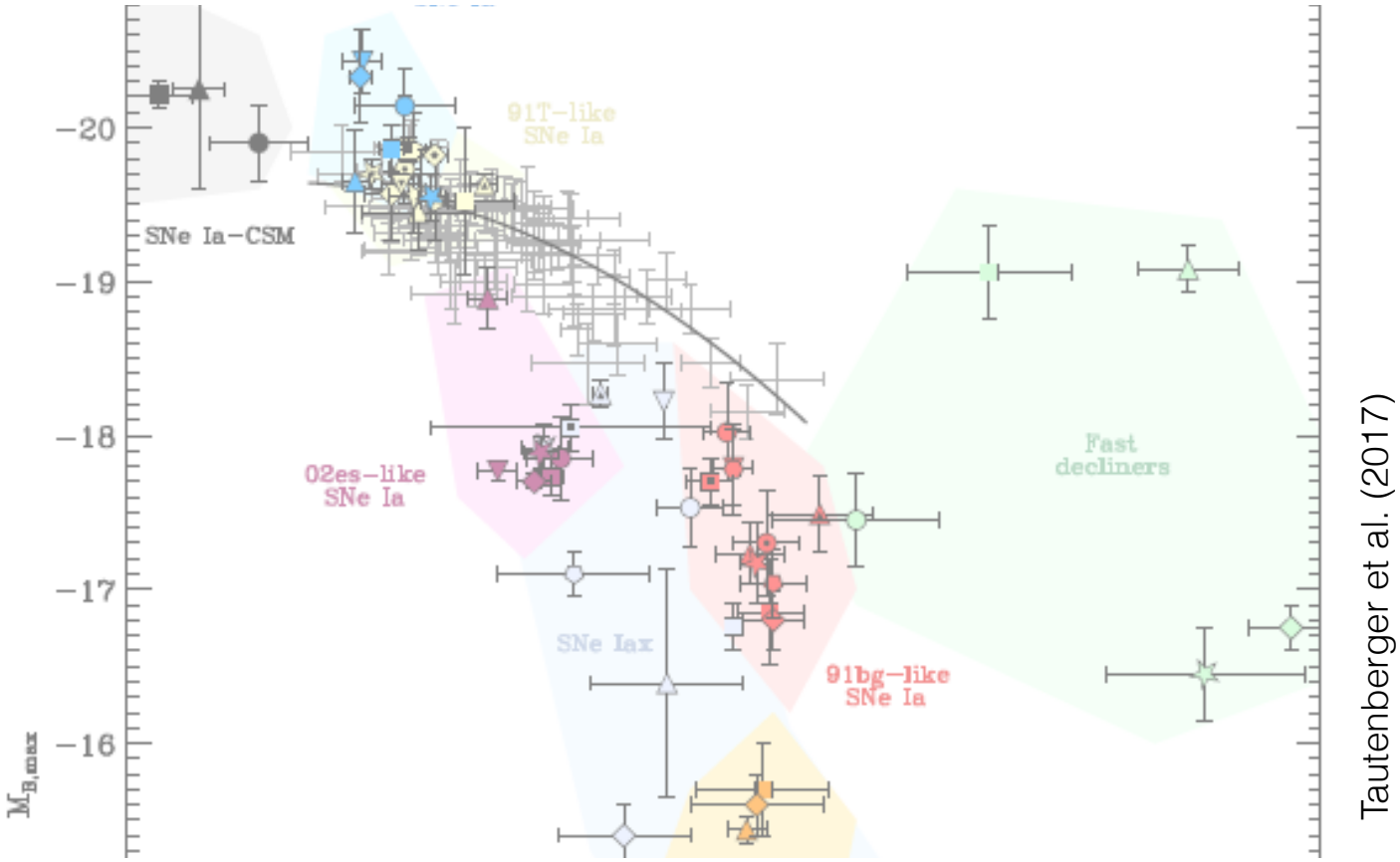


Tautenberger et al. (2017)

Scientific Figures

CASCA 2017 Graduate Student Workshop

Rodrigo Fernández - University of Alberta

Overview

1. Frame of mind: audience first

2. Think strategically: tell a story

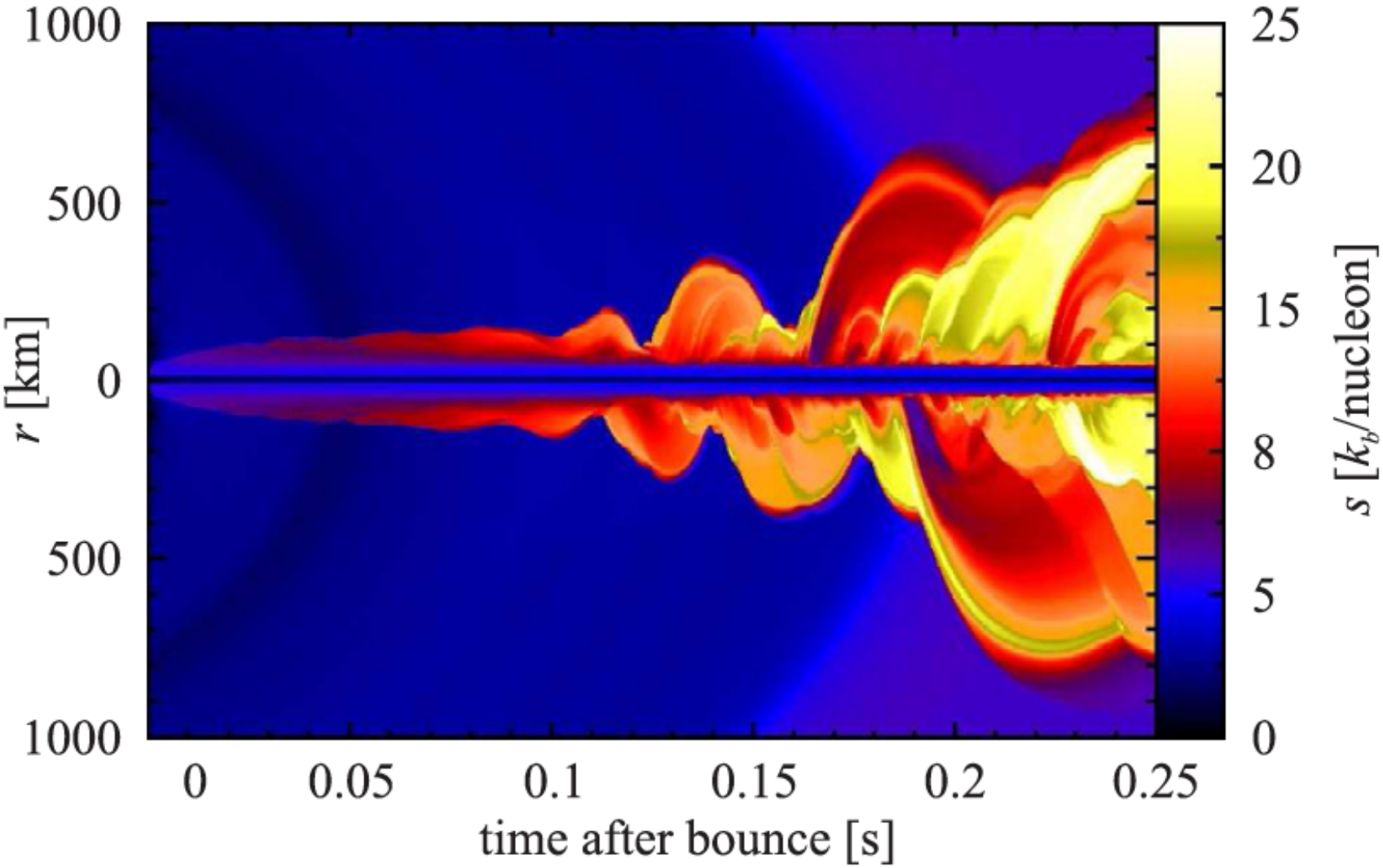
3. Developing your toolbox

Frame of mind: audience-centered

Making figures for scientific articles involves communicating with an audience. The audience is usually made up of one or more communities of scientists working on a topic.

