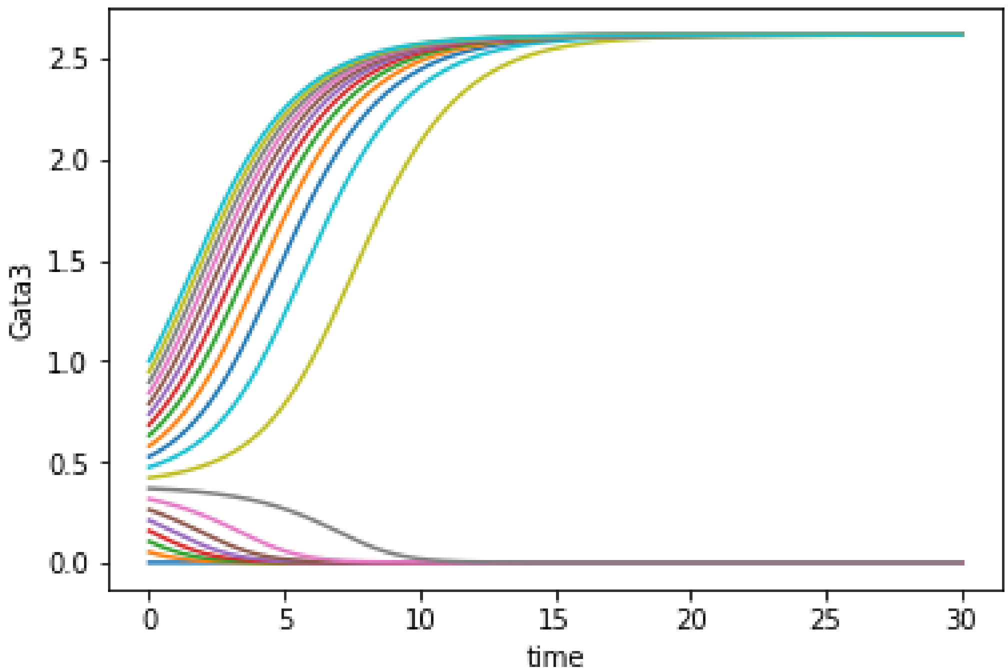
Gata3 - Python and PyDSTool

June 19, 2018

```
In [1]: import PyDSTool
        from pylab import plot, show, linspace, xlabel, ylabel
        from matplotlib import pyplot as pl
        pl.rcParams['figure.dpi'] = 150

In [2]: %matplotlib inline
```

1 ODE pre-analysis

```
In [3]: # we must give a name
        DSargs = PyDSTool.args(name='Gata3')

In [4]: # parameters
        DSargs.pars = {'alpha':0.02, 'k_g':5.0, 'k':1.0, 'S':0.0}

In [5]: # rhs of the differential equation
        DSargs.varspecs = {'v': 'alpha*S + k_g*v^2/((1+v)^2) - k*v'}

In [6]: # initial conditions
        DSargs.ics      = {'v': 1.0}

In [7]: # solve ODE
        DSargs.tdomain = [0,30] #integration time
        ode = PyDSTool.Generator.Vode_ODEsystem(DSargs) #instance of 'Generator' class

        pl.figure()
        for i, v0 in enumerate(linspace(0,1,20)):
            ode.set( ics = { 'v': v0 } )                        # Initial condition
            tmp = ode.compute('pol%3f' % i).sample()            # Trajectories are called pol0,
            plot(tmp['t'], tmp['v'])
        xlabel('time')
        ylabel('Gata3')

Out[7]: Text(0,0.5,'Gata3')
```



2 Bifurcation diagram

```
In [8]: # Prepare the system to start close to a steady state
        ode.set(pars = {'S': 0.0} ) # bifurcation parameter
        ode.set(ics =  {'v': 0.0} ) # starting near a steady-state
```

