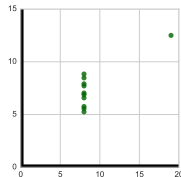
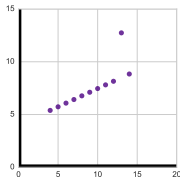
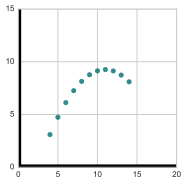
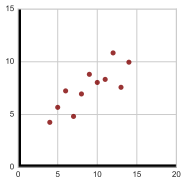


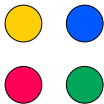
# Producing Pretty Plots in Python

Geraint Ian Palmer  
@GeraintPalmer

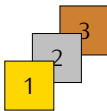
PyCon Namibia 2017



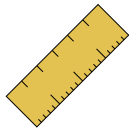
# Types of Data



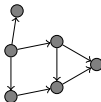
Nominal



Ordinal

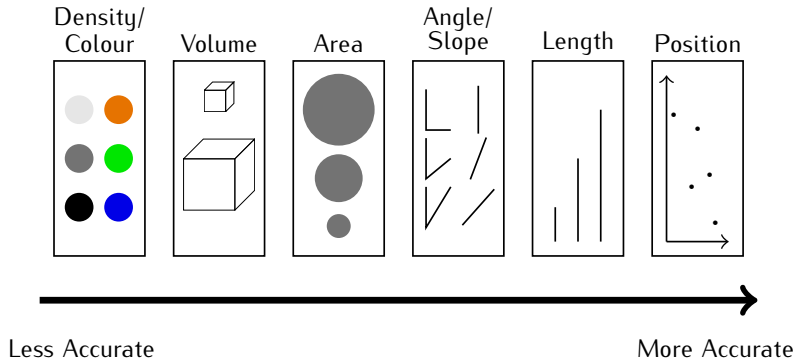


Quantitative



Relational

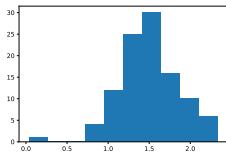
# Perceptual Accuracy



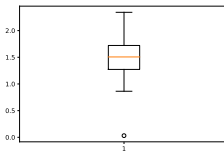
YouTube: Design Principles in Information Visualisation  
(Prof. Jessie Kennedy)

```
import matplotlib.pyplot as plt
```

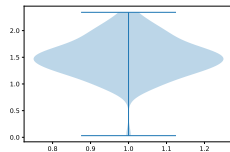
`plt.hist(xs)`



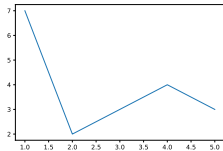
`plt.boxplot(xs)`



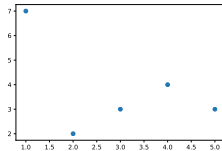
`plt.violinplot(xs)`



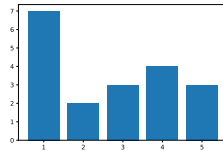
`plt.plot(xs, ys)`



`plt.scatter(xs, ys)`

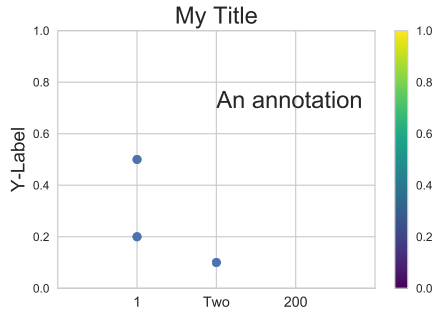


`plt.bar(xs, ys)`



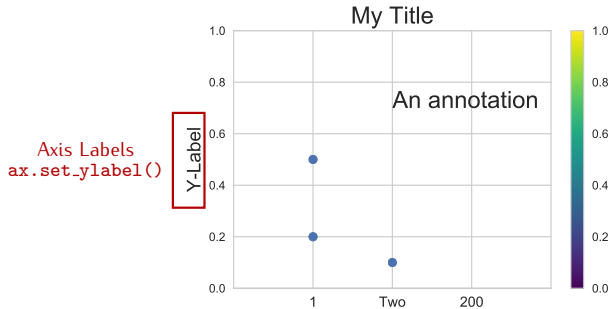
# Anatomy of a Plot

```
fig, ax = plt.subplots(1)
```