Each community has its own language. This includes not only scientific terms used to describe concepts, but also a graphical language: how information is communicated through images.

Frame of mind: audience-centered



Müller, Janka, & Heger (2012)

Frame of mind: audience-centered

Each community has its own language and what makes for a good figure in one field may not necessarily be good for another.

The first thing to keep in mind when making a figure is the audience you are addressing, and also the conventions within that community.

How do you become familiar with what those conventions are?

By reading lots of papers

Frame of mind: audience-centered

The most basic way to keep the audience in mind is to think of all the possible challenges that they may have in understanding your figure. This has implications for the choices you make regarding:

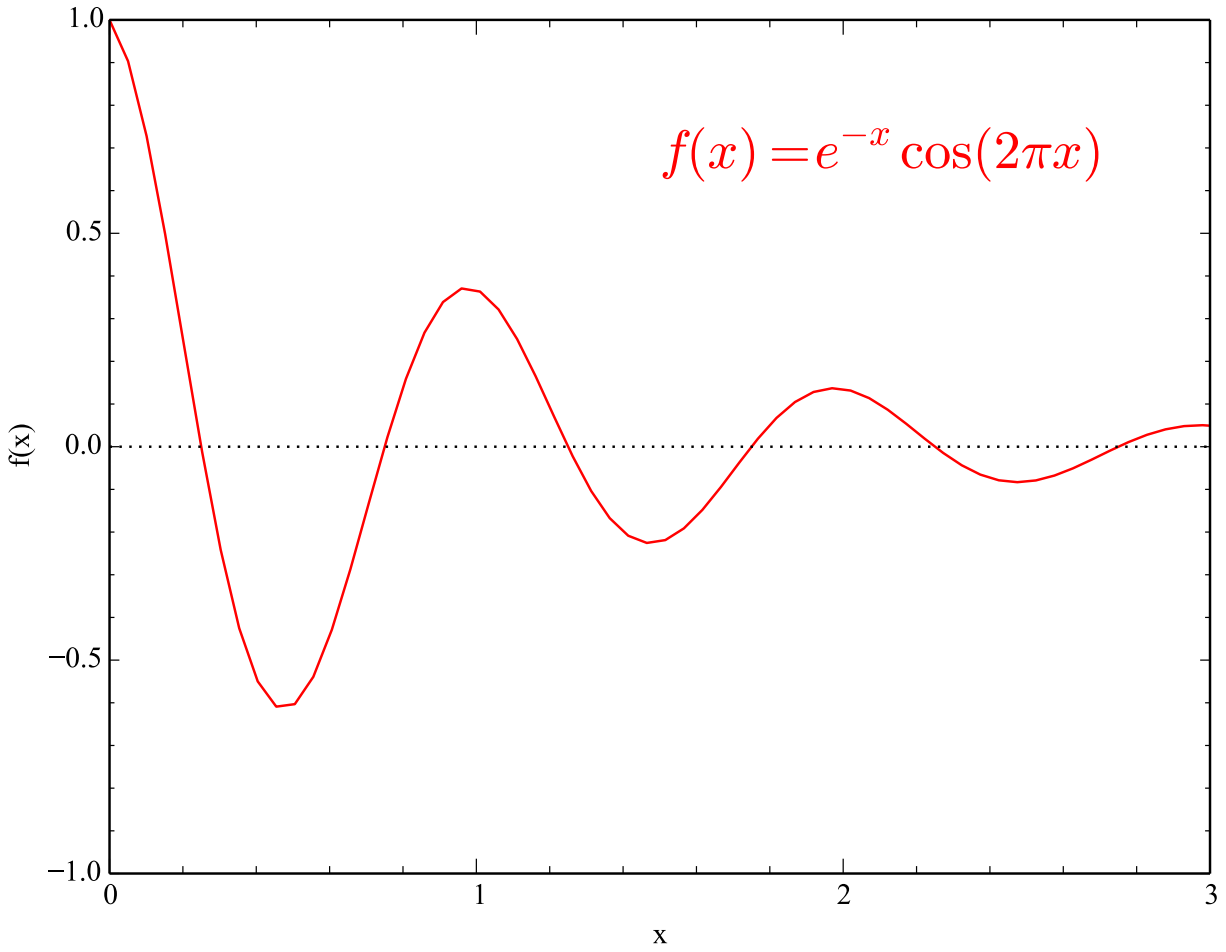
1) font size

2) thickness of lines

3) color scheme

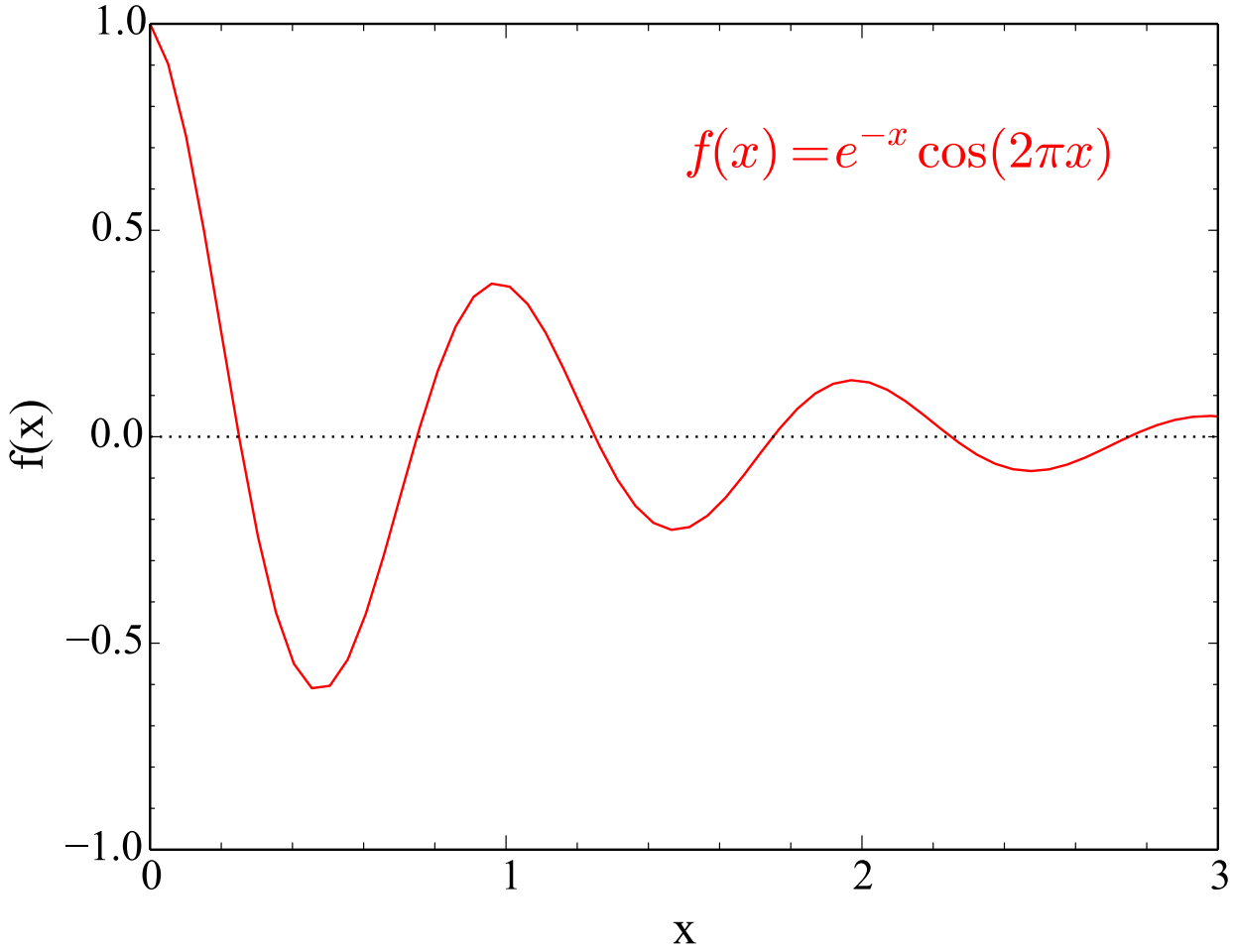
Font Size

Axis labels too small:



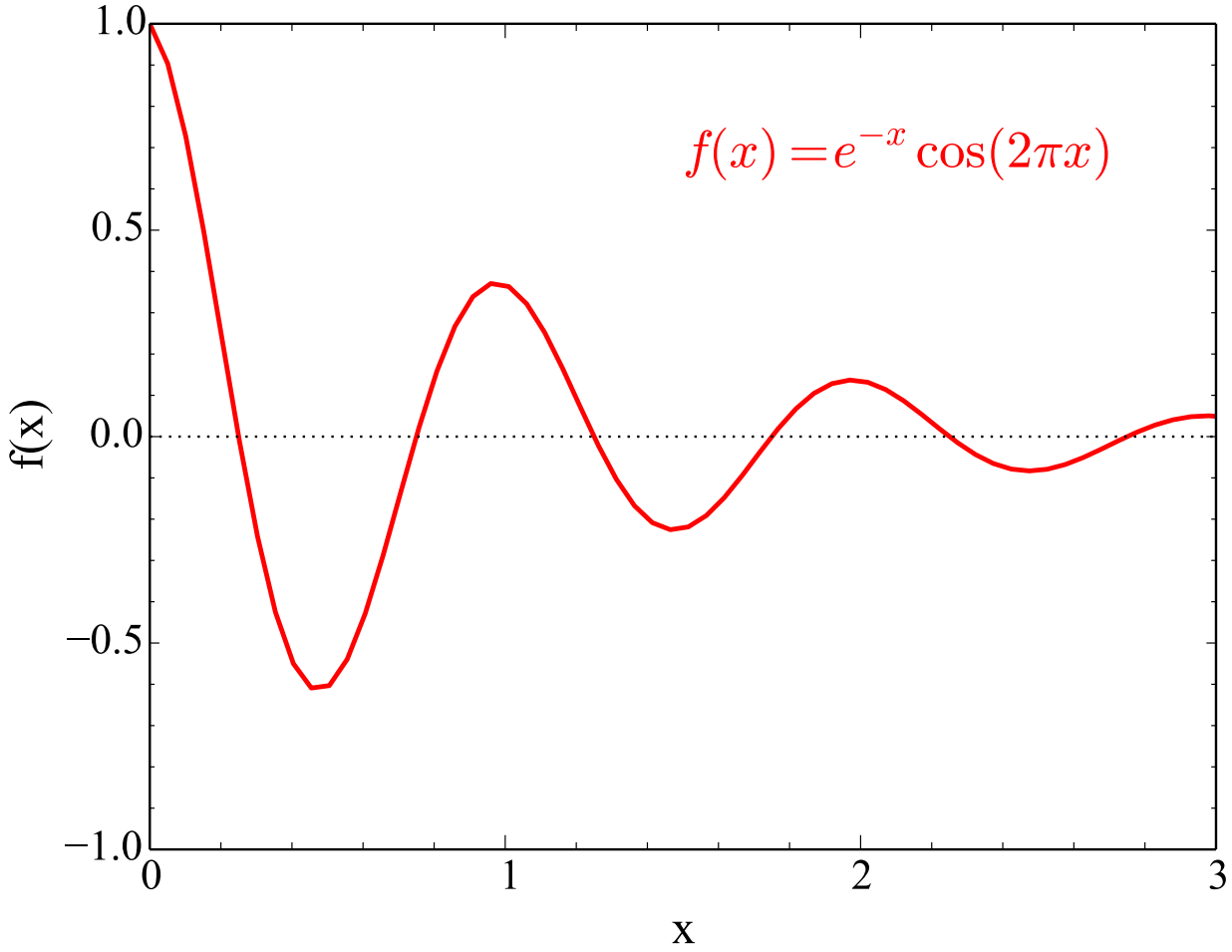
Font Size

Should be **at least** the size of the caption font



Thickness of lines

It always looks thinner in print than on screen, especially if your color figure is printed in B/W



