

Phylogrowth User Guide

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<https://github.com/yogischogi/phylogrowth/>

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1 Introduction

Phylogrowth is a program that calculates population growth from a phylogenetic tree by counting subclades and samples for given periods of time.

Periods of human growth and prosperity are often accompanied by strong population growth. For a society strong population growth simply means more surviving children. If more children survive there is also a higher chance of more mutations and thus more new branches on the phylogenetic tree. So a high number of new branches within a given period of time indicates strong population growth and good times.

Population growth usually continues until resources get scarce or the society is threatened by epidemics, natural disasters or war. It should be possible to detect those times by looking at the population growth.

Luckily we all carry important archeological evidence within us. It is encoded in our genetic markers. Modern technologies like next generation sequencing have made it possible to create highly accurate phylogenetic trees.

Phylogrowth can utilize those trees and give us insights into our history.

Have fun exploring human history!

Dirk

2 Installation

This guide is mainly targeted towards persons who use Linux Mint or other Linux versions of the Debian family. Some familiarity with the use of Linux commands is assumed.

Currently there are no binary distributions available for Windows or the Mac. Users of these operating systems can use Phylogrowth as well, but they will experience some laborious installation work. The best way is to follow the instructions provided on the [Go](#) home page.

The following list applies to Linux users only:

1. Make sure that the Go programming language is installed. If not it can be installed by typing
`sudo apt-get install golang`
2. Read the Go [Getting Started](#) guide. Make sure to set your *GOPATH* variable and include it in your *PATH* so that Go programs can be found.
3. Fetch the Phylogrowth program with
`go get github.com/yogischogi/phylogrowth`
4. Install the program with
`go install github.com/yogischogi/phylogrowth`

Now the Phylogrowth program should be installed.

3 Command Line Options

Command line options may be given in arbitrary order. Parameters may be specified by using a space or equals sign. For example the following options are identical: `-treein=mytree`, `-treein mytree`.

- help** Prints available program options.
- treein** Input filename for phylogenetic tree (.txt).
- treeout** Output filename for phylogenetic tree in TXT format.
- csvout** Output filename for histogram data in CSV format.
- txtout** Output filename for histogram data in TXT format.
- pngout** Output filename for PNG image. Needs Gnuplot [\[2\]](#) to be installed.
- step** Step length of histogram intervals in years. Default is 100.
- subclade** Selects a specific branch of the tree.

4 Examples

4.1 First Steps

Phylogenetic Input Tree

Before you can start you need to create a phylogenetic tree, that contains SNPs, IDs of the genetic samples and TMRCA estimates. The file format is text based and looks like this:

```
// This is an example tree.  
// Comments begin with //.
```

```
CTS4528, S1200 TMRCA 5000  
    S11481 TMRCA 2000  
        id:YF01234  
        id:YF00301  
        id:YF02016  
    S14328 TMRCA 4500  
        id:YF04242  
        id:YF00101  
        id:YF01010
```

Each line of the tree contains one or more SNPs or a sample ID. Subclades and samples are indented by using tabs or spaces. Each sample starts with `id:` followed by the ID. If a subclade has a TMRCA estimate Phylogrowth assumes that the population growth in a given period of time is proportional to the number of child branches.

To create a graph that shows population growth from the example tree:

1. Save the example tree to a file, for example *tree.txt*.
2. Go to a command line and type:
`phylogrowth -treein=tree.txt -pngout=example.png`
For this to work you need Gnuplot [\[2\]](#) to be installed.
3. Done! Your first graph should be stored in the file *example.png*.

