Beer Game Part-1

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Code

Here is our code, written in SageMath:

```
import collections

#parameters
Params = collections.namedtuple('Params', ['alpha', 'beta', 'theta', 'Q', 'RIO']);

#initial values of variables
Point = collections.namedtuple('Point', ['FI', 'FB', 'FPD2', 'FPD1', 'FPR', 'FOS', 'FIO',
    'FED', 'FSL', 'RI', 'RB', 'RIS', 'RIO', 'RED', 'ROP', 'RSL'])
init = Point(1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1)

#handy iterator class

class FunctionIter:
    x = 0
    f = lambda x: x
    step = 1
    n = 0
    m = 1
    def __init__(self,init,func,n,step):
        self.x = init
        self.f = func
        self.m = n
        self.step = step
    def __iter__(self):
        return self
    def next(self):
        ret = self.x
        for i in range(self.step):
            self.x = self.f(self.x)
        self.n = self.n + 1
        if self.n > self.m:
            raise StopIteration
        return ret


my_l = [];
def iterate(N, params):

   def do_beer_game(x):
      _FI = max(0,x.FI + x.FPD2 - x.FB - x.FIO)
      _FB = max(0,x.FB + x.FIO - x.FI - x.FPD2)
      _FED = params.theta*x.FIO + (1-params.theta)*x.FED
      _FSL = x.FPR + x.FPD1 #FSL_n = FPD1_n + FPD2_n = FPR_n-1 + FPD1_n-1
```

```
    _FOS = min(x.FI + x.FPD2, x.FB + x.FIO)
    _RI = max(0,x.RI + x.RIS - x.RB - params.RIO)
    _RB = max(0,x.RB + params.RIO - x.RI - x.RIS)
    _RED = params.theta*x.RIO + (1-params.theta)*x.RED
    _RSL = x.FOS + x.ROP + _FB + _FOS #RSL_n = RIS_n + FIO_n + FB_n + FOS_n = FOS_n-1 +
        ROP_n-1 + FB_n + FOS_n
    return Point(FI = _FI,
                 FB = _FB,
                 FPD2 = x.FPD1,
                 FPD1 = x.FPR,
                 FPR = max(0,_FED + params.alpha*(params.Q - _FI + _FB - params.beta*_FSL)),
                 FOS = _FOS,
                 FIO = x.ROP,
                 FED = _FED,
                 FSL = _FSL,
                 RI = _RI,
                 RB = _RB,
                 RIS = x.FOS,
                 RIO = params.RIO,
                 RED = _RED,
                 ROP = max(0,_RED + params.alpha*(params.Q - _RI + _RB - params.beta*_RSL)),
                 RSL = _RSL)
  global my_l
  my_l = list(FunctionIter(init,do_beer_game,N,1))

FI_l = lambda x: my_l[floor(x)+1].FI*(x - floor(x)) + my_l[floor(x)].FI*(1-x+floor(x))
FB_l = lambda x: my_l[floor(x)+1].FB*(x - floor(x)) + my_l[floor(x)].FB*(1-x+floor(x))
FPD1_l = lambda x: my_l[floor(x)+1].FPD1*(x - floor(x)) + my_l[floor(x)].FPD1*(1-x+floor(x))
FPD2_l = lambda x: my_l[floor(x)+1].FPD2*(x - floor(x)) + my_l[floor(x)].FPD2*(1-x+floor(x))
FPR_l = lambda x: my_l[floor(x)+1].FPR*(x - floor(x)) + my_l[floor(x)].FPR*(1-x+floor(x))
FOS_l = lambda x: my_l[floor(x)+1].FOS*(x - floor(x)) + my_l[floor(x)].FOS*(1-x+floor(x))
FIO_l = lambda x: my_l[floor(x)+1].FIO*(x - floor(x)) + my_l[floor(x)].FIO*(1-x+floor(x))
FED_l = lambda x: my_l[floor(x)+1].FED*(x - floor(x)) + my_l[floor(x)].FED*(1-x+floor(x))
FSL_l = lambda x: my_l[floor(x)+1].FSL*(x - floor(x)) + my_l[floor(x)].FSL*(1-x+floor(x))
RI_l = lambda x: my_l[floor(x)+1].RI*(x - floor(x)) + my_l[floor(x)].RI*(1-x+floor(x))
RB_l = lambda x: my_l[floor(x)+1].RB*(x - floor(x)) + my_l[floor(x)].RB*(1-x+floor(x))
RIS_l = lambda x: my_l[floor(x)+1].RIS*(x - floor(x)) + my_l[floor(x)].RIS*(1-x+floor(x))
RED_l = lambda x: my_l[floor(x)+1].RED*(x - floor(x)) + my_l[floor(x)].RED*(1-x+floor(x))
ROP_l = lambda x: my_l[floor(x)+1].ROP*(x - floor(x)) + my_l[floor(x)].ROP*(1-x+floor(x))
RSL_l = lambda x: my_l[floor(x)+1].RSL*(x - floor(x)) + my_l[floor(x)].RSL*(1-x+floor(x))
# plot all the different lists in different colors
def plotTrajectories(plot_begin, plot_end):
  show(plot([FI_l,
        FB_l,
        FPD1_l,
        FPD2_l,
        FPR_l,
        FOS_l,
        FIO_l,
        FED_l,
        FSL_l,
        RI_l,
        RB_l,
        RIS_l,
        RED_l,
        ROP_l,
        RSL_l],
        color = 'automatic',
        legend_label = ["FI",
```

