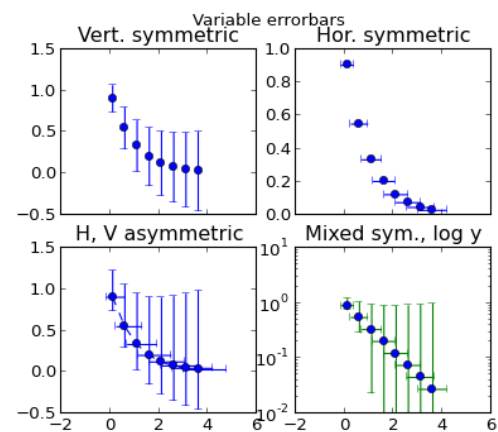
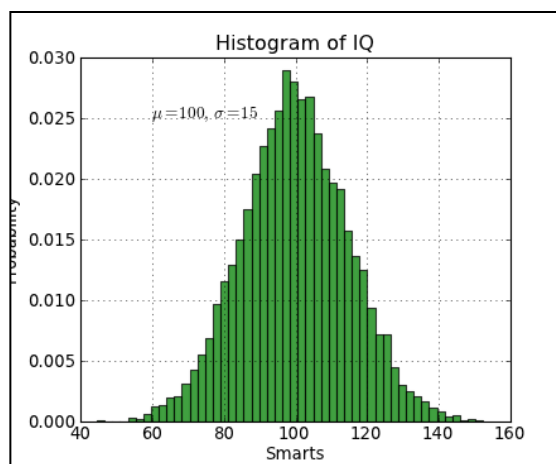
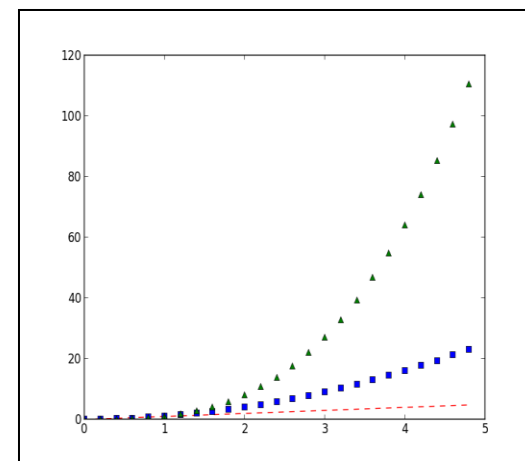
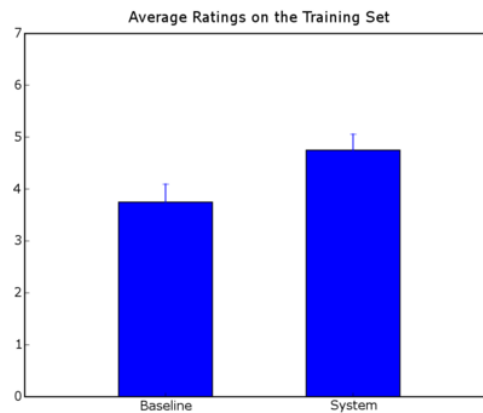
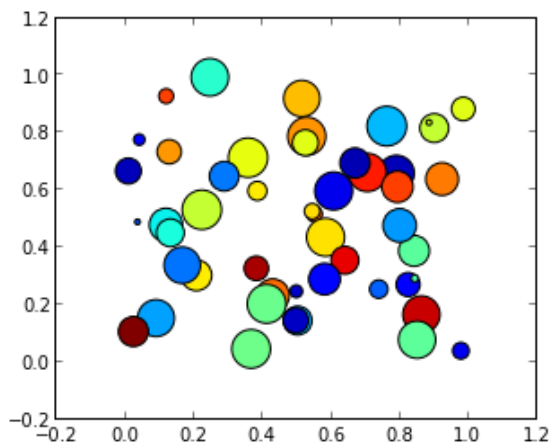


Simple plotting with pylab



matplotlib

Pyplot provides a procedural interface to the matplotlib object-oriented plotting library.

```
import pylab
```

```
plot(x, y)
```

```
#plot
import pylab
ax = [0, 0.5, 1.0, 1.5, 2.0]
ay = [0, 0.25, 1.0, 2.25, 4.0]

pylab.plot(ax,ay)
pylab.show()
```

```
#scatter
import pylab
ax = [0, 0.5, 1.0, 1.5, 2.0]
ay = [0, 0.25, 1.0, 2.25, 4.0]

pylab.scatter(ax,ay)
pylab.show()
```

```
pylab.savefig('plot.png') # png, pdf, eps
```