# Anatomy of a Plot

```
fig, ax = plt.subplots(1)
```



# Anatomy of a Plot

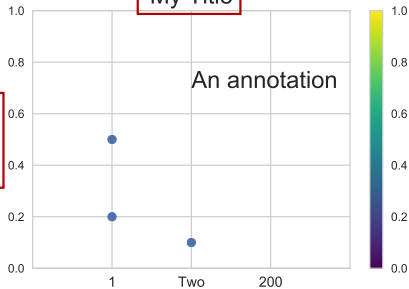
```
fig, ax = plt.subplots(1)
```

Title  
`ax.set_title()`

My Title

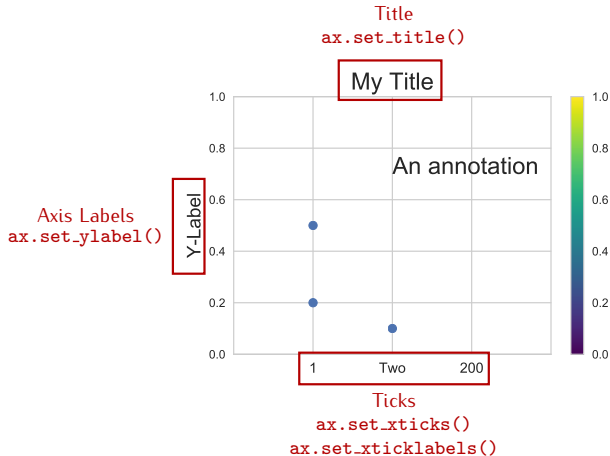
Axis Labels  
`ax.set_ylabel()`

Y-Label



# Anatomy of a Plot

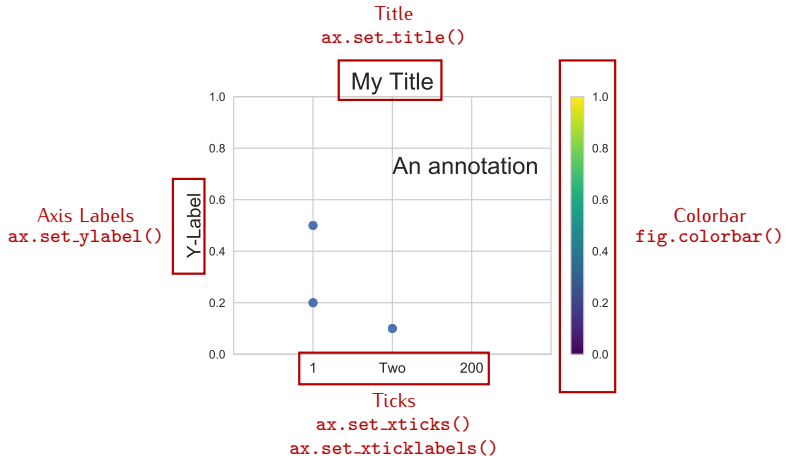
```
fig, ax = plt.subplots(1)
```





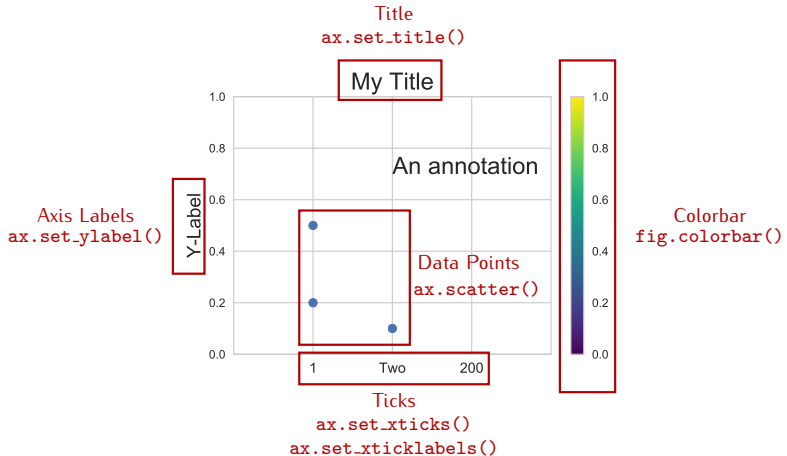
# Anatomy of a Plot

```
