Central Difference

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Given:

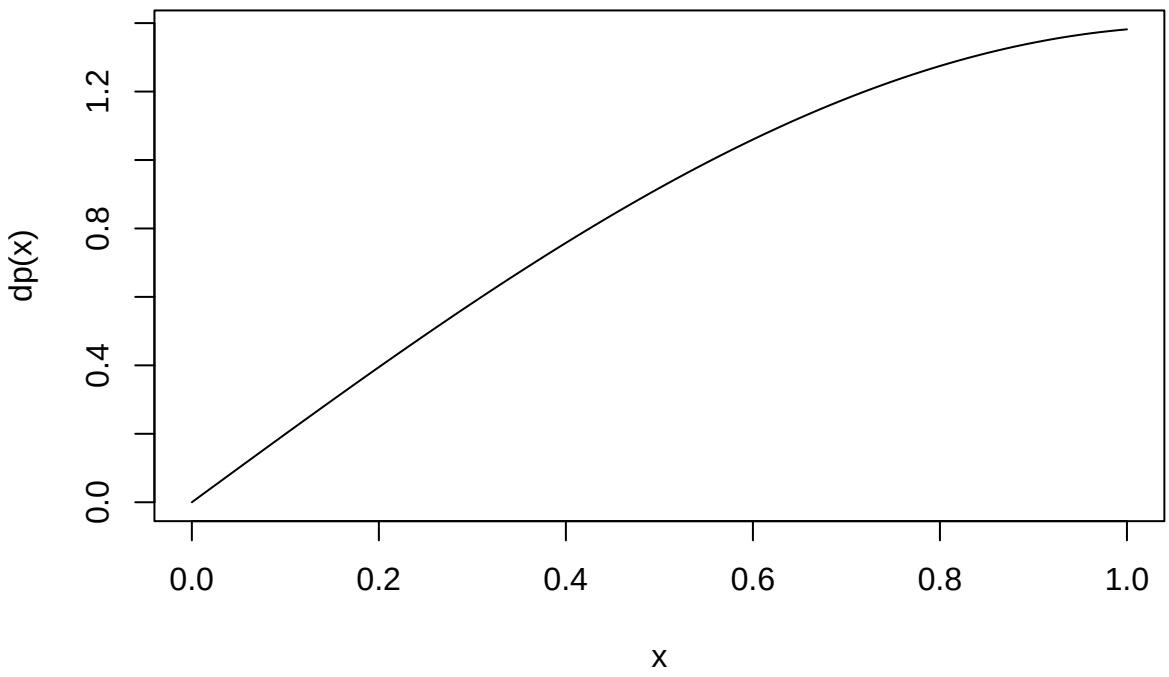
$$f(x) = x * sin(x)$$

Find $f'(0.4)$ using finite difference. $(actual = 0.7578427)$

```
f=function(x) x*sin(x)
dp = Deriv(f, "x")
dp(0.4)
```

```
## [1] 0.7578427
```

```
curve(dp)
```



START OF GETTING THE FINITE DIFFERENCE

```
f=function(x) x*sin(x)
x = c(0.2,0.3,0.4,0.5,0.6)
d=data.frame(x, f(x))
d
```

```
##     x       f.x.
## 1 0.2 0.03973387
## 2 0.3 0.08865606
## 3 0.4 0.15576734
## 4 0.5 0.23971277
## 5 0.6 0.33878548
```

```
j=1:5
f1=(f(x[j+1])-f(x[j]))/(x[j+1]-x[j])
d=data.frame(x, f(x), f1)
d
```

```
##     x       f.x.        f1
## 1 0.2 0.03973387 0.4892220
## 2 0.3 0.08865606 0.6711127
## 3 0.4 0.15576734 0.8394543
## 4 0.5 0.23971277 0.9907271
## 5 0.6 0.33878548        NA
```

```
f=function(x) x*sin(x)
j=1:5
f2=(f1[j+1]-f1[j])/(x[j+2]-x[j])
d=data.frame(x, f(x), f1, f2)
d
```

```
##     x       f.x.        f1        f2
## 1 0.2 0.03973387 0.4892220 0.9094540
## 2 0.3 0.08865606 0.6711127 0.8417079
## 3 0.4 0.15576734 0.8394543 0.7563641
## 4 0.5 0.23971277 0.9907271        NA
## 5 0.6 0.33878548        NA        NA
```

```
f=function(x) x*sin(x)
j=1:5
f3=(f2[j+1]-f2[j])/(x[j+3]-x[j])
d=data.frame(x, f(x), f1, f2, f3)
d
```

