hwk9.R

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```
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# M348 - hwk 9 - 5 April 2016

# Euler's Method
# inputs:
#   a: first endpoint
#   b: last endpoint
#   n: integer
#   e: initial condition
#   f: ODE given function
euler<-function(a, b, n, e, f){
  emat<-matrix(rep(0,n*2+2),nrow=2)

  # create h, t, w
  h<- (b - a)/n
  t<- a
  w<- e

  # first approx
  emat[1,1]<-t
  emat[2,1]<-w

  # loop over the 1 to n iterations
  for (i in 1:n){

    # set next w and t
    w<- w + h*f(t,w)
    t<- a + i*h

    # save approxs
    emat[1,i+1]<- t
    emat[2,i+1]<- w

  }
  # output
  return(emat)
}

# intial ODE function
f<-function(t,y){
  return(1+y/t)
}

# true function
f.tru<-function(t){
  return(t*log(t)+2*t)
}
```

```r
# matrix of approximations with n=10 => h=0.1
ans.6b<-euler(1,2,10,2,f)
ans.6b
```

```
##      [,1] [,2]     [,3]     [,4]     [,5]     [,6]     [,7]     [,8]
## [1,]    1  1.1 1.200000 1.300000 1.400000 1.500000 1.600000 1.700000
## [2,]    2  2.3 2.609091 2.926515 3.251632 3.583891 3.922817 4.267993
##          [,9]    [,10]    [,11]
## [1,] 1.800000 1.900000 2.000000
## [2,] 4.619052 4.975666 5.337543
```

```r
# matrix of approximations with n=1000 => h=0.001
ans.6c<-euler(1,2,1000,2,f)
ans.6c[,1:5]
```

```
##      [,1]  [,2]     [,3]     [,4]     [,5]
## [1,]    1 1.001 1.002000 1.003000 1.004000
## [2,]    2 2.003 2.006001 2.009003 2.012006
```

```r
ans.6c[,996:1001]
```

```
##          [,1]     [,2]     [,3]    [,4]     [,5]     [,6]
## [1,] 1.995000 1.996000 1.997000 1.99800 1.999000 2.000000
## [2,] 5.367338 5.371028 5.374719 5.37841 5.382102 5.385794
```

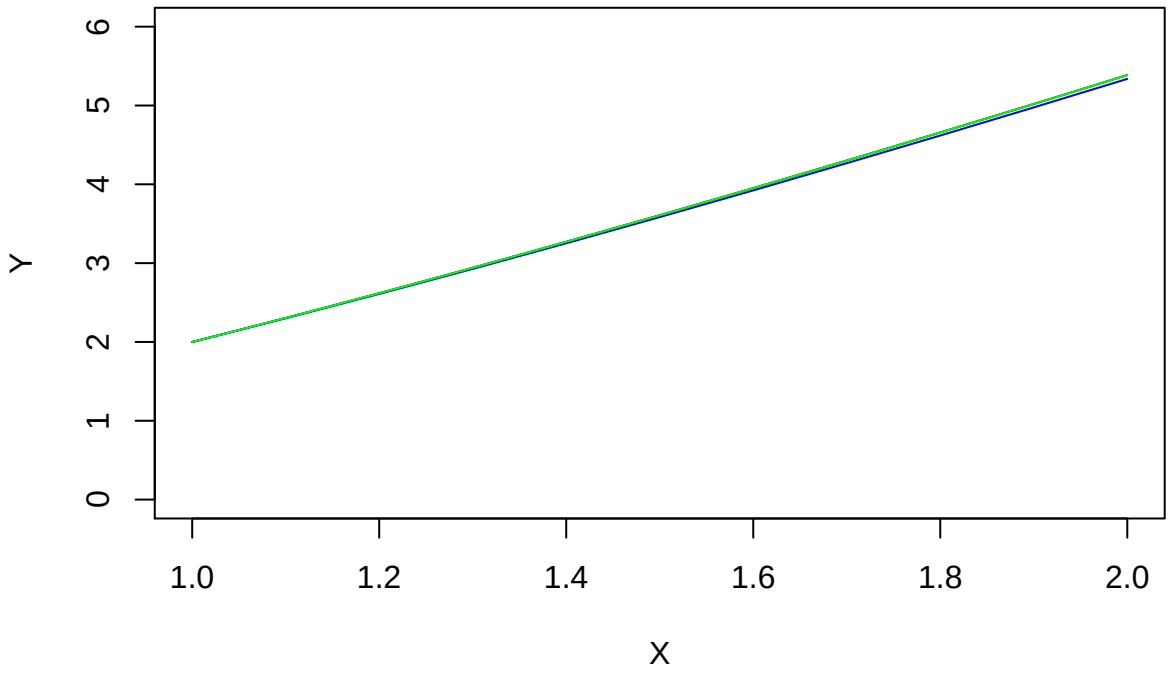
```r
# vector of true solutions over [1,2] by 0.0001
true.6<-c(f.tru(seq(1,2,0.0001)))

# plot coordinate plane over relevant interval
plot(NA, xlim=c(1,2), ylim=c(0,6), xlab="X", ylab="Y")

# true solution (black)
lines(seq(1,2,0.0001), true.6, col="black")

# approximation (b) (blue)
lines(ans.6b[1,], ans.6b[2,], col="blue")

# approximation (c) (green)
lines(ans.6c[1,], ans.6c[2,], col="green")
```


Y
0
1
2
3
4
5
6
1.0
1.2
1.4
1.6
1.8
2.0
X