# NegFeedback

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A+B <-> C -> D (k1f, k1r, k3f) 2B + C <-> E (k2f, k2r) A + C <-> F (k4f, k4r

```r
library(knitr)
knitr::opts_chunk$set(comment = NA, fig.width = 5, fig.height = 10, fig.align = "center")

library(deSolve)
```

```
##
## Attaching package: 'deSolve'

## The following object is masked from 'package:graphics':
##
##      matplot
```

```r
library(ggplot2)
library(gridExtra)

tstart <- 0
tstop <- 10
tby <- 0.1
A0 <- 10^5
B0 <- 10^5
C0 <- 0 # want 10
D0 <- 0
E0 <- 0
#F0 <- 0
k1f <- .03    # adds C,    subs A&B
k1r <- .03   # adds A&B, subs C
k2f <- 1.05  # adds E,    subs B&C
k2r <- .4   # adds B&C
k3f <- .01   # adds D,    subs C
k4f <- .08   # adds C,    subs A&E
k4r <- .2    # adds A&E, subs C


negfeed <- function(t, init, parameters)
{
  with(as.list(c(init,parameters)),{
    dA <- k1r*C - k1f*A*B - 1.5*k4f*A^1.5*C + 1.5*k4r*F
    dB <- k1r*C - k1f*A*B - 1.5*k2f*B^1.5*C + 1.5*k2r*E
    dC <- k1f*A*B - k1r*C - k3f*C - k2f*B^1.5*C - k4f*A^1.5*C + k2r*E + k4r*F
    dD <- k3f*C
    dE <- k2f*B^1.5*C - k2r*E
#     dF <- k4f*A^1.5*C - k4r*F
    list(c(dA,dB,dC,dD,dE))
  })
```

```
}

times <- seq(tstart, tstop, by = tby)
init <- c(A=A0,B=B0,C=C0,D=D0,E=E0)

tmain <- paste("tby =",tby,"k1f =",k1f,"k1r =",k1r,"k2f =",k2f,"k2r =",k2r,"k3f =",k3f,
               "k4f =",k4f,"k4r =",k4r)
out <- ode(y=init,time=times,func=negfeed,parms=NULL)
out
```

```
##       time            A              B           C            D          E
## 1     0.0 1.000000e+05 100000.00000  0.00000000 0.0000000000       0.00
## 2     0.1 2.888113e+04     23.51359  0.08655643 0.0001931229 34061.37
## 3     0.2 2.189273e+04     29.72739  0.12577323 0.0002972342 32727.28
## 4     0.3 1.520182e+04     40.84760  0.20773917 0.0004583087 31447.50
## 5     0.4 8.853031e+03     65.45707  0.43859194 0.0007585005 30226.42
## 6     0.5 3.261116e+03    132.54507  1.49070855 0.0015823347 29129.05
## 7     0.6 5.907430e+02    168.40577  4.18202676 0.0043988494 28602.56
## 8     0.7 1.309970e+02    141.74434  6.31637067 0.0097093428 28527.08
## 9     0.8 4.249997e+01    124.74190  7.78037539 0.0168086812 28517.90
## 10    0.9 1.768461e+01    115.83439  8.71554649 0.0250933060 28517.14
## 11    1.0 8.630859e+00    110.98793  9.29521734 0.0341218148 28517.56
## 12    1.1 4.685909e+00    108.20703  9.65529299 0.0436111157 28518.02
## 13    1.2 2.742521e+00    106.53913  9.88201547 0.0533883284 28518.38
## 14    1.3 1.697909e+00    105.50517 10.02689586 0.0633480890 28518.63
## 15    1.4 1.099608e+00    104.84926 10.12059146 0.0734251885 28518.80
## 16    1.5 7.404024e-01    104.42713 10.18164599 0.0835784698 28518.91
## 17    1.6 5.169596e-01    104.15370 10.22150487 0.0937814610 28518.98
## 18    1.7 3.741706e-01    103.97696 10.24739829 0.1040168524 28519.03
## 19    1.8 2.810257e-01    103.86412 10.26397613 0.1142731700 28519.06
## 20    1.9 2.193037e-01    103.79407 10.27428031 0.1245427249 28519.07
## 21    2.0 1.779107e-01    103.75294 10.28032599 0.1348203194 28519.08
## 22    2.1 1.498996e-01    103.73150 10.28347159 0.1451024182 28519.08
## 23    2.2 1.308131e-01    103.72352 10.28462618 0.1553866035 28519.08
## 24    2.3 