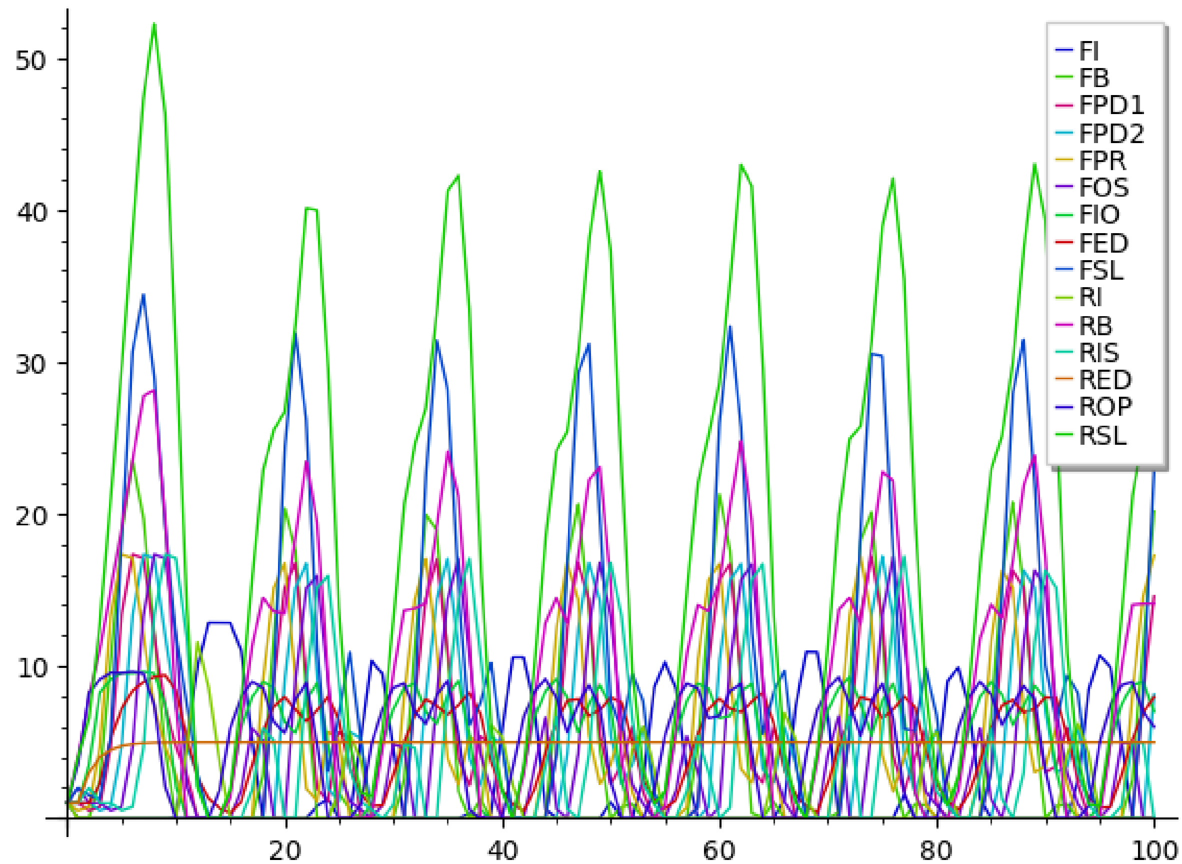
```
                      "FB",
                      "FPD1",
                      "FPD2",
                      "FPR",
                      "FOS",
                      "FIO",
                      "FED",
                      "FSL",
                      "RI",
                      "RB",
                      "RIS",
                      "RED",
                      "ROP",
                      "RSL"],
           xmin = plot_begin,
           xmax = plot_end))
def plotTwoComponents(var1, var2, plot_begin, plot_end):

   show(list_plot((map(lambda x : (getattr(x, var1), getattr(x, var2)), my_l)[plot_begin:
       plot_end]), plotjoined = True), axes_labels = ('$'+var1+'$', '$'+var2+'$'))
import IPython
IPython.embed()
```