fig, ax = plt.subplots(1)
```



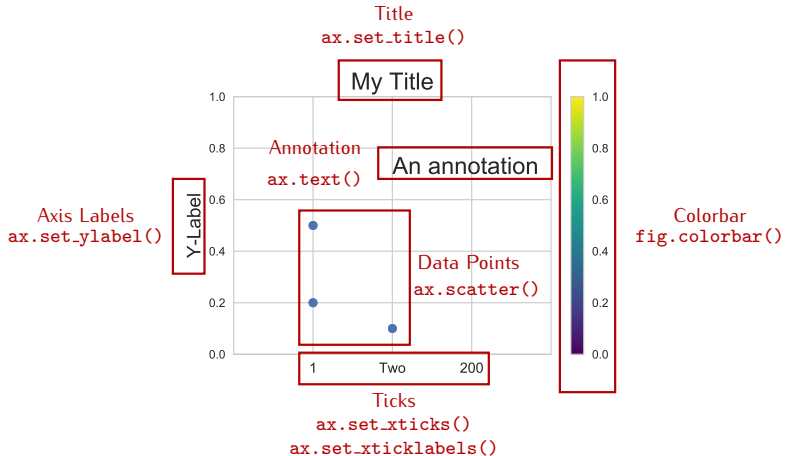
# Anatomy of a Plot

```
fig, ax = plt.subplots(1)
```



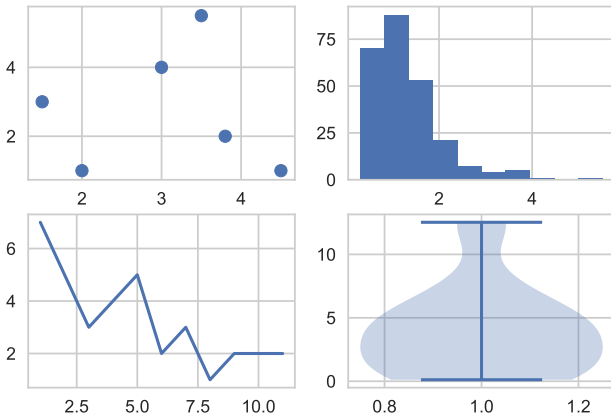
# Anatomy of a Plot

```
fig, ax = plt.subplots(1)
```



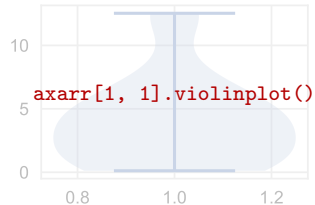
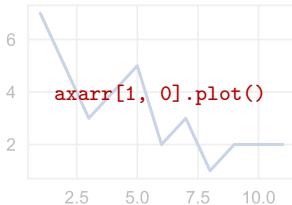
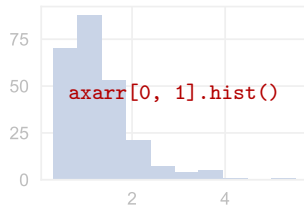
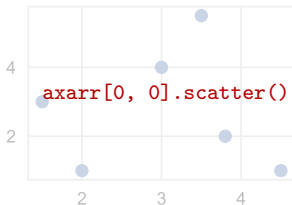
# Anatomy of a Plot

```
fig, axarr = plt.subplots(2, 2)
```