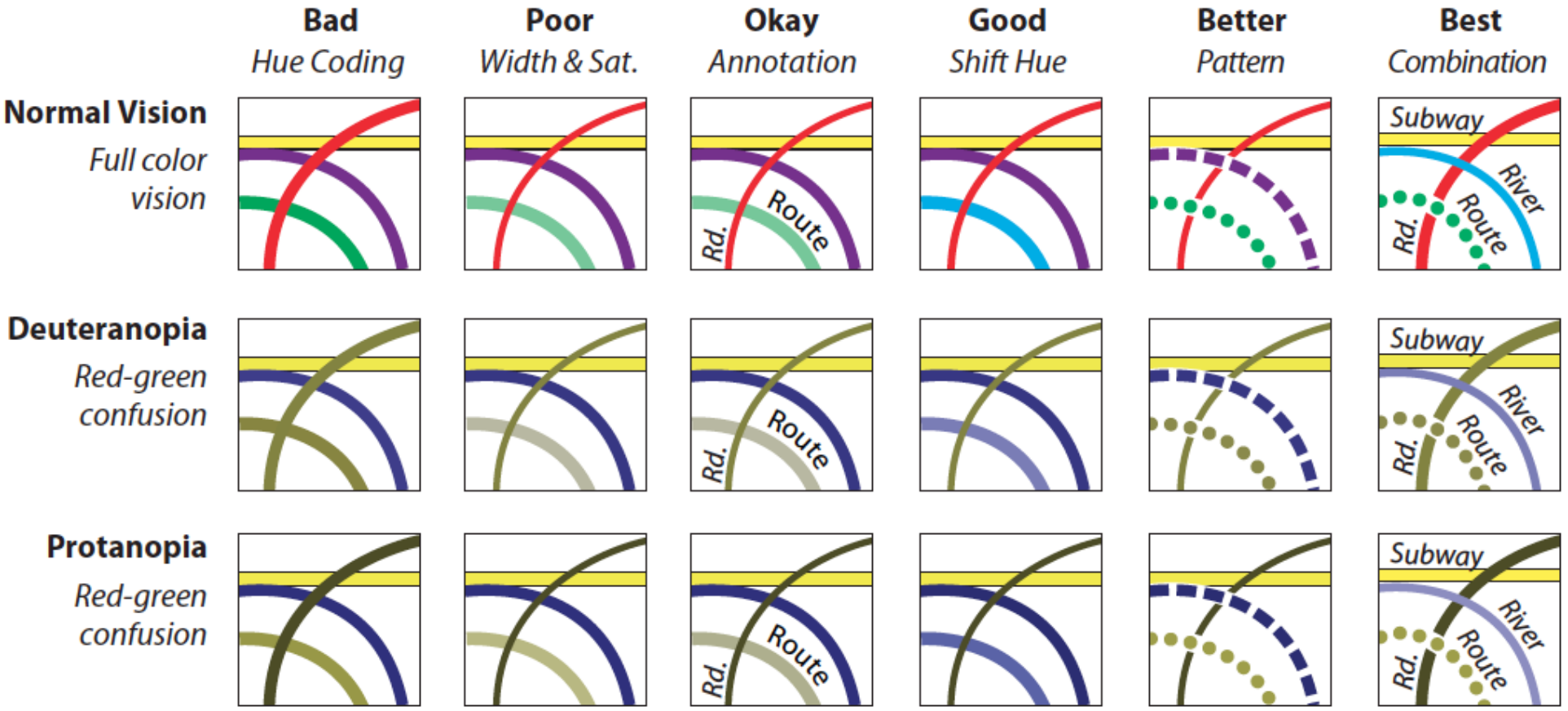
Color Scheme

About 8% of men have some form of color impairment: red & green confusion

	Cones	Affected men	Estimated perceived color spectrum
Protanopia	L-cones absent	1%	
Protanomaly	L-cones abnormal	1%	 *
Deuteranopia	M-cones absent	1%	
Deuteranomaly	M-cones abnormal	5%	 *
Full color vision		92%	

Jenny & Kelso (2007) → colororacle.org/design.html

Varying Color Scheme & Line Type



Jenny & Kelso (2007) → colororacle.org/design.html

Color Resources

- App to simulate color impaired vision

  colororacle.org

- Color palettes

  colorbrewer.org

- More palettes (‘I want hue’)

  http://tools.medialab.sciences-po.fr/iwanthue/

Frame of mind: audience-centered

Finally, the best way to make sure that your figures are audience-friendly is to ask for feedback from others.

Do this with the figures already within a draft. Try to use the same journal format as the final print version (available online for most journals) fill text with **Lorem Ipsum** if writing not done.

The general principle to keep in mind is that others will perceive your figure differently than you, because they are not as familiar as you are with your data. Make their job of digesting your data easier!

Strategy: Tell a Story

Most important question when assembling your work into a paper: what figures should I make?

You want the figures in our paper to tell a story, containing sufficient information to convey your most important points.

Scientists are busy, and many of them will **only** look at the figures in your paper (perhaps also the captions). So you want to put as much thought on this as you can, being **deliberate** about every aspect of your figures.

Storyboards

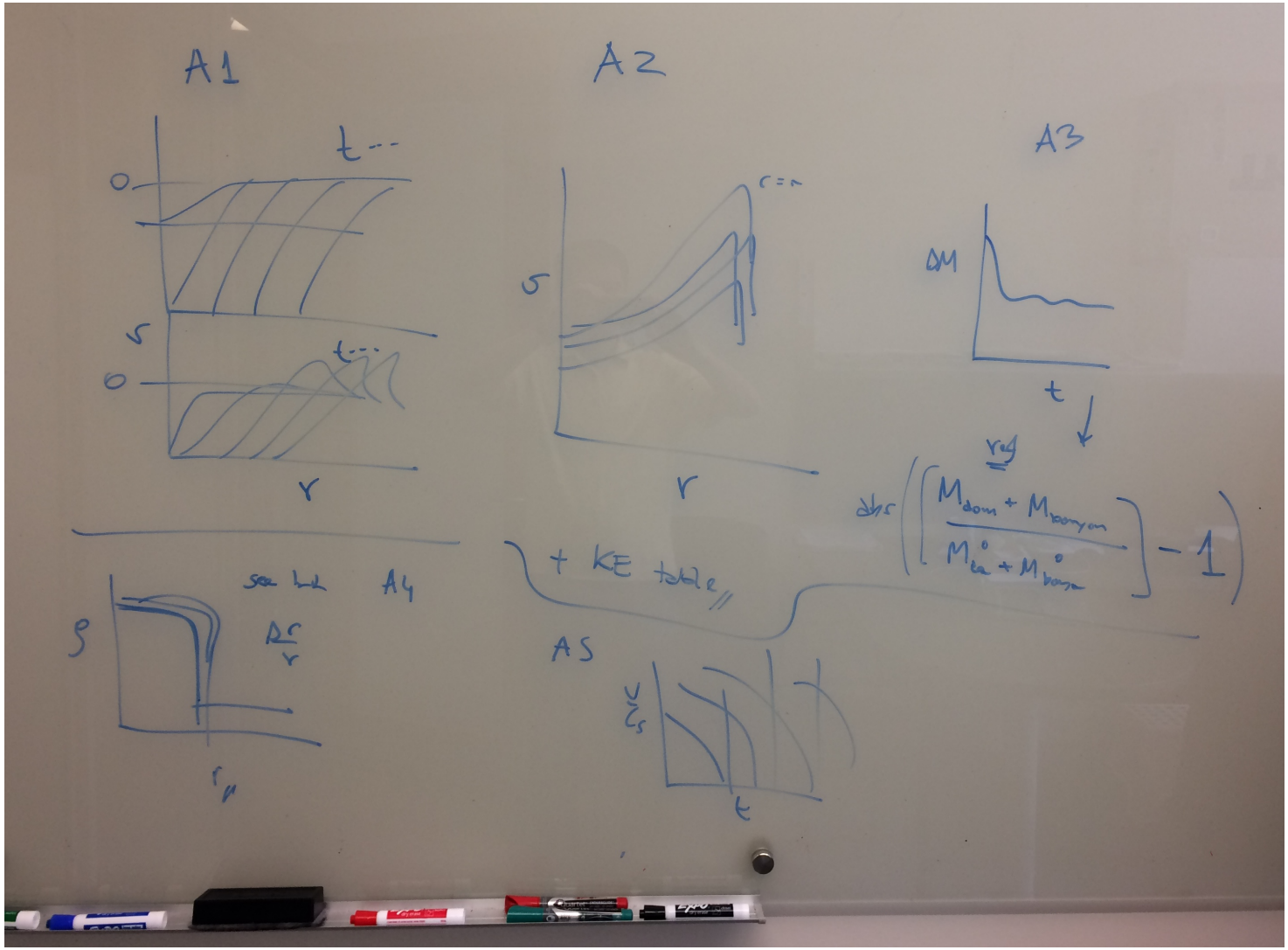
How to plan a story through figures before making them?