Example 1

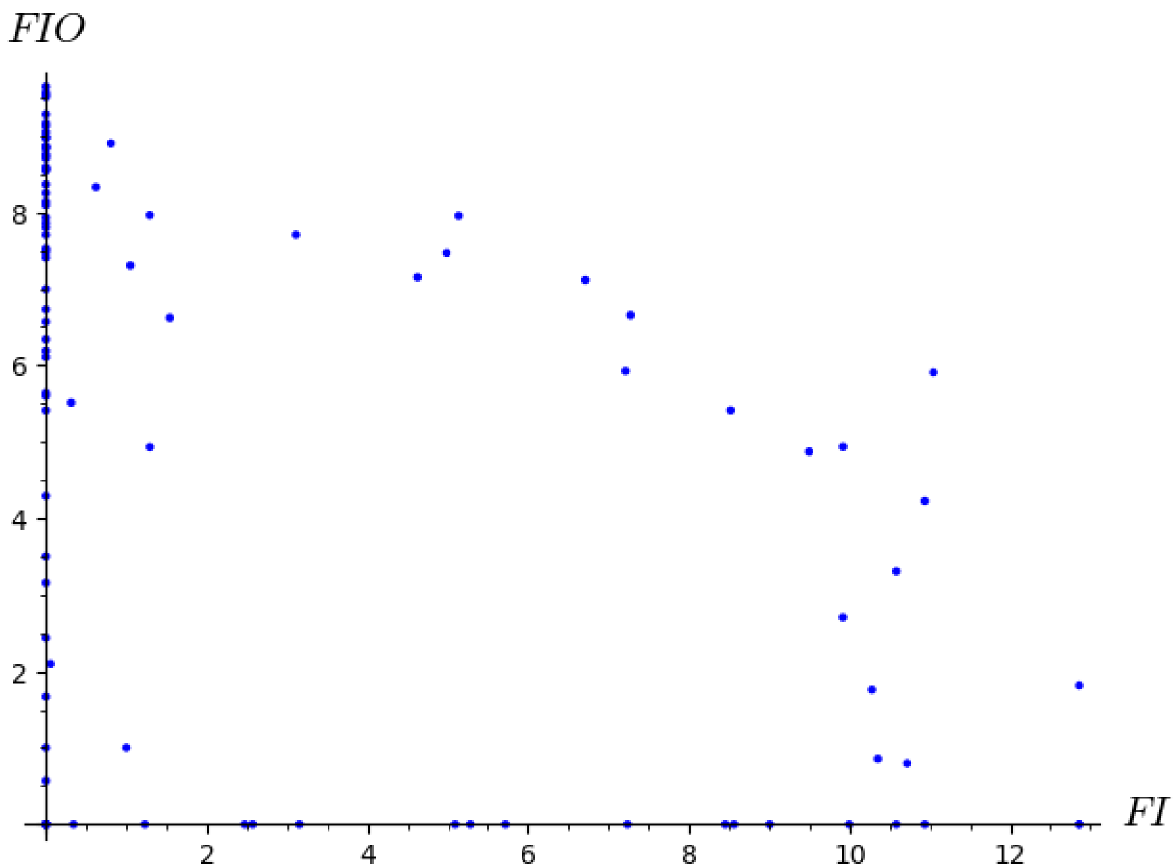
These parameters appear to give a periodic attractor with period around 15. Code:

```
#set parameters:
params = Params(alpha = 1.0,
           beta = 0.5,
           theta = 0.5,
           Q = 0.5,
           RIO = 5 #for now, demand is constant
        )


#iterate the map to 1000 steps
iterate(1000, params)

#plot parameters
plot_begin = 0
plot_end = 100

#plot the trajectory of each variable
plotTrajectories(plot_begin, plot_end)

#plot the factory's inventory against the factory's incoming orders
plotTwoComponents("FI", "FIO", plot_begin, plot_end)
```