# Anatomy of a Plot

```
fig, axarr = plt.subplots(2, 2)
```



## Women's 200m Olympic Medallists

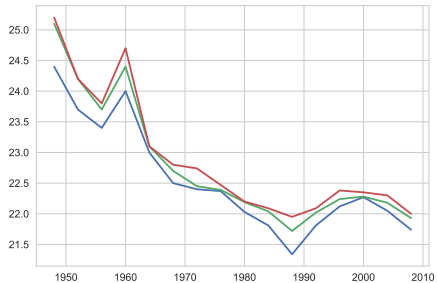
Year	Athlete	Medal	Country	Result
1948	Fanny Blankers-Koen	GOLD	NED	24.40
1948	Audrey Williamson	SILVER	GBR	25.10
1948	Audrey Patterson	BRONZE	USA	25.20
1952	Marjorie Jackson	GOLD	AUS	23.70
1952	Bertha Brouwer	SILVER	NED	24.20
⋮	⋮	⋮	⋮	⋮
2008	Allyson Felix	SILVER	USA	21.93
2008	Kerron Stewart	BRONZE	JAM	22.00

```
fig, ax = plt.subplots(1)
```

```
ax.plot(dates, gold)
```

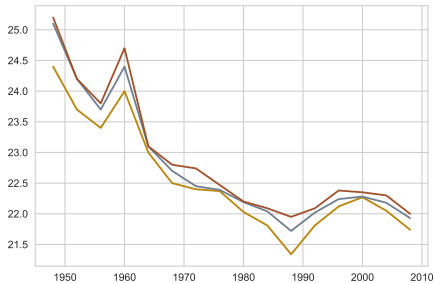
```
ax.plot(dates, silver)
```

```
ax.plot(dates, bronze)
```



```
plt.show()
```

```
fig, ax = plt.subplots(1)
ax.plot(dates, gold, c='darkgoldenrod')
ax.plot(dates, silver, c='slategray')
ax.plot(dates, bronze, c='sienna')
```



```
plt.show()
```

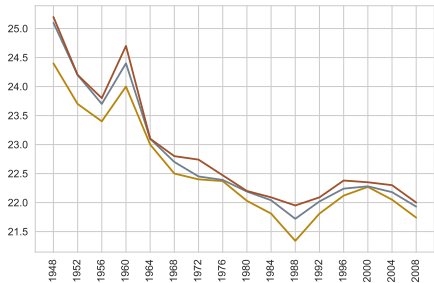


```
fig, ax = plt.subplots(1)

ax.plot(dates, gold, c='darkgoldenrod')
ax.plot(dates, silver, c='slategray')
ax.plot(dates, bronze, c='sienna')

ax.set_xticks(dates)
ax.set_xticklabels(dates, rotation='vertical')
```

```
plt.show()
```



```

fig, ax = plt.subplots(1)

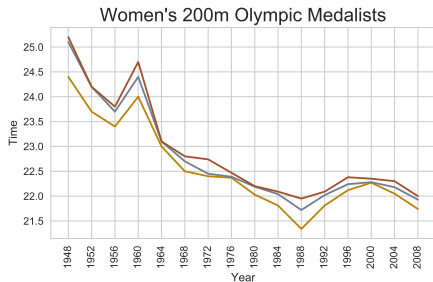
ax.plot(dates, gold, c='darkgoldenrod')
ax.plot(dates, silver, c='slategray')
ax.plot(dates, bronze, c='sienna')

ax.set_xticks(dates)
ax.set_xticklabels(dates, rotation='vertical')

ax.set_xlabel("Year")
ax.set_ylabel("Time")
ax.set_title("Women's 200m Olympic Medalists", fontsize=18)

plt.show()