linspace - vectorization

$$y=x^2$$

```
import pylab
xs = [1,2,3,4,5]
ys = [x**2 for x in xs]

pylab.plot(xs, ys)
pylab.show()
```

```
import pylab
x = pylab.arange(0.0, 5.0, 0.01)
y = x**2

pylab.plot(x, y)
pylab.show()
```

$$0 < x < 2\pi, y = \sin(x)^2 \text{ graph}$$

```
import pylab
n=1000
xmin,xmax = 0, 2*pylab.pi
d=(xmax - xmin) / (n-1)
x = n * [0.]
y = n * [0.]
for i in range(n):
    x[i] = xmin + i*d
    y[i] = pylab.sin(x[i])**2
pylab.plot(x, y)
pylab.show()
```

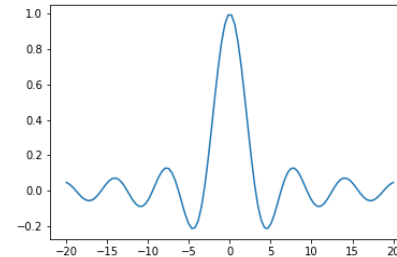
```
import pylab
n=1000
xmin,xmax = 0, 2*pylab.pi

x=pylab.linspace(xmin, xmax, n)
y=pylab.sin(x)**2

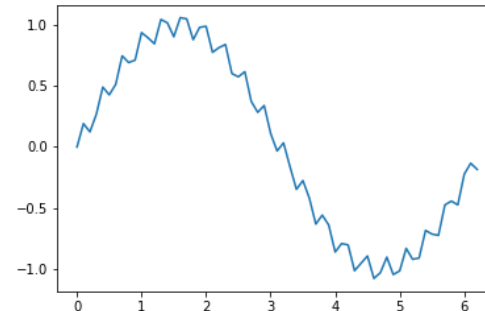
pylab.plot(x, y)
pylab.show()
```

example

- $-20 \leq x \leq 20$ 의 범위에서 $y = \sin(x) / x$ 의 그래프를 그리시오.



- $0 \leq t \leq \pi$ 의 범위에서 $y = \sin(t) + 0.1 \sin(20t)$ 의 그래프를 그리시오.

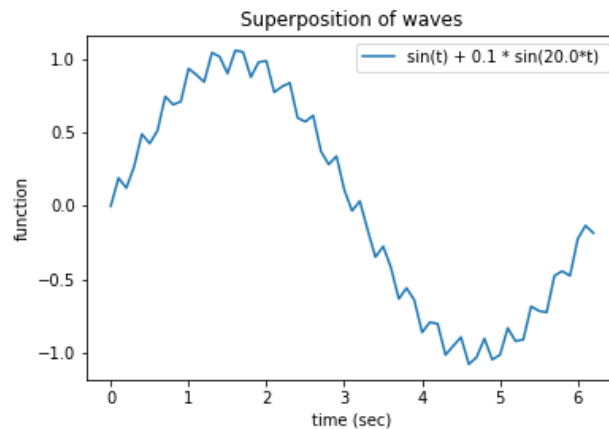


Labels, legend, customization

```
import pylab
t = pylab.arange(0.0, 2.0*pylab.pi, 0.1)

y = pylab.sin(t) + 0.1 * pylab.sin(20.0*t)
pylab.xlabel('time (sec)')
pylab.ylabel('function')
pylab.title('Superposition of waves')
pylab.plot(t, y, label='sin(t) + 0.1 * sin(20.0*t) ')
pylab.legend()
pylab.show()
```

} labels

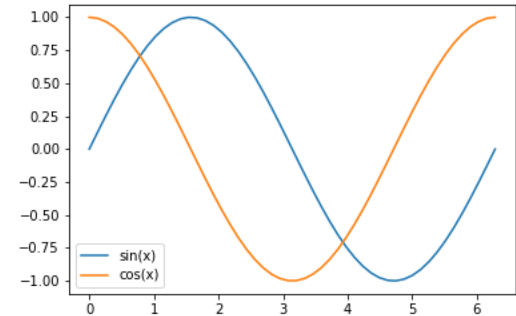


Legend location

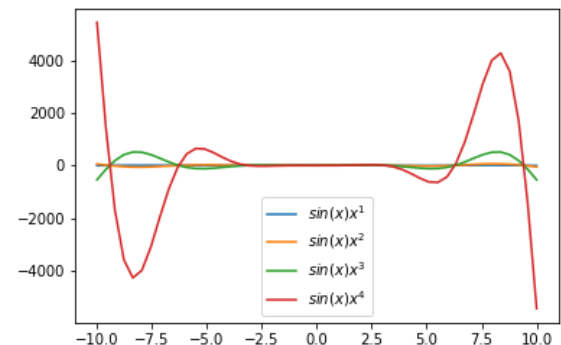
best, upper right, upper left
lower left, lower right, right
center left, center right
lower center, upper center
Center
Eg. legend(loc='center')

example

- $0 \sim 2\pi$ 범위에서 $\sin(x)$, $\cos(x)$ 의 그래프를 그리고 범례를 추가하시오.



