

Research Methods

CSCI 8901:
Visualizing Your Research

Prof. Tim Wood
GWU

Research Pitch

Next class is our last class!

5 minute research presentation

- Extended elevator pitch

Get us excited about your research area!

Visuals Matter

Slides

Posters

Papers

- Diagrams
- Graphs
- Even fonts and formatting!

You want your work to look:

- Professional
- Attractive
- Memorable
- Informative

Let's go back in time...

Tim Wood's Thesis Defense

Sometime in April, 2011

Somewhere in farm country, Massachusetts

Data Centers

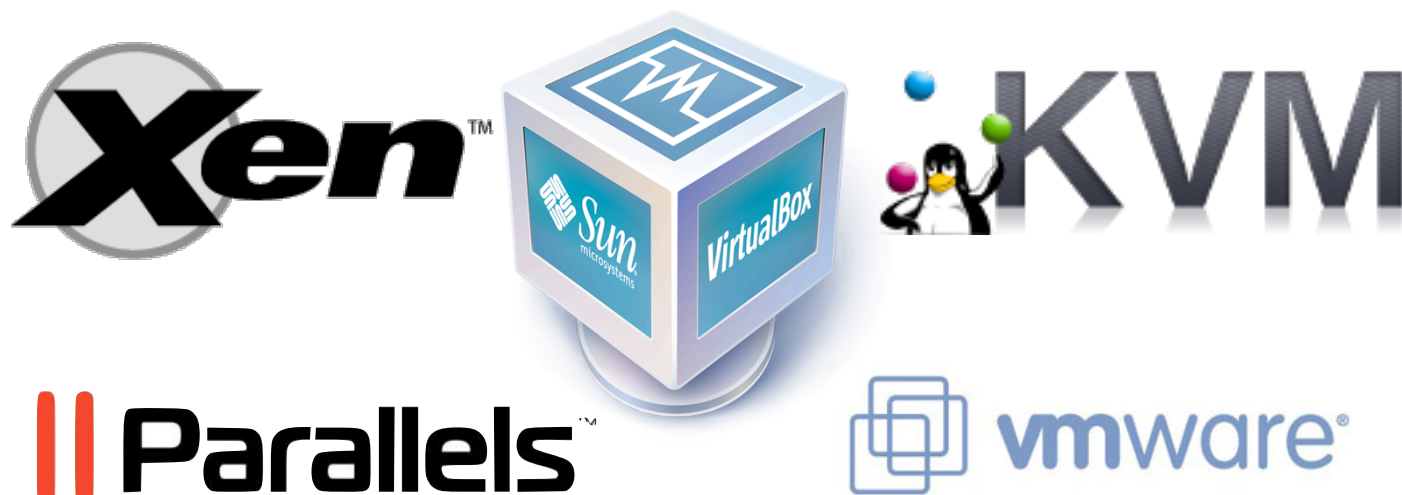
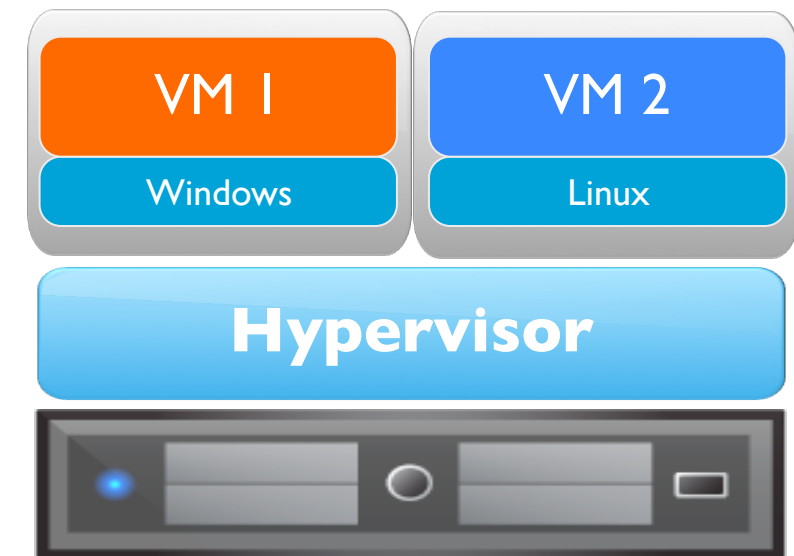
- **Infrastructure as a Service** clouds rent server and storage resources on demand
- Data Centers are BIG server farms
 - Clusters of 10,000s of servers
 - Growing to 100s of thousands
- Host many application types
 - Web servers, databases
 - Custom business apps
 - Search clusters, data mining