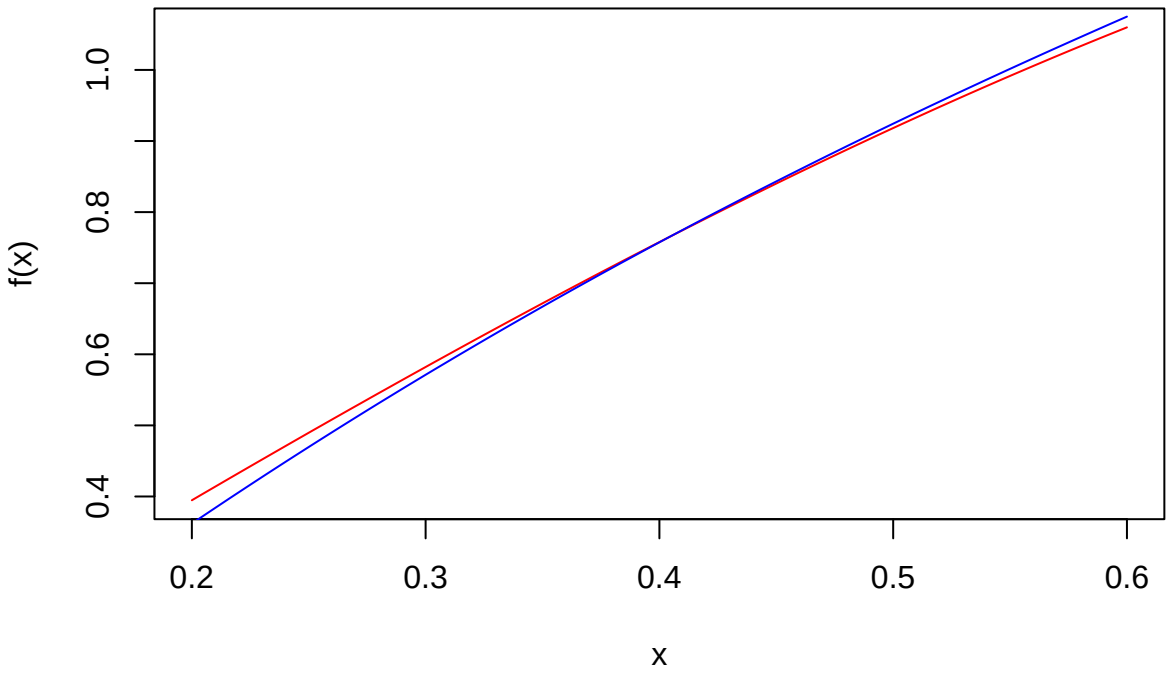
```
##     x       f.x.        f1        f2         f3
## 1 0.2 0.03973387 0.4892220 0.9094540 -0.2258203
## 2 0.3 0.08865606 0.6711127 0.8417079 -0.2844792
## 3 0.4 0.15576734 0.8394543 0.7563641         NA
## 4 0.5 0.23971277 0.9907271        NA         NA
## 5 0.6 0.33878548        NA        NA         NA
```

```r
f=function(x) x*sin(x)
j=1:5
f4=(f3[j+1]-f3[j])/(x[j+4]-x[j])
d=data.frame(x, f(x), f1, f2, f3, f4)
d
```

```
##     x       f.x.        f1        f2         f3         f4
## 1 0.2 0.03973387 0.4892220 0.9094540 -0.2258203 -0.1466473
## 2 0.3 0.08865606 0.6711127 0.8417079 -0.2844792         NA
## 3 0.4 0.15576734 0.8394543 0.7563641         NA         NA
## 4 0.5 0.23971277 0.9907271        NA         NA         NA
## 5 0.6 0.33878548        NA        NA         NA         NA
```

```r
f=function(x){sin(x)+x*cos(x)}
p=function(x) {0.4892220+(0.9094540)*((x - 0.3)+(x - 0.2))+
    (-0.2258203)*((x - 0.3)*(x - 0.2)+ (x - 0.4)*(x - 0.2) +
    (x - 0.5)*(x - 0.4))+ (-0.1466473)*((x - 0.5)*(x - 0.4)*(x - 0.2)+
    (x - 0.6)*(x - 0.4)*(x - 0.3)+(x - 0.6)*(x - 0.4)*(x - 0.2))+
    (x - 0.6)*(x-0.5)*(x-0.4)}

curve(f,0.2,0.6, col="red")
curve(p,0.2,0.6, add = T, col="blue")
```



CENTRAL DIFFERENCE

```
f=function(x) x*sin(x)
n = c(1,2,2^2,2^3,2^4)
delta_x = 0.05/n
dfdx = (f(0.4+delta_x)-f(0.4-delta_x))/(2*(delta_x))
error = dfdx-0.7578427
round(dfdx, 5);round(error, 5)
```

```
## [1] 0.75720 0.75768 0.75780 0.75783 0.75784
```

```
## [1] -0.00064 -0.00016 -0.00004 -0.00001  0.00000
```