virtual Box”  
<http://www.cs.sjsu.edu/~mak/tutorials/InstallUbuntu.pdf>
- “Configure Ubuntu for Software Development”  
<http://www.cs.sjsu.edu/~mak/tutorials/ConfigureUbuntu.pdf>

You can also install MPIR directly on MacOS X instead of on Ubuntu.

## Download MPIR

Download the source files of MPIR from <http://mpir.org/downloads.html>. Choose the latest version from “Old releases”, currently the 2017-03-01 MPIR 3.0.0 version. Unzip to create a file named (for example) mpir-3.3.0.

If you are using the Ubuntu subsystem of Windows 10, use a browser in Windows (such as Microsoft Edge) to download the `.zip` compressed installation file. Then in the Ubuntu terminal window, use the `mv` command to move the installation file out of the Windows downloads directory into your Ubuntu home directory. Use `/mnt/c` or `/mnt/d` to access directories and files in the Windows file system. For example, from your Ubuntu home directory, enter a command similar to

```
mv /mnt/c/Users/rmak/Downloads/mpir-3.0.0.zip .
```

## Configure and build MPIR

**Change to your MPIR directory** and type the following commands in the Ubuntu terminal window:

```
./configure --enable-cxx  
make
```

The configure script may say that **yasm** and/or **m4** are missing from your system. If you are on Ubuntu, install them with these commands:

```
sudo apt install yasm  
sudo apt install m4
```

If you are on MacOS X, install yasm and m4 with these commands:

```
brew install yasm  
brew install m4
```

## Check MPIR

Type the following command to compile and run test programs that check your MPIR build:

```
make check
```

## Install MPIR

Type the following commands to install the MPIR header files into `/usr/local/include` and the MPIR library files into `/usr/local/lib`:

```
sudo make install  
sudo ldconfig
```

## Compile, link, and run a program

If your program depends on MPIR, you must include `mpir.h`:

```
#include <mpir.h>
```

If your program also uses the C++ feature of overloaded arithmetic operators, you must also include `mpirxx.h`:

```
#include <mpirxx.h>
```

For example, to compile, link, and run a program named `BigPi.cpp`:

The `-lmpir` option tells the linker to look for the MPIR library `mpir` that you installed in `/usr/local/lib`. (That's a lower-case letter "ell" and not the digit "1".)

```
g++ -o BigPi BigPi.cpp -lmpir  
./BigPi
```