We borrow a technique from artists and designers, and **make a storyboard for prototyping.**

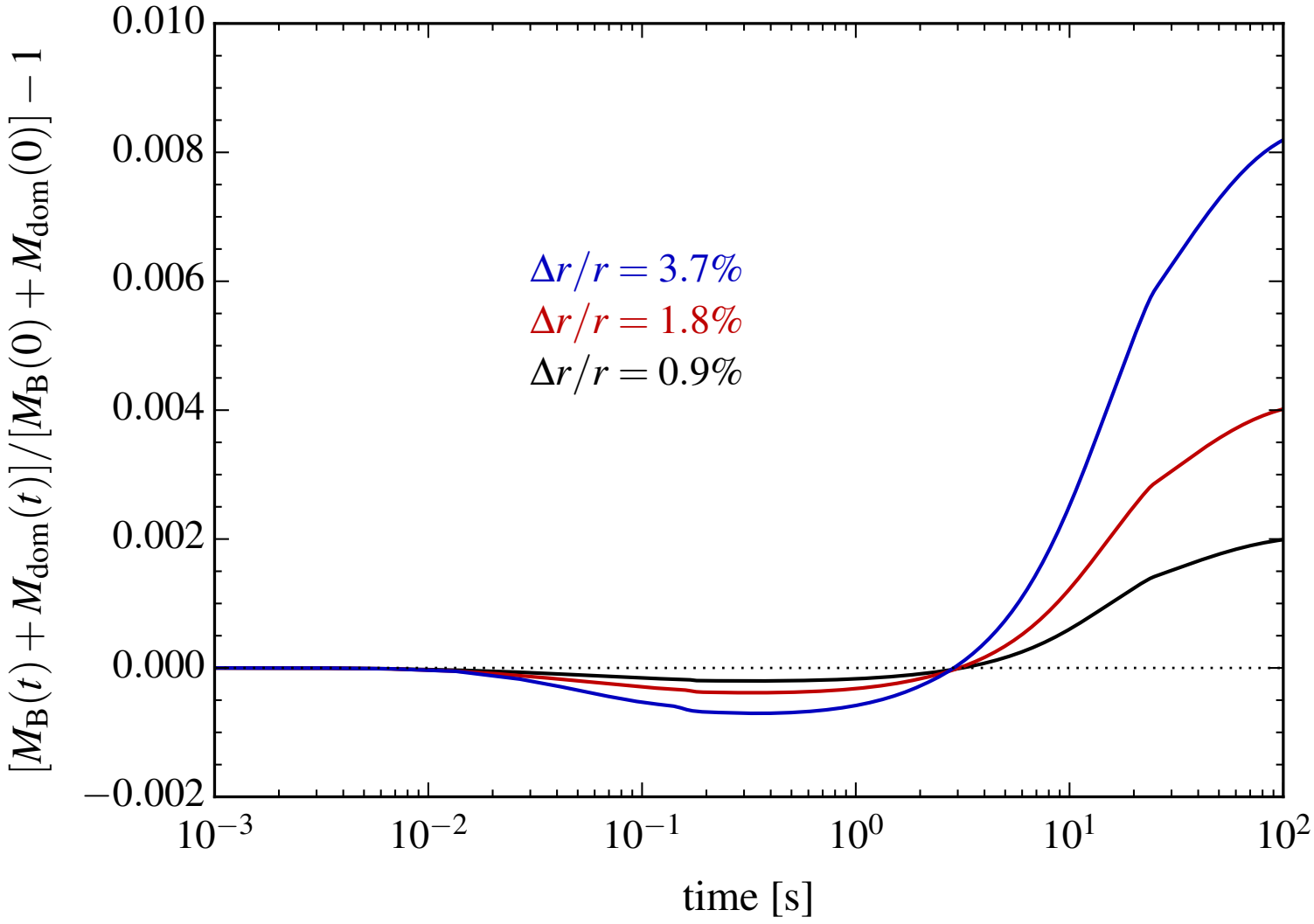
This is a set of sketches of the plots that you will make, based on preliminary exploration of your data.

Ian McCaig (pinterest)

Storyboards



Storyboards



RF et al. in prep

How to design figures?

The purpose of a figure is to convey information. You want to convey interesting / new information, minimizing redundant and/or unnecessary noise.

Some questions to ask:

1) What variables are the most informative?

2) What type of representation is most suitable?

3) How many datasets to show?

4) Are there any data properties worth enhancing?

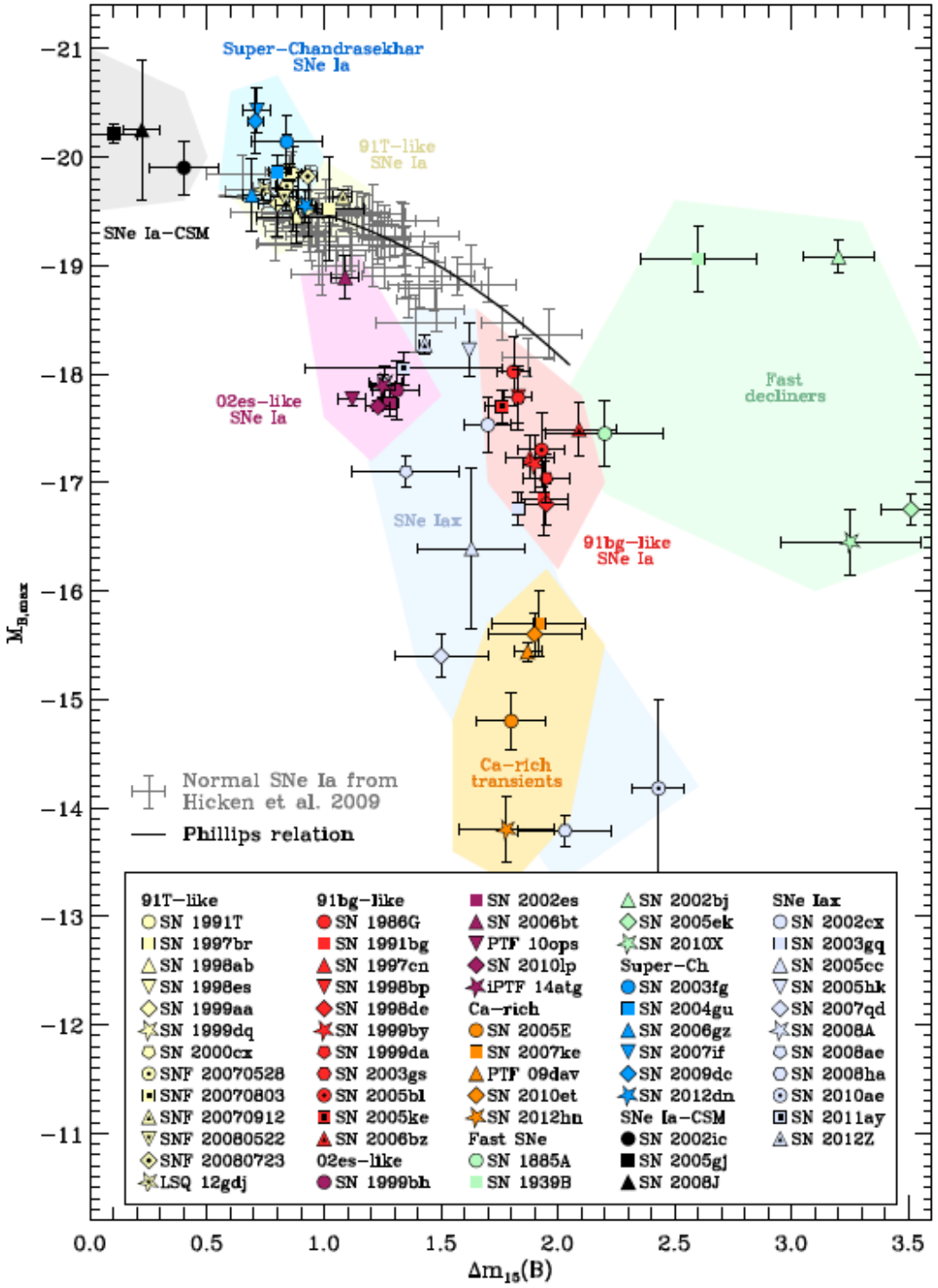
Example: types of SN Ia

1) Chooses right variables to describe parameter space

2) Uses color to divide sets

3) Combines symbols, annotation, and shaded background to provide clarity in groups yet allows to distinguish individual events of interest.

