

Continuation methods

- Blyth, Renson, and Marucci (2020)
- Starting from a known attractor/equilibrium point of a system, move in parameter space (typically 1D) to detect *nearby* points/cycles.
- Tricks: *backward-time* solution may find unstable points/orbits

grind

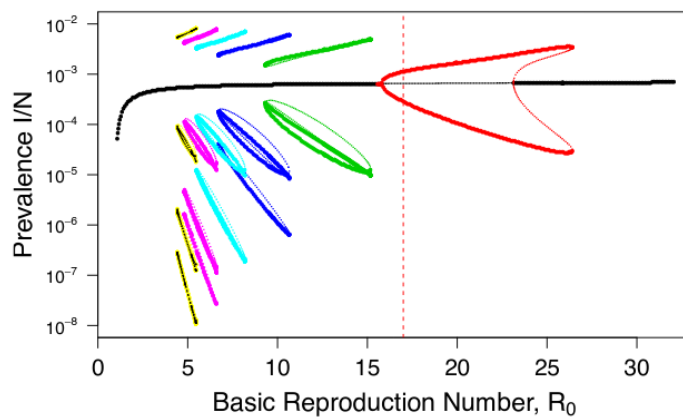
- [tutorial](#)
- [code](#)
- [MATLAB version](#)
- Uses Newton-Raphson to find steady-state solutions (not necessarily stable)
- evaluate Jacobian numerically

```
remotes::install_github("hansschepers/grindr")
library(Grind)
```

- **disadvantages:** not very powerful
- **advantages:** pretty basic, can see what it's doing

XPPAUT

- Old-school
- Handy for graphical exploration of 2D systems
- interface to AUTO (Doedel et al. 2007)
- Used by Krylova and Earn (2013)
 - [supplementary material from Krylova et al.](#)



- **disadvantages:** old-school, need to integrate with Python/R for nice plots
- **advantages:** fast, easy to use, graphical, powerful

PyDSTool/PyCont

Python based, interface to AUTO (Clewley et al. 2007)

- [PyDSTool documentation](#)
- [PyCont documentation](#)
- [Hindmarsh-Rose example on GitHub](#)
- **disadvantages:** inscrutable Python objects
- **advantages:** fast, powerful

References

- Blyth, Mark, Ludovic Renson, and Lucia Marucci. 2020. "Tutorial of Numerical Continuation and Bifurcation Theory for Systems and Synthetic Biology." *arXiv:2008.05226 [Q-Bio]*, August. <http://arxiv.org/abs/2008.05226>.
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- Clewley, Robert H., W. E. Sherwood, M. D. LaMar, and J. M. Guckenheimer. 2007. "PyDSTool, a Software Environment for Dynamical Systems Modeling." URL [Http://Pydstool.Sourceforge.Net](http://Pydstool.Sourceforge.Net). <https://pydstool.github.io/PyDSTool/FrontPage.html>.
- Doedel, Eusebius J., Thomas F. Fairgrieve, Björn Sandstede, Alan R. Champneys, Yuri A. Kuznetsov, and Xianjun Wang. 2007. "AUTO-07P: Continuation and Bifurcation Software for Ordinary Differential Equations."
- Earn, David J. D., Pejman Rohani, Benjamin M. Bolker, and Bryan T. Grenfell. 2000. "A Simple Model for Complex Dynamical Transitions in Epidemics." *Science* 287 (5453): 667–70. <https://doi.org/10.1126/science.287.5453.667>.
- Krylova, Olga, and David J. D. Earn. 2013. "Effects of the Infectious Period Distribution on Predicted Transitions in Childhood Disease Dynamics." *Journal of the Royal Society Interface* 10 (84): 20130098. <https://doi.org/10.1098/rsif.2013.0098>.