Challenges: large scale and dynamic workload fluctuations

Server Virtualization

- Data centers use virtualization to share physical resources and simplify automation
- Allows a server to be “sliced” into Virtual Machines
- VM has own OS/applications
- Rapidly adjust resource allocations
- VM migration within a LAN



Within a Data Center

- How to transition applications to VMs and account for virtualization overheads?
 - **MOVE**: Modeling Overheads of Virtual Environments
- Where should VMs be placed to allow for the greatest level of server consolidation?
 - **Memory Buddies**: Memory sharing guided placement
- How to dynamically allocate VM resources to prevent server overload?
 - **Sandpiper**: Automated VM migration and resizing

Deployment : Resource Management : Reliability

MOVE

Memory
Buddies

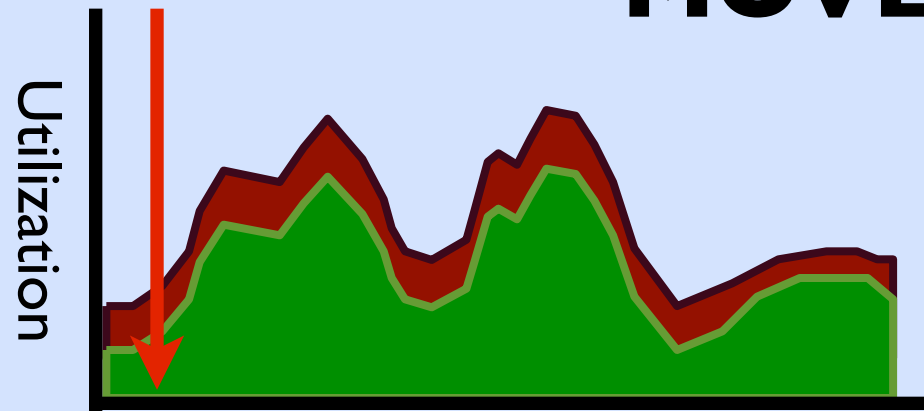
Sandpiper

CloudNet

Pipe
Cloud

Within a Data Center

MOVE



Predict initial
resource requirements

VM1

VM2

VM3

VM4

VM5

Memory Buddies

Determine initial
placement

Consolidate
servers

0x11223344

0x55667788

Memory

0 1 1 0 ... 0 0 1 1

Sandpiper

Balance load to
prevent hotspots

VM1

VM4

VM2

VM3

VM5

What is good in these slides?

What is good in these slides?

Good balance of text and visuals

Nice high level overview of thesis

Good connections between components of thesis

Animation is a bit excessive

Slide Tips

US Wireless Market – Q2 2010 Update

What to expect in the coming months?

31% of the US subscription base is now smartphones.

The pace of product introduction is accelerating with each quarter. Devices of all shapes and sizes are coming into the market literally every week. Players are having to re-evaluate their businesses and long-term strategies. Several new impressive devices got introduced during the course of 1H of 2010 including the iPad and EVO.

There are several players whose future is at stake (to put it mildly). The competition has grown fierce and companies are finding it hard to take ideas from R&D to products in market in a short amount of time.

Microsoft announced its comeback with the W7 commercial launch imminent. The change in UI was refreshing and the expectations are quite high. W7 v2 is likely around the corner to update on the flaws of v1. HP acquired Palm in an attempt to become relevant again in the mobile device space. It has been an action packed 1H 2010 and we can expect more of the same for the remainder of the year.

2010 has also been active on the regulatory front as the national broadband plan was unveiled in March and the subsequent debate over the course of nations broadband future kept the spectrum, net-neutrality, and exclusivity issues at the forefront.