- $f_n(x) = \sin(x)x^n$ 의 그래프를 $n=1,2,3,4$ 일 때 그리고 범례를 추가하시오.



```
import pylab
```

```
x = pylab.linspace(-10, 10)
```

```
k=1
```

```
y1 = pylab.sin(x)*x**k
```

```
pylab.plot(x,y1, label='$sin(x)x^{k}$'.format(k))
```

```
k=2
```

```
y1 = pylab.sin(x)*x**k
```

```
pylab.plot(x,y1, label='$sin(x)x^{k}$'.format(k))
```

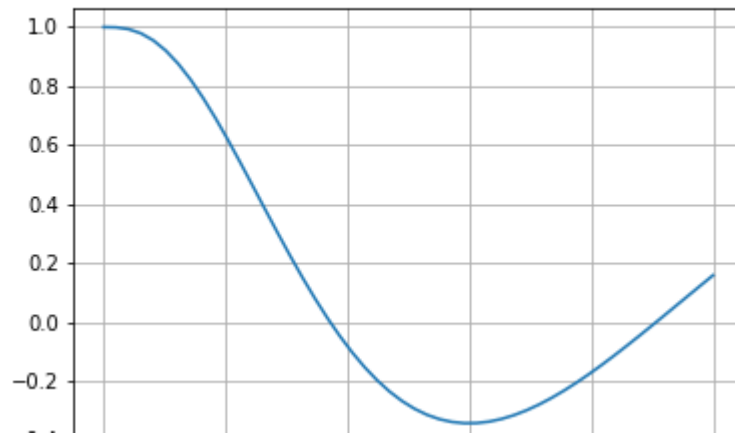
```
#....
```

```
pylab.legend()
```

```
pylab.show()
```


example

- $f(x) = -x^3 e^{-x} + 1$ 의 해가 보이는 구간으로 그래프를 그리시오.



Marker, Color, LineStyles

`plot(x, y, 'line specifiers')`

`plot(x, y, c='r', m='o')`

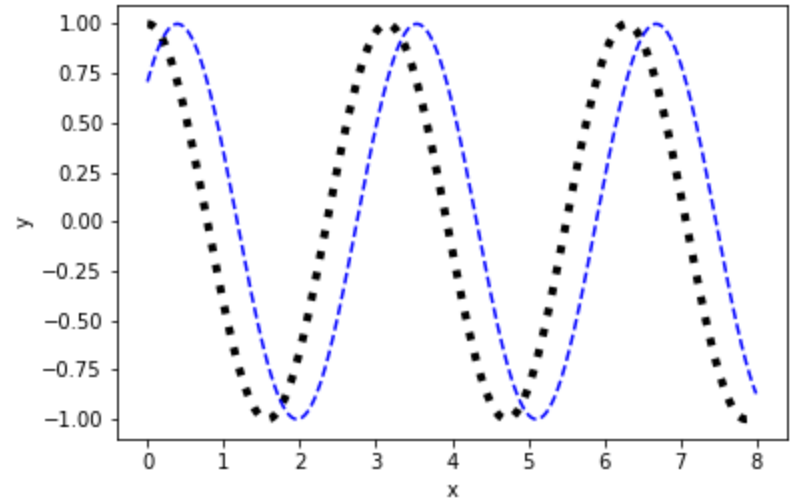
선 종류	지정자
실선(기본) Solid line	-
파 선 Dashed line	--
점 선 Dotted line	:
일점쇄선 Dash-dot line	-.