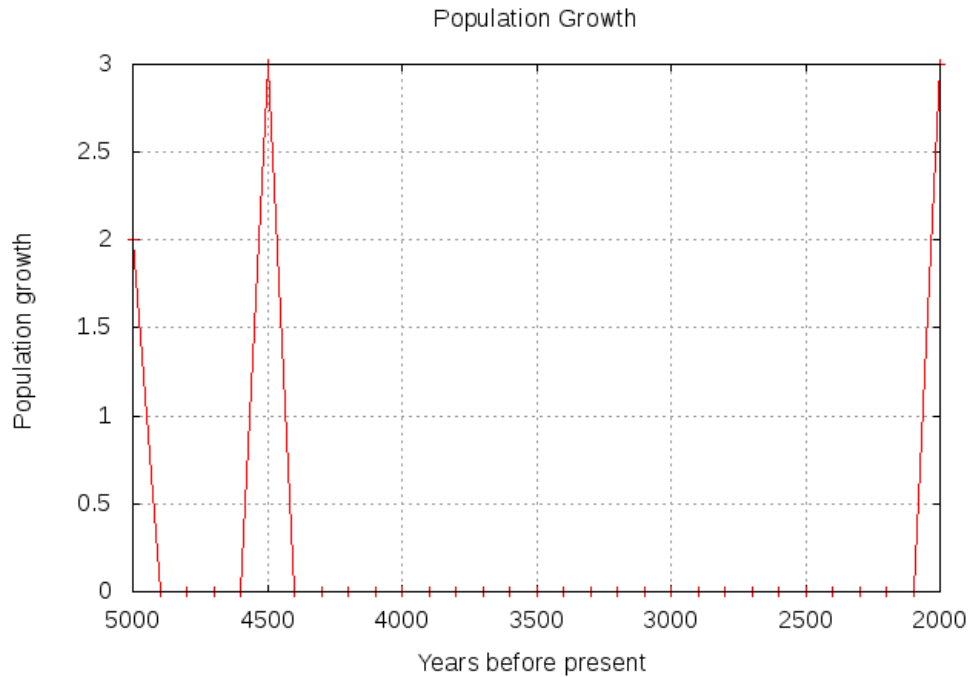


Figure 1: The first example showing time periods of population growth.

4.2 Using the YFull Tree

Phylogrowth is especially well suited for the use of the YFull tree [3]. It's TMRCA estimates are based on SNP counting and calibrated by ancient and modern DNA samples [1].

As a more sophisticated example let us calculate the population growth for the P312 haplogroup. P312 is widespread in Western Europe and most common in Spain, France and on the British Isles.

1. Go to the YFull R1b tree at <https://yfull.com/tree/R1b/>.
2. Copy the tree directly from the Web page and save it to a text file named *yfull-tree.txt*. Be careful that the indentations are preserved.
3. Go to a command line and type:

```
phylogrowth -treein=yfull-tree.txt -subclade=P312 -pngout=P312.png
```
4. Done! Now watch *P312.png*. Can you spot the Bronze Age expansion, the Roman Empire and the Migration Period?

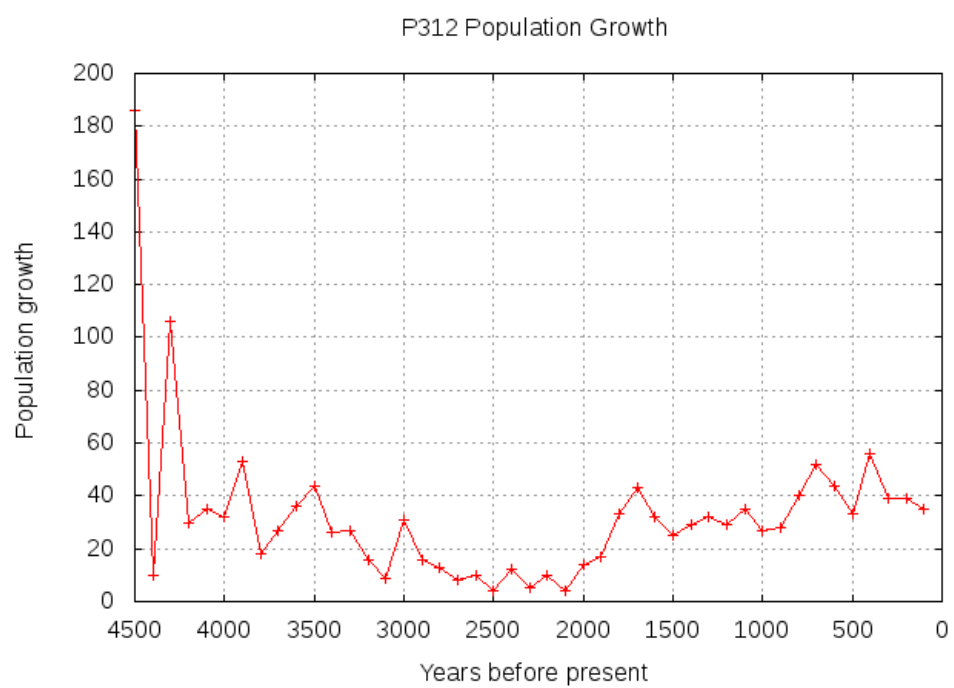


Figure 2: Population growth of the P312 haplogroup.

References

- [1] Dmitry Adamov, Vladimir Guryanov, Sergey Karzhavin, Vladimir Tagankin, Vadim Urasin. *Defining a New Rate Constant for Y-Chromosome SNPs based on Full Sequencing Data*. The Russian Journal of Genetic Genealogy (Русская версия), Vol 6, No 2 (2014)/Vol 7, No 1 (2015).
- [2] Thomas Williams, Colin Kelley, *Gnuplot*. Thomas Williams, Colin Kelley, 1986–1993, 1998, 2004, Date visited: 2016-06-23.
- [3] YFull, *YFull Phylogenetic Tree*. Date visited: 2016-06-23.