```



```

fig, ax = plt.subplots(1)

ax.plot(dates, gold, c='darkgoldenrod')

ax.plot(dates, silver, c='slategray')

ax.plot(dates, bronze, c='sienna')

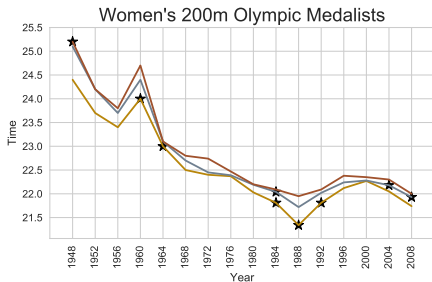
ax.scatter(usa_x, usa_y, lw=0.8,
           facecolor='black',
           marker='*', s=100)

ax.set_xticks(dates)
ax.set_xticklabels(dates, rotation='vertical')

ax.set_xlabel("Year")
ax.set_ylabel("Time")
ax.set_title("Women's 200m Olympic Medalists", fontsize=18)

plt.show()

```



```

fig, ax = plt.subplots(1)

ax.plot(dates, gold, c='darkgoldenrod',
        zorder=1)
ax.plot(dates, silver, c='slategray',
        zorder=1)
ax.plot(dates, bronze, c='sienna',
        zorder=1)

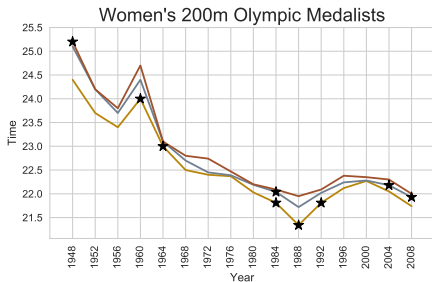
ax.scatter(usa_x, usa_y, lw=0.8,
          facecolor='black',
          marker='*', s=100,
          zorder=2)

ax.set_xticks(dates)
ax.set_xticklabels(dates, rotation='vertical')

ax.set_xlabel("Year")
ax.set_ylabel("Time")
ax.set_title("Women's 200m Olympic Medalists", fontsize=18)

plt.show()

```



```

fig, ax = plt.subplots(1)

ax.plot(dates, gold, c='darkgoldenrod',
        zorder=1)
ax.plot(dates, silver, c='slategray',
        zorder=1)
ax.plot(dates, bronze, c='sienna',
        zorder=1)

ax.scatter(usa_x, usa_y, lw=0.8,
          facecolor='black',
          marker='*', s=100,
          zorder=2)

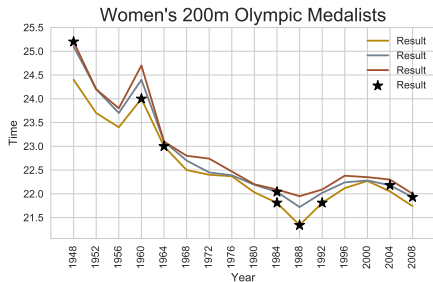
ax.legend()

ax.set_xticks(dates)
ax.set_xticklabels(dates, rotation='vertical')

ax.set_xlabel("Year")
ax.set_ylabel("Time")
ax.set_title("Women's 200m Olympic Medalists", fontsize=18)

plt.show()

```



```

fig, ax = plt.subplots(1)

ax.plot(dates, gold, c='darkgoldenrod',
        zorder=1, label='Gold Medal')
ax.plot(dates, silver, c='slategray',
        zorder=1, label='Silver Medal')
ax.plot(dates, bronze, c='sienna',
        zorder=1, label='Bronze Medal')

ax.scatter(usa_x, usa_y, lw=0.8,
          facecolor='black',
          marker='*', s=100,
          zorder=2, label='USA Athletes')

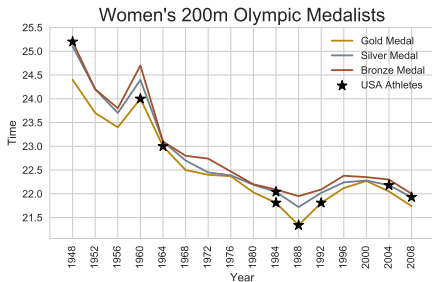
ax.legend()

ax.set_xticks(dates)
ax.set_xticklabels(dates, rotation='vertical')

ax.set_xlabel("Year")
ax.set_ylabel("Time")
ax.set_title("Women's 200m Olympic Medalists", fontsize=18)

plt.show()