선 색깔	지정자
red	r
green	g
blue	b
cyan	c
magenta	m
yellow	y
black	k
white	w

Marker 모양	지정자
plus 부호	+
원	o(알파벳)
별표	*
점	.
▲/▼	^/v
■	s
◆	d
x	x

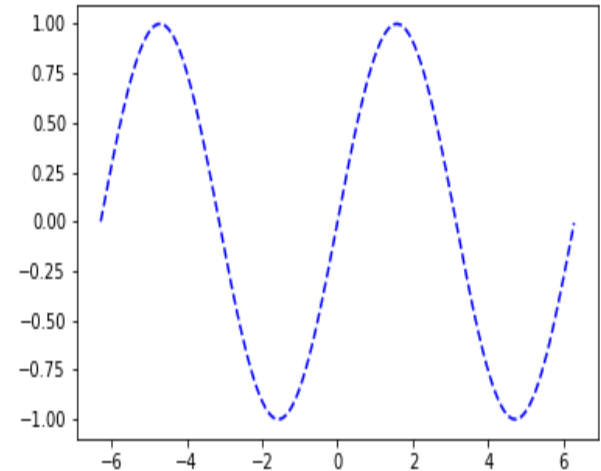
example

```
from pylab import *  
x = arange(0.0, 8.0, 0.01)  
y1 = cos(2.*x)  
y2 = cos(2.*x - pi/4.)  
xlabel('x')  
ylabel('y')  
plot(x, y1, 'k:', linewidth=4)  
plot(x, y2, 'b--')  
show()
```



Setting limits

```
from pylab import *  
x = arange(-2*pi, 2*pi, 0.01)  
y = sin(x)  
plot(x, y, 'b--')  
xlim(x.min() * 1.1, x.max() * 1.1)  
ylim(y.min() * 1.1, y.max() * 1.1)  
show()
```



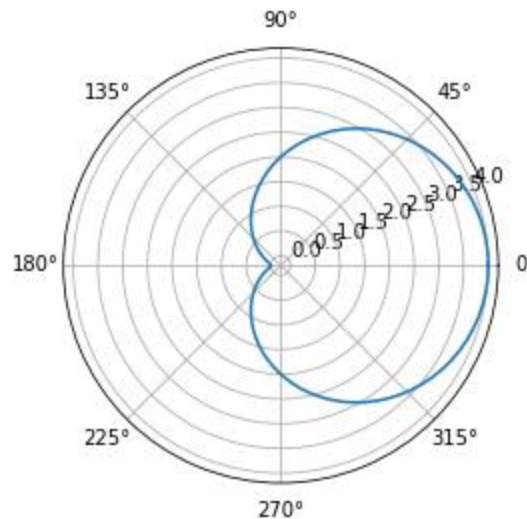
3.3 MORE ADVANCED PLOTTING

Polar plot

- 극좌표는 평면 상의 한 점의 위치를 각도 θ 와 이 점까지의 반경(거리) r 로 정의하는 좌표계

`polar(θ , r , 'line specifiers')`

- $0 \sim 2\pi$, $r = 2a(1+\cos(t))$ 의 그래프를 그리시오.



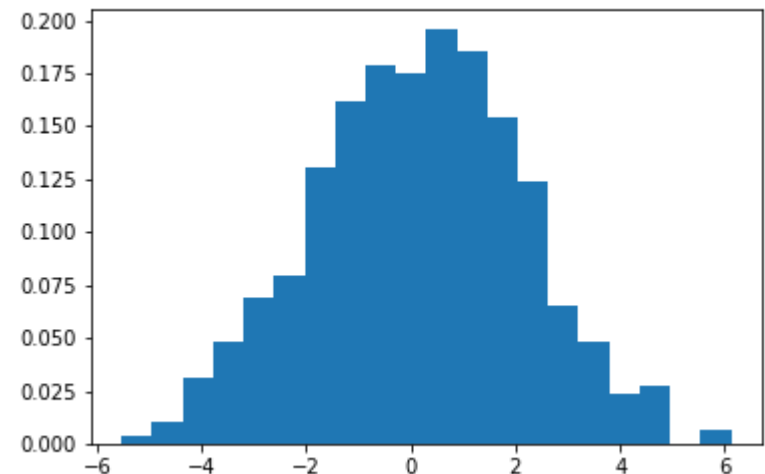
Histograms

- ❖ 주어진 데이터의 전체 범위를 작은 구간(계급)들로 나누고 각 구간에 속하는 데이터의 개수(빈도수)를 세로막대로 나타내어 데이터의 크기별 분포를 보여줌