Output:



FI
FB
FPD1
FPD2
FPR
FOS
FIO
FED
FSL
RI
RB
RIS
RED
ROP
RSL
50
40
30
20
10
20
40
60
80
100



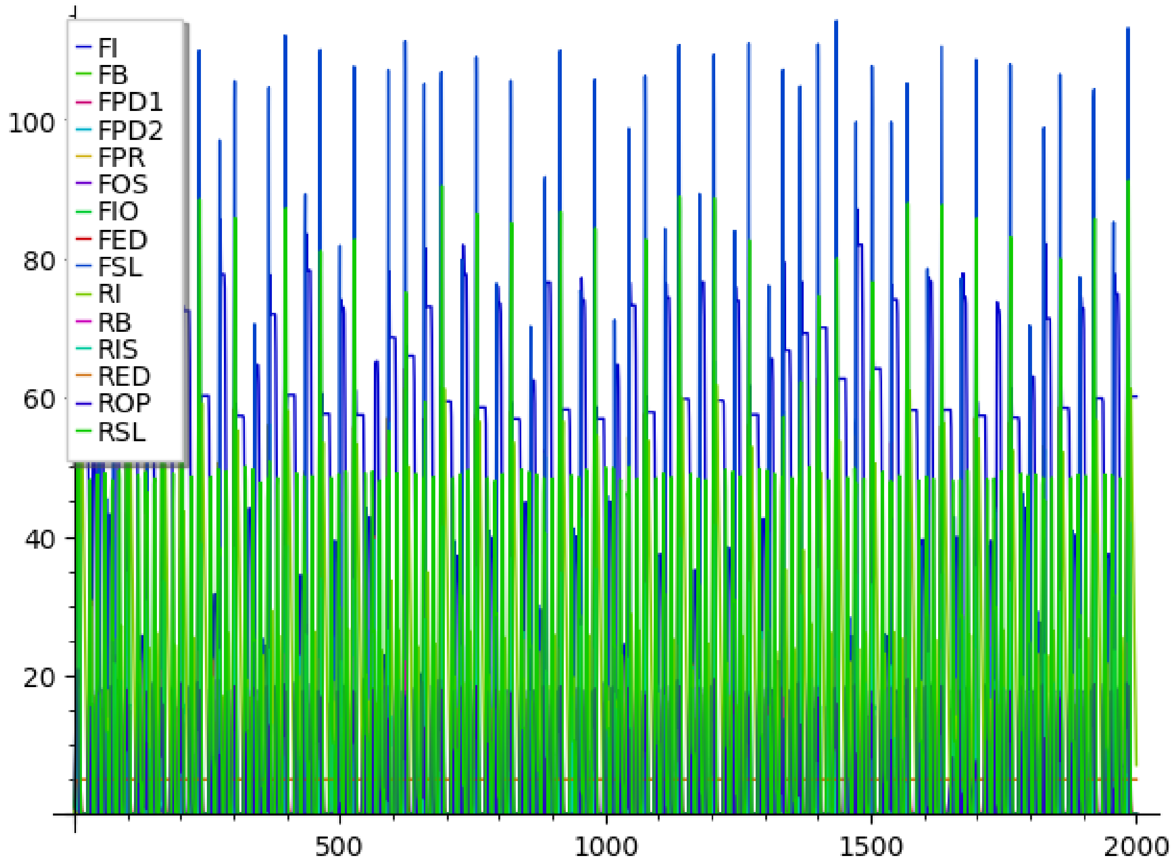
Example 2

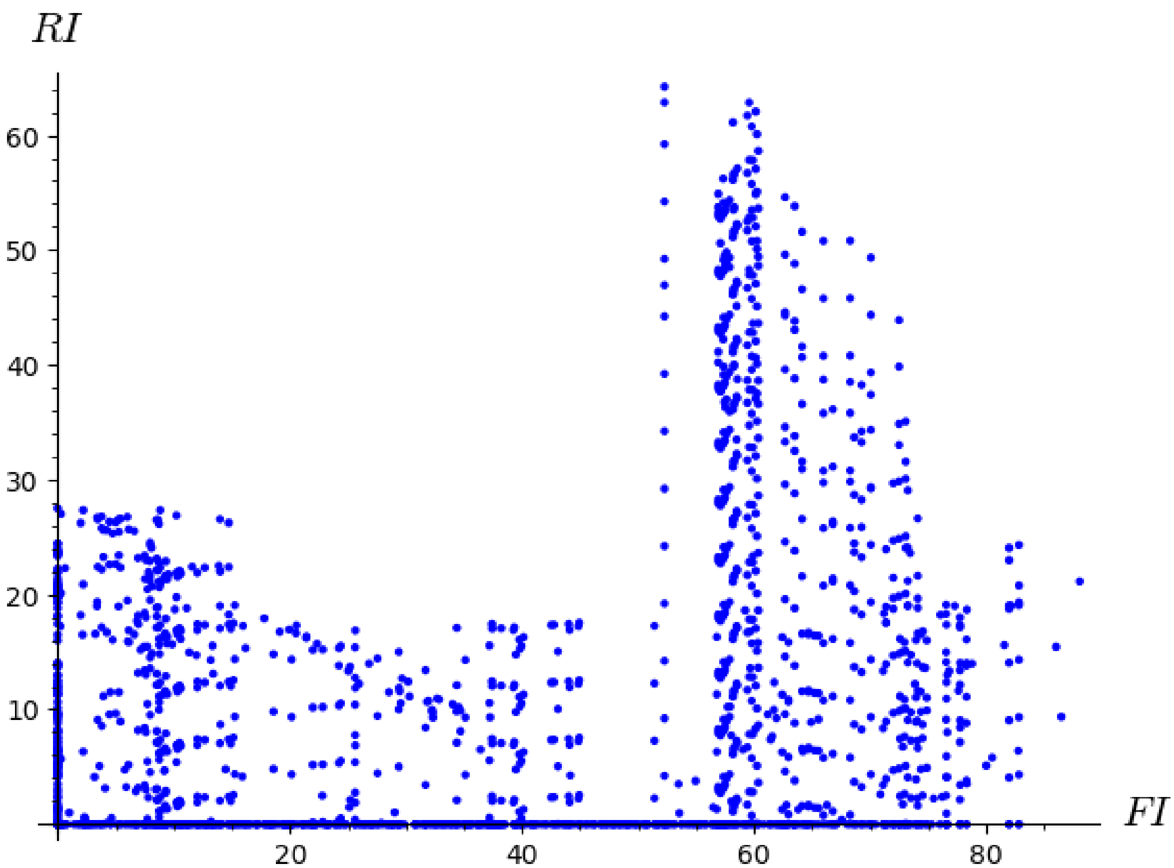
These parameters seem to result in chaos. I gave a much larger time scale to demonstrate that the trajectory doesn't seem to settle down in a pattern.
Code:

```
#set parameters:
params = Params(alpha = 1.6,
           beta = 0.2,
           theta = 0.6,
           Q = 0.1,
           RIO = 5 #for now, demand is constant
        )


#iterate the map to 5000 steps
iterate(5000, params)

#plot parameters
plot_begin = 0
plot_end = 2000

#plot the trajectory of each variable
plotTrajectories(plot_begin, plot_end)

#plot the factory's inventory against the factory's incoming orders
```

```
plotTwoComponents("FI", "RI", plot_begin, plot_end)
```

Output:




RI
60
50
40
30
20
10
20
40
60
80
FI