1.177402e-01    103.72479 10.28441447 0.1656712172 28519.07
## 25    2.4 1.087507e-01    103.73241 10.28326243 0.1759551196 28519.06
## 26    2.5 1.025498e-01    103.74443 10.28146250 0.1862375258 28519.06
## 27    2.6 9.826167e-02    103.75947 10.27921578 0.1965178954 28519.04
## 28    2.7 9.528863e-02    103.77661 10.27666634 0.2067958552 28519.03
## 29    2.8 9.322225e-02    103.79518 10.27389623 0.2170711489 28519.02
## 30    2.9 9.178142e-02    103.81475 10.27098485 0.2273435997 28519.01
## 31    3.0 9.077186e-02    103.83500 10.26797411 0.2376130858 28519.00
## 32    3.1 9.006019e-02    103.85572 10.26489565 0.2478795245 28518.99
## 33    3.2 8.955604e-02    103.87677 10.26177101 0.2581428606 28518.97
## 34    3.3 8.919529e-02    103.89803 10.25861546 0.2684030558 28518.96
## 35    3.4 8.893341e-02    103.91945 10.25543963 0.2786600846 28518.95
## 36    3.5 8.873997e-02    103.94097 10.25225078 0.2889139305 28518.94
## 37    3.6 8.859430e-02    103.96255 10.24905383 0.2991645834 28518.93
## 38    3.7 8.848156e-02    103.98418 10.24585233 0.3094120370 28518.91
## 39    3.8 8.839126e-02    104.00583 10.24264877 0.3196562878 28518.90
## 40    3.9 8.831649e-02    104.02749 10.23944476 0.3298973346 28518.89
## 41    4.0 8.825265e-02    104.04916 10.23624140 0.3401351776 28518.88
## 42    4.1 8.819650e-02    104.07084 10.23303978 0.3503698181 28518.86
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## 43   4.2 8.814562e-02        104.09251 10.22983982 0.3606012578 28518.85
## 44   4.3 8.809832e-02        104.11417 10.22664249 0.3708294987 28518.84
## 45   4.4 8.805354e-02        104.13583 10.22344776 0.3810545436 28518.83
## 46   4.5 8.801055e-02        104.15748 10.22025586 0.3912763952 28518.81
## 47   4.6 8.796884e-02        104.17912 10.21706692 0.4014950563 28518.80
## 48   4.7 8.792799e-02        104.20076 10.21388103 0.4117105301 28518.79
## 49   4.8 8.788775e-02        104.22238 10.21069823 0.4219228194 28518.78
## 50   4.9 8.784794e-02        104.24399 10.20751857 0.4321319276 28518.77
## 51   5.0 8.780845e-02        104.26559 10.20434207 0.4423378576 28518.75
## 52   5.1 8.776920e-02        104.28719 10.20116874 0.4525406128 28518.74
## 53   5.2 8.773012e-02        104.30877 10.19799859 0.4627401962 28518.73
## 54   5.3 8.769117e-02        104.33034 10.19483162 0.4729366110 28518.72
## 55   5.4 8.765233e-02        104.35190 10.19166784 0.4831298605 28518.70
## 56   5.5 8.761357e-02        104.37345 10.18850725 0.4933199478 28518.69
## 57   5.6 8.757488e-02        104.39499 10.18534983 0.5035068760 28518.68
## 58   5.7 8.753625e-02        104.41652 10.18219560 0.5136906485 28518.67
## 59   5.8 8.749768e-02        104.43804 10.17904454 0.5238712683 28518.65
## 60   5.9 8.745915e-02        104.45954 10.17589666 0.5340487386 28518.64
## 61   6.0 8.742067e-02        104.48104 10.17275193 0.5442230627 28518.63
## 62   6.1 8.738224e-02        104.50253 10.16961037 0.5543942436 28518.62
## 63   6.2 8.734385e-02        104.52400 10.16647197 0.5645622845 28518.61
## 64   6.3 8.730550e-02        104.54547 10.16333672 0.5747271886 28518.59
## 65   6.4 8.726719e-02        104.56692 10.16020461 0.5848889590 28518.58
## 66   6.5 8.722893e-02        