`hist(data, bins, density)`

```
import pylab
import random
data = []
for i in range(500):
    data.append(random.normalvariate(0,2))

pylab.hist(data, bins=20, density=True)
pylab.show()
```



example

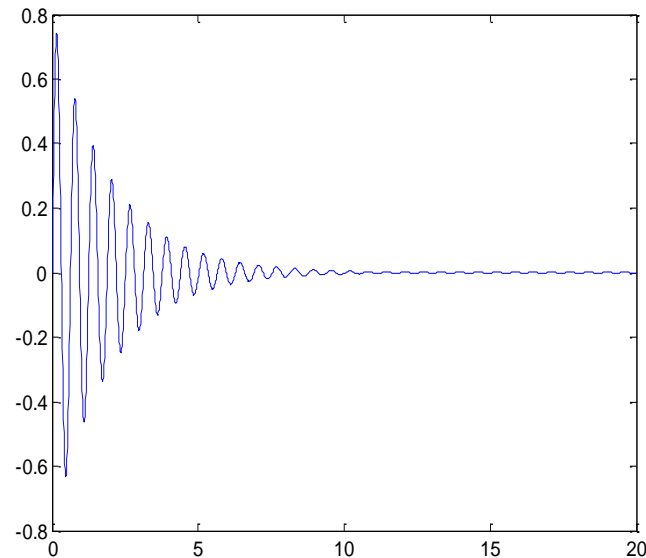
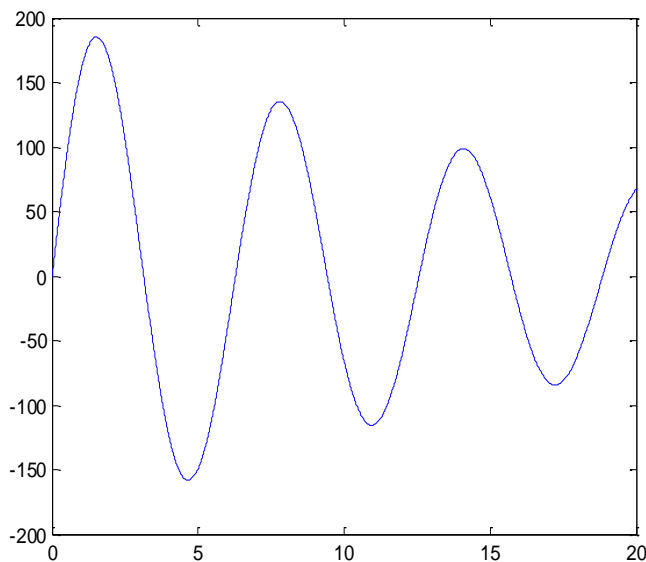
주어진 파일 'myfile.txt'를 읽어 10개구간의 도수분포그래프로
나타내 보자

```
import pylab
f = open('myfile.txt','r')
data = []
for line in f:
    fields = line.split()
    for x in fields:
        data.append(int(x))
f.close()

pylab.hist(data, bins=10)
```


example

- $0 \leq x \leq 20$ 의 범위에서
- $y = 200e^{-0.05x}\sin(x)$,
 $y = 0.8e^{-0.5x}\sin(10x)$ 의 그래프를 함께 그려보자.



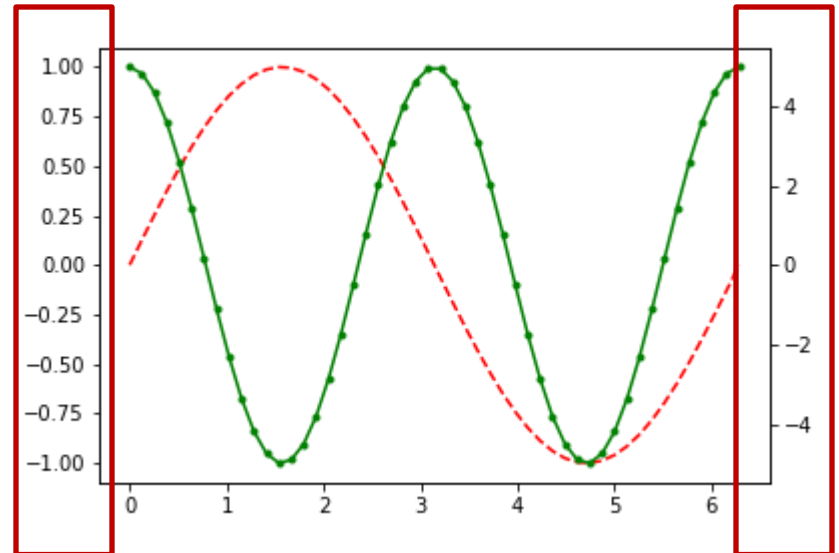
Multiple axes

```
import pylab
x = pylab.linspace(0,2*pi)
y1 = sin(x)
pylab.plot(x,y1,'--r')
```

pylab.twinx()

```
y2 = 5*cos(2*x)
pylab.plot(x,y2,'.-g')
pylab.show()
```

`pylab.twinx()`



example

- Data1.txt 파일을 읽어온다.
- 첫 열은 data1(age), 두 번째 열은 data2(height), 세 번째 열은 data3(weight)를 이용하여 다음과 같은 그래프를 그린다.