Tautenberger (2017), arXiv: 1703.00528



How to design figures?

Be aware of all degrees of freedom at your disposal:

1) Plot size: single or double column, vertical extent

2) Lines or symbols: type, thickness, color, shading

3) Annotation: color, font, positioning

4) Background shading

5) Axes: independent or stacked, multi-panel

6) Color table & opacity if 2D or 3D plots.

Tips on Figure Design

Use captions wisely. Can be purely descriptive, but also add a sentence to convey the main point of the figure (interpretation).

Try to present one or few ideas per figure. Sometimes you can use figures for multiple purposes, but it's better to keep them easy to digest.

Tip from a supernova observer: **a good figure is one that other people can/will show in their talks!**

Developing your Toolbox

The first tool in your arsenal is your memory. Read lots of papers, all the time. Set aside those that you consider particularly good, either because the science is great (=classic paper) or because the writing or figures are particularly good. Keep this list of **exemplars** for reference.

When reading a paper, don't start from the beginning and read sequentially. Read the abstract, put together the table of contents, look at all the figures carefully, then read the first sentence of each paragraph. Only then go through all the text if it's still worth it.

Developing your Toolbox

Select a suitable plotting tool. You might have your own, but it may have limited capabilities. Tools often used in astronomy:

1) python (matplotlib)
2) gnuplot
3) IDL
4) SM
5) Tioga (MESA)
6) Grace

For multi-D plots:

1) VisIt
2) Mayavi (python)
3) ParaView
4) Vapor

Developing your Toolbox

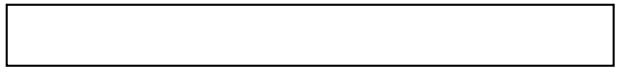
Understand RGB color space: 3-dimensional vector space

red (1,0,0)

green (0,1,0)

blue (0,0,1)

white (1,1,1)



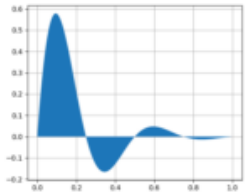
black (0,0,0)

green (0,0.75,0)

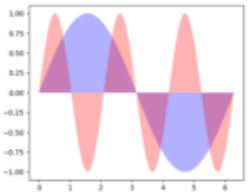
Galleries

Lines, bars, and markers

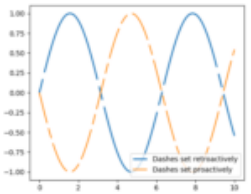
barh_demo



fill_demo



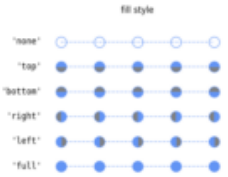
fill_demo_features



line_demo_dash_control

line_styles_reference

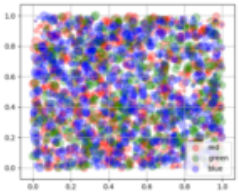
linestyles



marker_fillstyle_reference

marker_reference

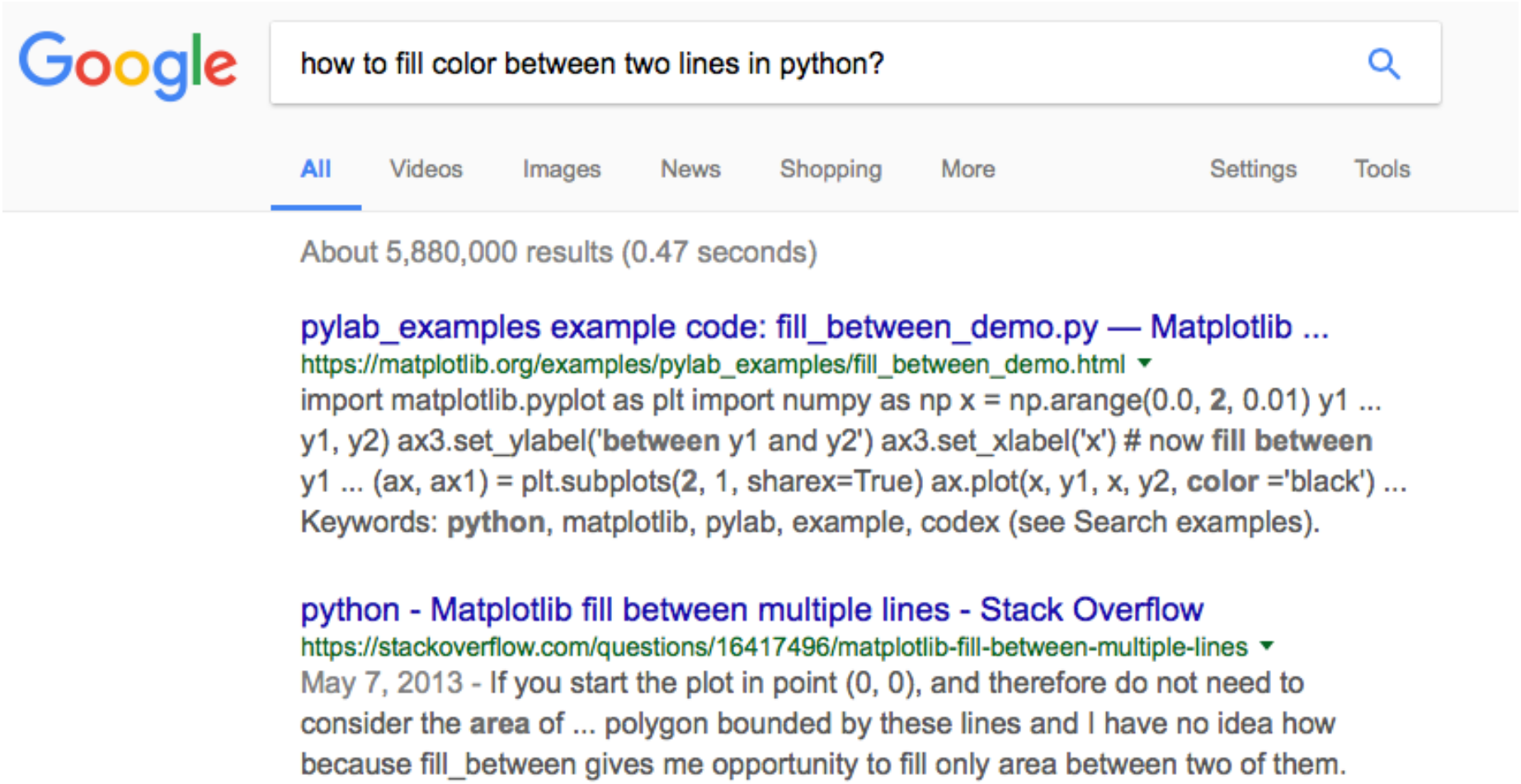
marker_reference



scatter_with_legend

https://matplotlib.org/gallery.html

Google + Stack Overflow are your friends



Google + Stack Overflow are your friends

stackoverflow Questions Jobs Documentation BETA Tags Users Search... Log In

11

To use `fill_between`, specify the X values first, than the two Y sets that you want to "fill between". An example is show below:

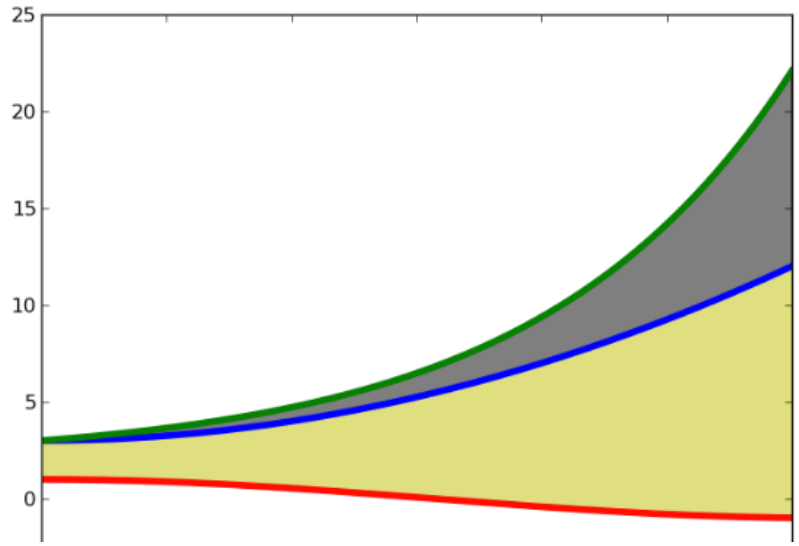
```
import pylab as plt
import numpy as np

X  = np.linspace(0,3,200)
Y1 = X**2 + 3
Y2 = np.exp(X) + 2
Y3 = np.cos(X)

plt.plot(X,Y1,lw=4)
plt.plot(X,Y2,lw=4)
plt.plot(X,Y3,lw=4)

plt.fill_between(X, Y1,Y2,color='k',alpha=.5)
plt.fill_between(X, Y1,Y3,color='y',alpha=.5)

plt.show()
```

Are heat maps "one of the least effect data visualization"?

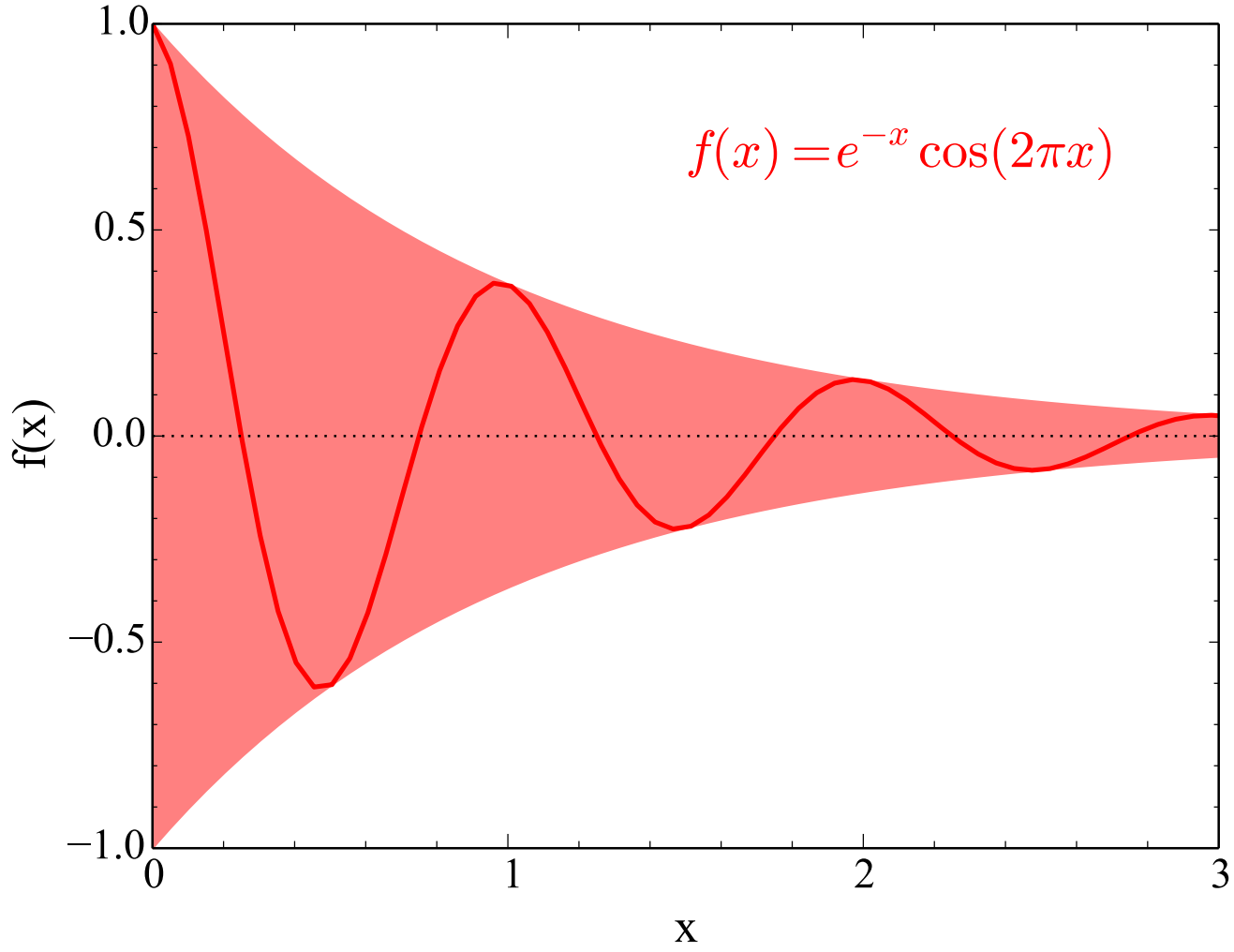
Strange code running at startup

Is there a haloalkane for astatine?

Opposite of the digital root!

