NTUtestQ2

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2022/2/27

```
library(deSolve)
```

Question 2

8.2

This is my first time write a code to solve equations using the fourth-order Runge-Kutta method. I'll try my best.

```

time <- 0:100
E0 <- 1
S0 <- 10
ES0 <- 0
P0 <- 0
k1 <- 100
k2 <- 600
k3 <- 150
parms <- c(k1 = k1, k2 = k2, k3 = k3)
e <- c(E = E0)
s <- c(S = S0)
p <- c(P = P0)
ES <- c(ES = ES0)
```

Setup the data

```

logistE <- function(t, e, parms) {
  with(as.list(parms), {
    de <- k2 * ES[1] - k1 * e[1] * s[1] + k3 * ES[1]
    list(de)
  })
}

## reasonable numerical solution with rk4
time <- seq(0, 100, 2)
outE <- as.data.frame(rk4(e, time, logistE, parms))
```

Calculate for E

```

logistS <- function(t, s, parms) {
  with(as.list(parms), {
    ds <- k2 * ES[1] - k1 * e[1] * s[1]
    list(ds)
  })
}

outS <- as.data.frame(rk4(s, time, logistS, parms))
```

Calculate for S

```
logistES <- function(t, ES, parms) {
  with(as.list(parms), {
    dES <- k1 * e[1] * s[1] - k2 * ES[1] - k3 * ES[1]
    list(dES)
  })
}

outES <- as.data.frame(rk4(ES, time, logistES, parms))
```

Calculate for ES

```
parms <- c(k1 = k1, k2 = k2, k3 = k3, ES = outES$ES)

logistP <- function(t, p, parms) {
  with(as.list(parms), {
    dp <- k3 * ES
    list(dp)
  })
}

outP <- as.data.frame(rk4(p, time, logistP, parms))
```

Calculate for P

```
Output <- cbind(outE, outS$S, outES$ES, outP$P)
print(Output)
```

Put them togethor

```
##    time             E       outS$S       outES$ES outP$P
## 1     0  1.000000e+00 1.000000e+01   0.000000e+00      0
## 2     2  6.653353e+11 6.535313e+08  -2.805015e+11      0
## 3     4  4.426711e+23 4.271032e+16  -5.901082e+22      0
## 4     6  2.945247e+35 2.791253e+24  -1.241447e+34      0
## 5     8  1.959577e+47 1.824172e+32  -2.611707e+45      0
## 6    10  1.303776e+59 1.192153e+40  -5.494409e+56      0
## 7    12  8.674481e+70 7.791095e+47  -1.155892e+68      0
## 8    14  5.771439e+82 5.091725e+55  -2.431722e+79      0
## 9    16  3.839942e+94 3.327602e+63  -5.115762e+90      0
## 10   18 2.554849e+106 2.174692e+71 -1.076234e+102      0
## 11   20 1.699831e+118 1.421229e+79 -2.264140e+113      0
## 12   22 1.130958e+130 9.288180e+86 -4.763209e+124      0
## 13   24 7.524663e+141 6.070117e+94 -1.002066e+136      0
## 14   26 5.006424e+153 3.967012e+102 -2.108107e+147      0
## 15   28 3.330951e+165 2.592566e+110 -4.434953e+158      0
## 16   30 2.216199e+177 1.694323e+118 -9.330082e+169      0
## 17   32 1.474516e+189 1.107293e+126 -1.962826e+181      0
## 18   34 9.810474e+200 7.236510e+133 -4.129318e+192      0
## 19   36 6.527255e+212 4.729286e+141 -8.687100e+203      0
## 20   38 4.342813e+224 3.090737e+149 -1.827558e+215      0
## 21   40 2.889427e+236 2.019893e+157 -3.844746e+226      0
## 22   42 1.922438e+248 1.320064e+165 -8.088429e+237      0
## 23   44 1.279066e+260 8.627029e+172 -1.701612e+249      0
## 24   46 8.510077e+271 5.638034e+180 -3.579786e+260      0
## 25   48 5.662055e+283 3.684632e+188 -7.531015e+271      0
## 26   50 3.767165e+295 2.408022e+196 -1.584346e+283      0
## 27   52 2.506428e+307 1.573718e+204 -3.333085e+294      0
## 28   54           NaN 1.028474e+212 -7.012015e+305      0
## 29   56           NaN 6.721401e+219            NaN      0
## 30   58           NaN 4.392646e+227            NaN      0
## 31   60           NaN 2.870732e+235            NaN      0
## 32   62           NaN 1.876113e+243            NaN      0
## 33   64           NaN 1.226099e+251            NaN      0
## 34   66           NaN 8.012940e+258            NaN      0
## 35   68           NaN 5.236708e+266            NaN      0
## 36   70           NaN 3.422353e+274            NaN      0
## 37   72           NaN 2.236615e+282            NaN      0
## 38   74           NaN 1.461698e+290            NaN      0
## 39   76           NaN 9.552653e+297            NaN      0
## 40   78           NaN 6.242958e+305            NaN      0
## 41   80           NaN           NaN            NaN      0
## 42   82           NaN           NaN            NaN      0
## 43   84           NaN           NaN            NaN      0
## 44   86           NaN           NaN            NaN      0
## 45   88           NaN           NaN            NaN      0
## 46   90           NaN           NaN            NaN      0
## 47   92           NaN           NaN            NaN      0
## 48   94           NaN           NaN            NaN      0
## 49   96           NaN           NaN            NaN      0
## 50   98           NaN           NaN            NaN      0
## 51  100           NaN           NaN            NaN      0
```