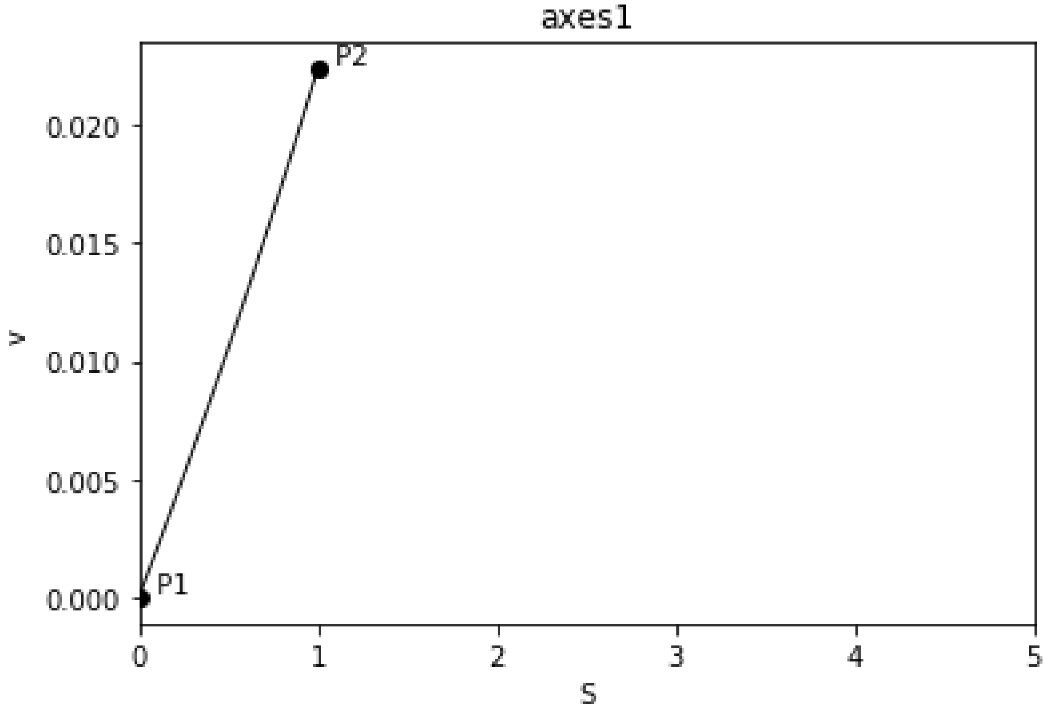
2.1 Experiment 1

```
In [9]: #--- experiment 1 ---#
        # Bifurcation diagram
        PyCont = PyDSTool.ContClass(ode)                    # Set up continuation class
        PCargs = PyDSTool.args(name='EQ1', type='EP-C')  # 'EP-C' stands for Equilibrium Point
        PCargs.freepars     = ['S']                         # control parameter(s) (it should be 

        PCargs.MaxNumPoints = 1000                          # The following 3 parameters are set 
        PCargs.MaxStepSize  = 1e-3
        PCargs.MinStepSize  = 1e-4
        PCargs.StepSize     = 1e-3

        PCargs.LocBifPoints = 'LP'                          # detect limit points / saddle-node b
        PCargs.SaveEigen    = True                          # to tell unstable from stable branch

        PyCont.newCurve(PCargs)
        PyCont['EQ1'].forward()
```

```
pl.figure()
PyCont.display(['S','v'], stability=True)        # stable and unstable branches as sol
pl.xlim([0,5])
```

```
/home/user/.local/lib/python2.7/site-packages/matplotlib/cbook/deprecation.py:107: MatplotlibDe
  warnings.warn(message, mplDeprecation, stacklevel=1)
```

Out[9]: (0, 5)