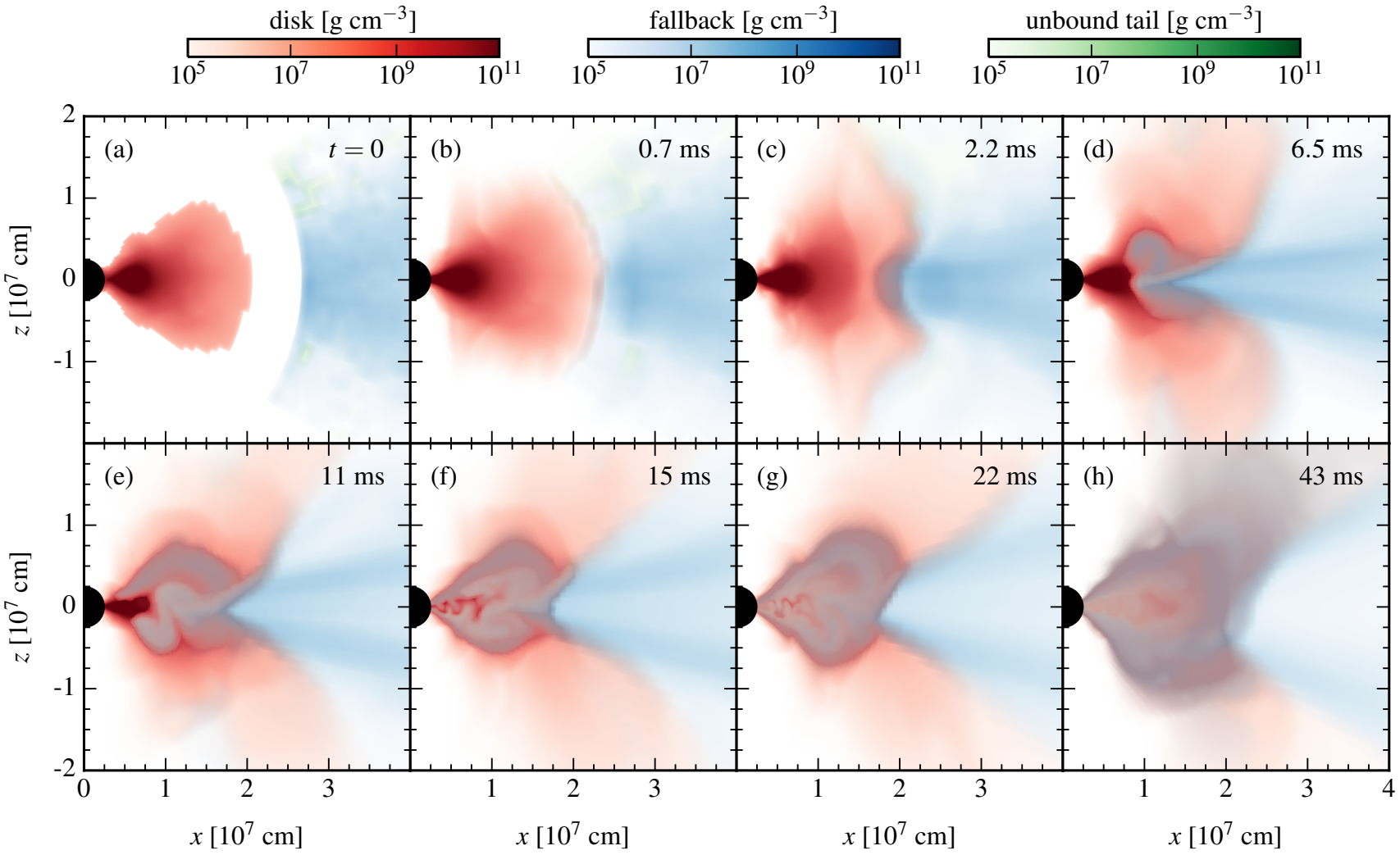


Google + Stack Overflow are your friends



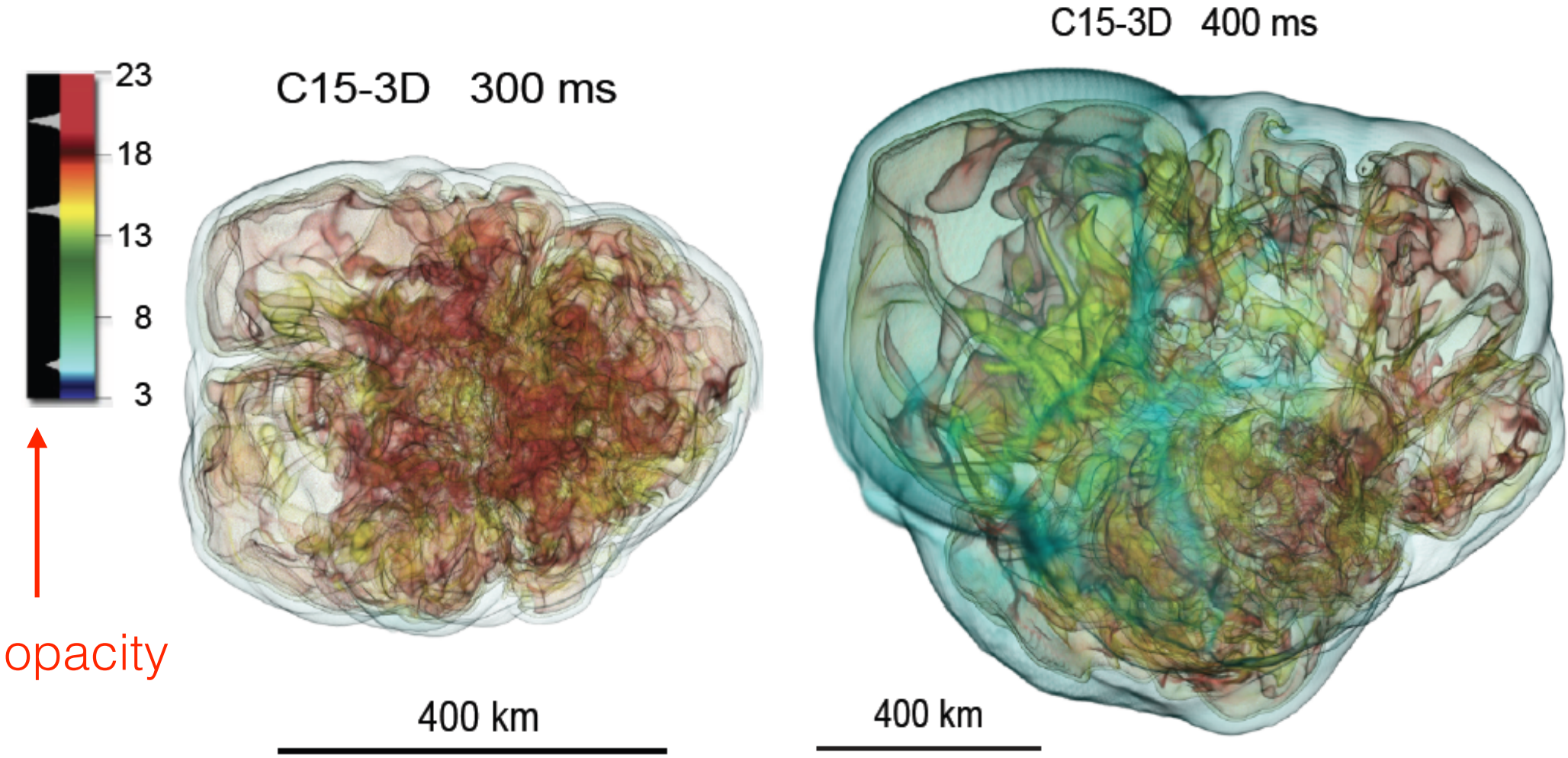
(use **fill_between** in matplotlib)

2D plots: opacity & color scheme



RF et al. (2016)

3D plots: opacity & color scheme



Lentz et al. (2015)

Summary

1) Always keep in mind that you're making figures for an audience different than you. Learn the customs of your community by reading lots of papers.

2) Organize your paper as a story told through your figures. Use storyboards to sketch, and make use of all degrees of freedom to convey the most interesting information

3) Be systematic about the tools you use: learn what's out there, what types of figures are made outside your field, learn RGB color space, and ask Google if you don't know.