104.58837 10.15707564 0.5950475988 28518.57
## 67   6.6 8.719070e-02        104.60980 10.15394980 0.6052031113 28518.56
## 68   6.7 8.715251e-02        104.63123 10.15082710 0.6153554995 28518.54
## 69   6.8 8.711437e-02        104.65264 10.14770752 0.6255047665 28518.53
## 70   6.9 8.707626e-02        104.67404 10.14459106 0.6356509155 28518.52
## 71   7.0 8.703819e-02        104.69543 10.14147771 0.6457939497 28518.51
## 72   7.1 8.700016e-02        104.71682 10.13836746 0.6559338720 28518.50
## 73   7.2 8.696217e-02        104.73819 10.13526032 0.6660706856 28518.48
## 74   7.3 8.692422e-02        104.75955 10.13215628 0.6762043937 28518.47
## 75   7.4 8.688630e-02        104.78090 10.12905533 0.6863349992 28518.46
## 76   7.5 8.684843e-02        104.80224 10.12595747 0.6964625054 28518.45
## 77   7.6 8.681059e-02        104.82357 10.12286269 0.7065869152 28518.43
## 78   7.7 8.677279e-02        104.84489 10.11977098 0.7167082317 28518.42
## 79   7.8 8.673503e-02        104.86620 10.11668234 0.7268264581 28518.41
## 80   7.9 8.669731e-02        104.88749 10.11359677 0.7369415974 28518.40
## 81   8.0 8.665963e-02        104.90878 10.11051426 0.7470536527 28518.39
## 82   8.1 8.662199e-02        104.93006 10.10743480 0.7571626270 28518.37
## 83   8.2 8.658438e-02        104.95133 10.10435839 0.7672685233 28518.36
## 84   8.3 8.654682e-02        104.97259 10.10128503 0.7773713448 28518.35
## 85   8.4 8.650929e-02        104.99383 10.09821471 0.7874710944 28518.34
## 86   8.5 8.647180e-02        105.01507 10.09514742 0.7975677752 28518.33
## 87   8.6 8.643434e-02        105.03630 10.09208316 0.8076613902 28518.31
## 88   8.7 8.639693e-02        105.05751 10.08902192 0.8177519425 28518.30
## 89   8.8 8.635955e-02        105.07872 10.08596370 0.8278394351 28518.29
## 90   8.9 8.632221e-02        105.09991 10.08290849 0.8379238709 28518.28
## 91   9.0 8.628491e-02        105.12110 10.07985629 0.8480052531 28518.27
## 92   9.1 8.624765e-02        105.14228 10.07680710 0.8580835845 28518.25
## 93   9.2 8.621042e-02        105.16344 10.07376090 0.8681588683 28518.24
## 94   9.3 8.617323e-02        105.18460 10.07071770 0.8782311073 28518.23
## 95   9.4 8.613608e-02        105.20574 10.06767748 0.8883003046 28518.22
## 96   9.5 8.609897e-02        105.22688 10.06464024 0.8983664632 28518.20
```

```
## 97    9.6 8.606189e-02      105.24800 10.06160599 0.9084295861 28518.19
## 98    9.7 8.602485e-02      105.26912 10.05857470 0.9184896762 28518.18
## 99    9.8 8.598785e-02      105.29022 10.05554638 0.9285467365 28518.17
## 100   9.9 8.595088e-02      105.31132 10.05252103 0.9386007700 28518.16
## 101 10.0 8.591396e-02      105.33240 10.04949863 0.9486517795 28518.14
```

```r
#axis(2, at = seq(0,100000,by=10000))
#pch=21 WAS working at one point with type="p"
#lines(out[,1],out[,7], type = "l", col="pink")

plot(out[,1],out[,2], type = "l", col="purple", ylim=c(0,40000),main = tmain)
lines(out[,1],out[,3], type = "l", col="green")
lines(out[,1],out[,4], type = "p", pch=21, col="red")
lines(out[,1],out[,5], type = "l", col="black")
lines(out[,1],out[,6], type = "l", col="blue")
```



by = 0.1 k1f = 0.03 k1r = 0.03 k2f = 1.05 k2r = 0.4 k3f = 0.01 k4f = 0.08 k4r