```



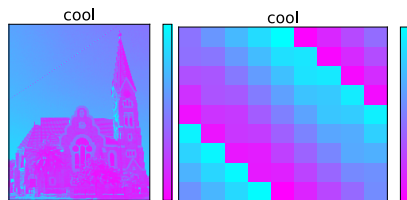
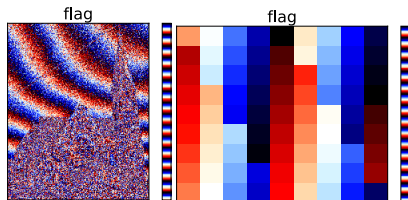
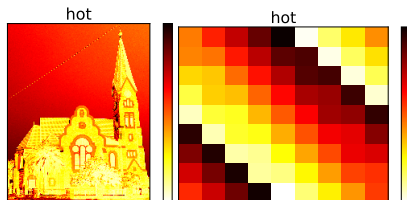
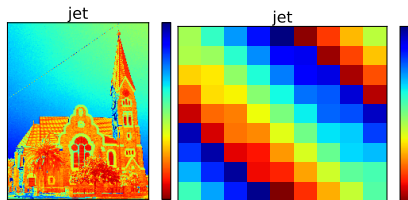
# Choosing Colormaps

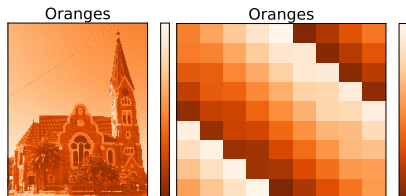
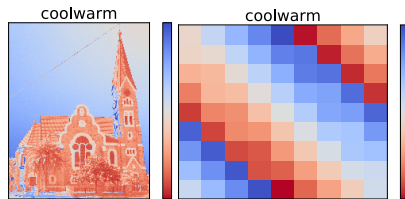
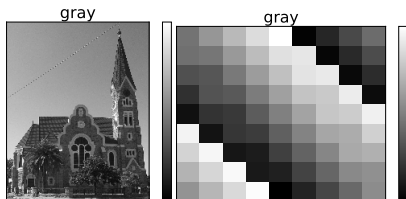
YouTube: A Better Default Colormap for Matplotlib –  
SciPy 2015 (Nathaniel Smith and Stéfan van der Walt)



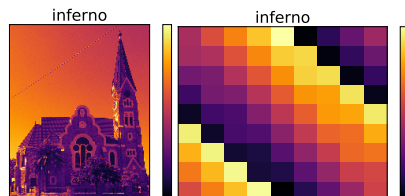
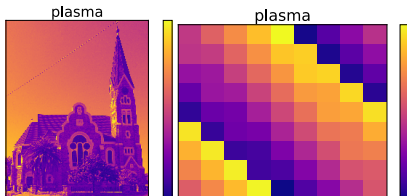
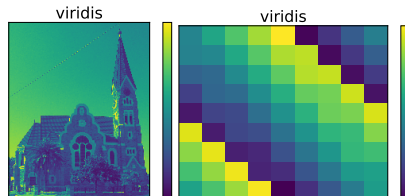
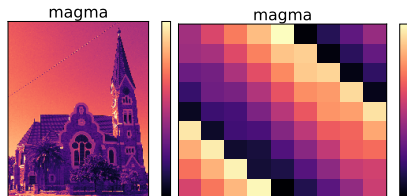
37	48	59	70	81	2	13	24	35
36	38	49	60	71	73	3	14	25
26	28	39	50	61	72	74	4	15
16	27	29	40	51	62	64	75	5
6	17	19	30	41	52	63	65	76
77	7	18	20	31	42	53	55	66
67	78	8	10	21	32	43	54	56
57	68	79	9	11	22	33	44	46
47	58	69	80	1	12	23	34	45