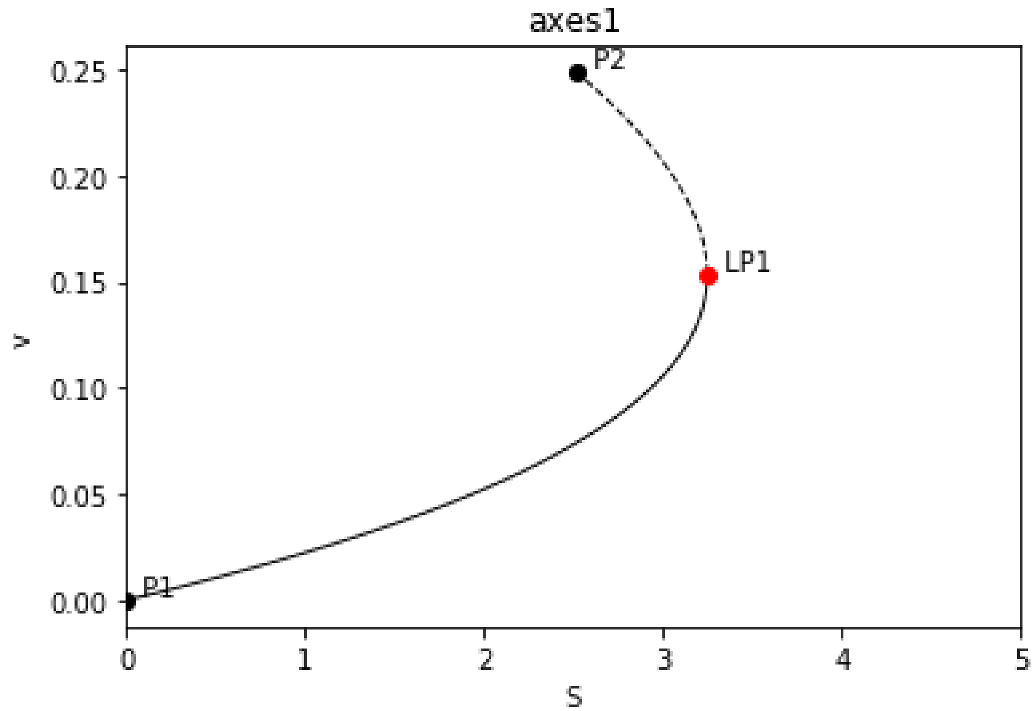
2.2 Experiment 2

In [10]:
```
#--- experiment 2 ---#
# Bifurcation diagram
PyCont = PyDSTool.ContClass(ode)                    # Set up continuation class
PCargs = PyDSTool.args(name='EQ1', type='EP-C')   # 'EP-C' stands for Equilibrium Poin
PCargs.freepars     = ['S']                         # control parameter(s) (it should be

PCargs.MaxNumPoints = 4000                          # The following 3 parameters are set
PCargs.MaxStepSize  = 1e-3
PCargs.MinStepSize  = 1e-4
PCargs.StepSize     = 1e-3

PCargs.LocBifPoints = 'LP'                          # detect limit points / saddle-node
```

```
        PCargs.SaveEigen    = True                         # to tell unstable from stable branc

        PyCont.newCurve(PCargs)
        PyCont['EQ1'].forward()
        pl.figure()
        PyCont.display(['S','v'], stability=True)          # stable and unstable branches as so
        pl.xlim([0,5])
```

```
LP Point found
```

```
Out[10]: (0, 5)
```



2.3 Experiment 3

```
In [11]: #--- experiment 3 ---#
         # Bifurcation diagram
         PyCont = PyDSTool.ContClass(ode)                  # Set up continuation class
         PCargs = PyDSTool.args(name='EQ1', type='EP-C')   # 'EP-C' stands for Equilibrium Poin
         PCargs.freepars     = ['S']                       # control parameter(s) (it should be

         PCargs.MaxNumPoints = 1000                        # The following 3 parameters are set
         PCargs.MaxStepSize  = 1e-1
         PCargs.MinStepSize  = 1e-4
```

```python
PCargs.StepSize     = 1e-2

PCargs.LocBifPoints = 'LP'                          # detect limit points / saddle-node b
PCargs.SaveEigen    = True                          # to tell unstable from stable branc

PyCont.newCurve(PCargs)
PyCont['EQ1'].forward()
pl.figure()
PyCont.display(['S','v'], stability=True)        # stable and unstable branches as so
pl.xlim([0,5])
PyCont.plot.toggleLabels(visible='off', bylabel=['LP2','P2'])
```

```
LP Point found
LP Point found
```