Bertini_Real

User's Manual

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Manual by
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July 23, 2015

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1 Introduction

Welcome to Bertini_real, software for real algebraic geometry. This manual is intended to help the user operate this piece of numerical software, to obtain useful and high-quality results from decomposing real algebraic curves and surfaces.

Bertini_real is compiled software, links against a parallel version of Bertini 1 compiled as a library, and requires Matlab and the Symbolic Computation toolbox. It also requires several other libraries, including a few from Boost, and an installation of MPI. All libraries should be compiled using the same compilers.

1.1 Contact

Acknowledgements

- This research utilized the CSU ISTeC Cray HPC System supported by NSF Grant CNS-0923386.

- This material is based upon work supported by the National Science Foundation under Grants No. DMS-1025564 and DMS-1115668.

1.2 License

Disclaimer

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2 Quick Start

Bertini_Real can be downloaded from http://bertinireal.com/download.html. Use of Bertini_Real depends on Bertini, which itself has several important dependencies (see section 3) Once installed, you can run Bertini_real on an input file from the command line. After navigating to the working directory of the input file, the flow of Bertini_real is as follows:

1. Run Bertini on an input file using the "tracktype: 1" setting. This is done by typing in the command line: `bertini` with an input file named 'input'. Bertini will produce a Numerical Irreducible Decomposition that will be used by Bertini_real.

2. Run Bertini_Real on the same input file. Similarly, just type `bertini_real` in the command line. Bertini_Real will provide a cellular decomposition of the real portion of a one- or two-dimensional complex algebraic set.

3. Visualize the results of Bertini_real in MATLAB. Enter MATLAB and call gather_br_samples, which parses the output results of Bertini_real into a .mat file, and then call bertini_real_plotter, which will plot the curve or surface in MATLAB (N.B. The MATLAB executable must be on the path to the input file for Bertini_real to run).

3 Compilation and Installation

3.1 Installation

Before installing Bertini_real, you must first be sure to have several libraries and dependencies that the software requires.

First, you must install Bertini (as a library). The Bertini source code can be found at https://bertini.nd.edu/download.html. Download the Bertini source code using the ./configure && make && make install process.

Bertini itself has the following dependencies: a C++ compiler capable of the C++ 11 standard, an MPI (such as MPICH2), Boost >= 1.53, MPFR, and GMP. Instructions specifically for mac users are listed below. If on Linux, use the package manager provided (e.g. apt-get). Unfortunately, Windows users are unsupported at this time, except possibly through Cygwin or a virtual machine. If interested in porting Bertini and Bertini_real to windows, please contact Dr. Brake at dbrake@nd.edu. Bertini_real also is dependent on MATLAB. Once Bertini and all the necessary dependencies are installed, navigate to the directory containing Bertini_real and install Bertini_real via the ./configure && make && make install process.

3.2 Installation of Bertini/bertini_real on macIntosh

If you are using a mac, we encourage the use of Homebrew (http://brew.sh) to install these packages. After installing Homebrew itself, installing the previously listed dependencies becomes simple. In terminal, just type, `brew search` ____ to list packages related to ____, where ____ is your search (for example, GMP, Boost, or MPICH2). To download via Homebrew, type in terminal: `brew install` ____.

4 Using Bertini_Real

4.1 Command Line Options

Below are the command line options for Bertini_real. These are placed after the initial `bertini_real` command. Each command starts with a single dash, and any required arguments should be placed after. For example, if you wanted to run Bertini_real decomposing a specific component, you would type: `bertini_real -component x` where x is the integer index of the component to decompose.

- `-debug`
  If used, program will pause for 30 seconds before running for debugging purposes. No required argument.

- `-dim` or `-d`
  Required argument is the target dimension for Bertini_real to shoot for

- `-component`, `-comp`, or `-c`
  Required argument is the integer index of the component for Bertini_real to decompose (e.g `-component 1`)

- `-gammatrick` or `-g`
  Indicator for whether Bertini_real should use the gamma trick in a particular solver. Required argument is either 1 (if you'd like Bertini_real to use the gamma trick) or 0 (if not).

- `-verb`
  Required argument is the level of the verbosity you'd like to set.

- `-output`, `-out`, or `-o`
  Required argument is the name of the output directory.

- `-nostifle` or `-ns`
  If used, screen output will not be stifled. No required argument

- `-nomerge` or `-nm`
  Indicates that Bertini_real should not merge ends. No required argument.

- `-projection`, `-pi`, or `-p`
  Indicator for whether to read the projection from a file, rather than randomly choose it. Required argument is the file name.

- `-sphere` or `-s`
  Sets indicator that Bertini_real should use sphere created by user rather than just compute sphere. Required argument is the name of the file for Bertini_real to read

- `-input` or `-i`
  Used if input file is named something other than 'input'. Required argument is the file name.

- `-quick` or `-q`
  Sets the level of quickness for the solver. The quicker the solver, the less robust it is as well.
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Not sure the difference between setting quick_run value to be 1 or 2 via -quick and -veryquick

- `-veryquick` or `-vq`
  Sets the level of quickness for the solver. The quicker the solver, the less robust it is as well.

- `-version` or `-v`
  Displays the version of Bertini_real running on your computer. Has no required argument.

- `-help` or `-h`
  Displays a help message containing the version of Bertini_real, where Bertini_real can be found online, support information, and finally the command line options.

- `-mode` or `-m`
  Sets the mode of Bertini_real to be used. Required argument is the mode of operation, and there are currently two valid modes (`bertini_real` and `crit`). `bertini_real` is the default mode.

5 Troubleshooting

6 Visualization

7 3D Printing

A Output Formats

A.1 .curve

(num_variables total) num_vertices num_edges
num_V0 num_V1 num_midpts num_newpts

indices of V0
indices of V1
indices of midpoints
indices of added_points
projection excluding the homogeneous 0 coordinate.

A.2 .edge

A.3 .vert