## *Perceptually Uniform Sequential Colormaps*

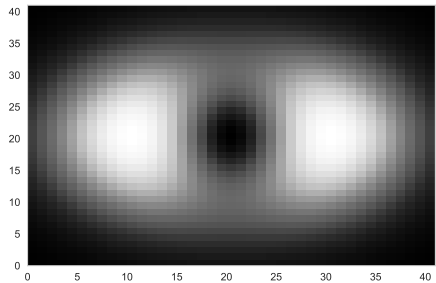


## Heatmaps with pcolor

$$f(x, y) = -(x^2 + 3y^2) e^{-x^2 - y^2}$$

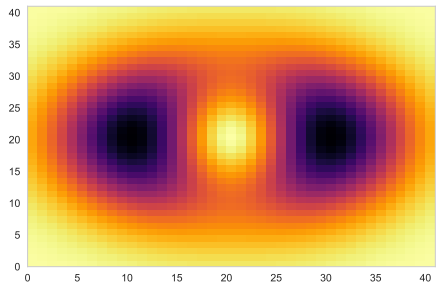
$$\begin{pmatrix} -0.005 & -0.007 & -0.010 & \dots & -0.010 & -0.007 & -0.005 \\ -0.008 & -0.011 & -0.014 & \dots & -0.014 & -0.011 & -0.008 \\ -0.011 & -0.015 & -0.020 & \dots & -0.020 & -0.015 & -0.011 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ -0.011 & -0.015 & -0.020 & \dots & -0.020 & -0.015 & -0.011 \\ -0.008 & -0.011 & -0.014 & \dots & -0.014 & -0.011 & -0.008 \\ -0.005 & -0.007 & -0.010 & \dots & -0.010 & -0.007 & -0.005 \end{pmatrix}$$

```
fig, ax = plt.subplots(1)
hm = ax.pcolor(z)
```



```
plt.show()
```

```
fig, ax = plt.subplots(1)
hm = ax.pcolor(z, cmap='inferno')
```

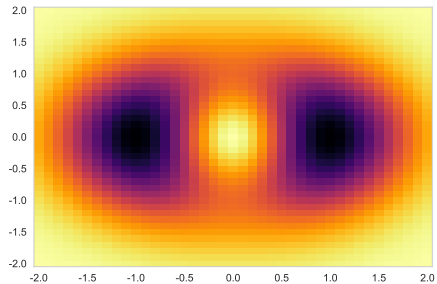


```
plt.show()
```

```
fig, ax = plt.subplots(1)
hm = ax.pcolor(z, cmap='inferno')

ax.set_xticks([i*5 + 0.5 for i in range(9)])
ax.set_yticks([i*5 + 0.5 for i in range(9)])
ax.set_xticklabels(ticks)
ax.set_yticklabels(ticks)
```

```
plt.show()
```

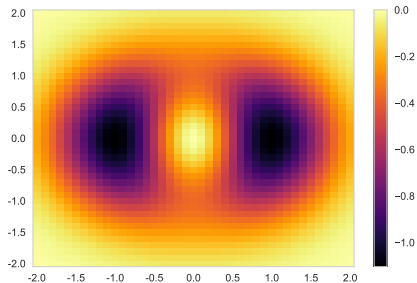


```
fig, ax = plt.subplots(1)
hm = ax.pcolor(z, cmap='inferno')

ax.set_xticks([i*5 + 0.5 for i in range(9)])
ax.set_yticks([i*5 + 0.5 for i in range(9)])
ax.set_xticklabels(ticks)
ax.set_yticklabels(ticks)

cbar = fig.colorbar(hm)
```

```
plt.show()
```





```

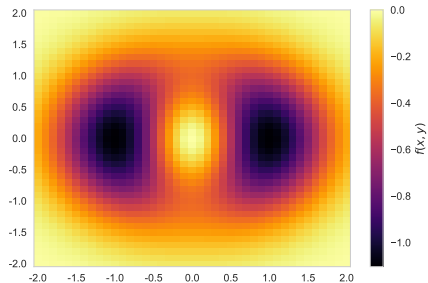
fig, ax = plt.subplots(1)
hm = ax.pcolor(z, cmap='inferno')

ax.set_xticks([i*5 + 0.5 for i in range(9)])
ax.set_yticks([i*5 + 0.5 for i in range(9)])
ax.set_xticklabels(ticks)
ax.set_yticklabels(ticks)

cbar = fig.colorbar(hm)
cbar.set_label(r"$f(x, y)$")

```

```
plt.show()
```



```

fig, ax = plt.subplots(1)
hm = ax.pcolor(z, cmap='inferno')

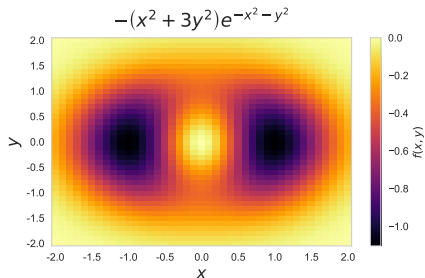
ax.set_xticks([i*5 + 0.5 for i in range(9)])
ax.set_yticks([i*5 + 0.5 for i in range(9)])
ax.set_xticklabels(ticks)
ax.set_yticklabels(ticks)

cbar = fig.colorbar(hm)
cbar.set_label(r"$f(x, y)$")

title = r"$\left(x^2+3y^2\right)e^{-x^2-y^2}$"
ax.set_title(title, fontsize=18)
ax.set_xlabel(r"$x$", fontsize=16)
ax.set_ylabel(r"$y$", fontsize=16)

plt.show()

```



```

fig, ax = plt.subplots(1)
hm = ax.pcolor(z, cmap='inferno', zorder=0)

ax.set_xticks([i*5 + 0.5 for i in range(9)])
ax.set_yticks([i*5 + 0.5 for i in range(9)])
ax.set_xticklabels(ticks)
ax.set_yticklabels(ticks)

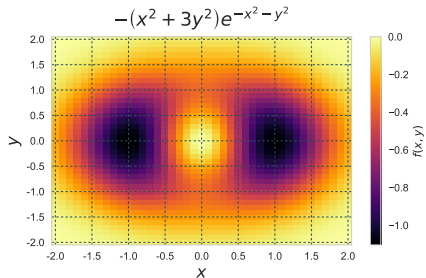
cbar = fig.colorbar(hm)
cbar.set_label(r"$f(x, y)$")

title = r"$\left(x^2+3y^2\right)e^{-x^2-y^2}$"
ax.set_title(title, fontsize=18)
ax.set_xlabel(r"$x$", fontsize=16)
ax.set_ylabel(r"$y$", fontsize=16)

ax.grid(which='major', color='darkslategrey',
        linestyle=':', linewidth=1, axis='both')

plt.show()

```





- Cardiff University Phoenix Project
- Cardiff School of Mathematics
- PyCon Namibia 2017

- matplotlib
- numpy
- seaborn
- jupyter

[www.geraintianpalmer.org.uk/talks](http://www.geraintianpalmer.org.uk/talks)  
@GeraintPalmer

# Links

- [http://matplotlib.org/api/axes\\_api.html](http://matplotlib.org/api/axes_api.html)
- [http://matplotlib.org/api/pyplot\\_summary.html](http://matplotlib.org/api/pyplot_summary.html)
- <http://matplotlib.org/examples/index.html>
- [http://matplotlib.org/examples/color/colormaps\\_reference.html](http://matplotlib.org/examples/color/colormaps_reference.html)
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