To start planning for 4G, 5G, and beyond, US should think about rolling a 50 year broadband plan. While more spectrum is always helpful, will we have all the spectrum we need in 2050? or do we need to invent new technologies and business models that use spectrum more wisely? This topic will keep the industry occupied for some time to come. (We will be going in-depth into this subject at our Sept event with some very senior and experienced executives)

2010 is also the year of network rollouts. T-Mobile has been rolling out HSPA+ at an impressive rate, Clearwire announced its intention to move to LTE, Verizon is betting big on LTE and looking for competitive marketing advantage over the course of the next 12 months. AT&T has been adding backhaul, upgrading to HSPA+ and planning for LTE all at once. Even the smaller carriers like MetroPCS are looking for competitive advantage with quicker LTE launch and beat others by carrying the first LTE smartphone. (We will be releasing the next edition of our "State of the Mobile Broadband Nation" paper later this year)

As we had mentioned last year, the mobile data traffic kept on growing disproportional to the revenues. A series of solutions have come into the market from players big and small. We released the second edition of our in-depth research paper on data growth - "Managing Growth and Profits in the Yottabyte Era" last quarter.

We will be keeping a very close eye on the micro- and macro-trends and reporting on the market on a regular basis in various private and public settings.



Limit your text (84 point)

Use large fonts (41 point)

- Not smaller than this (32 point)

Use bullets, not paragraphs

- **Emphasize** your key points

Don't try to be exhaustive

- Unless the slides will be referred to later without your speech

Don't try to cram in too much content!

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Mix Text and Images

Microboxes: High Performance NFV with Customizable, Asynchronous TCP Stacks and Dynamic Subscriptions

Guyue (Grace) Liu, Yuxin Ren, Mykola Yurchenko
K.K. Ramakrishnan, Timothy Wood

GW

UCR

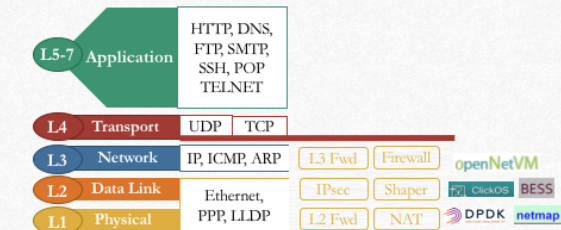
Why Improve Existing NFV Frameworks?

- Existing NFV frameworks focus on L2/L3 processing



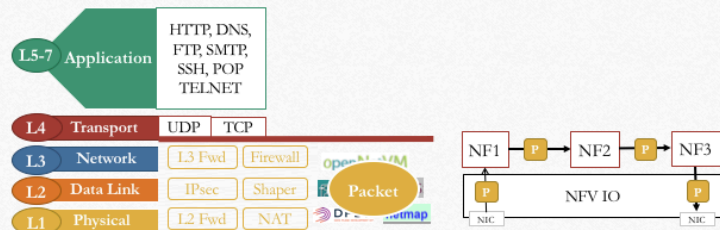
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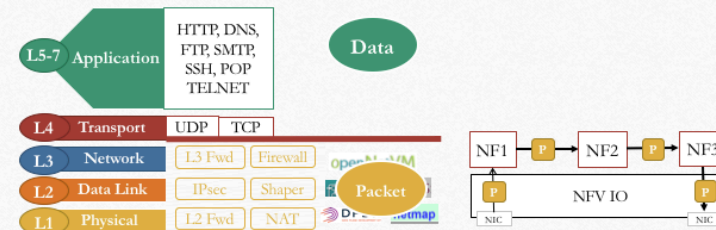
Why Improve Existing NFV Frameworks?

- Existing NFV frameworks are based on a packet-centric model



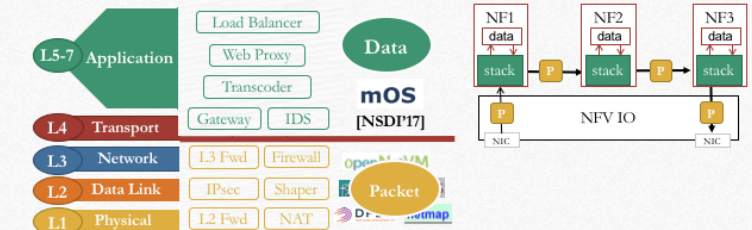
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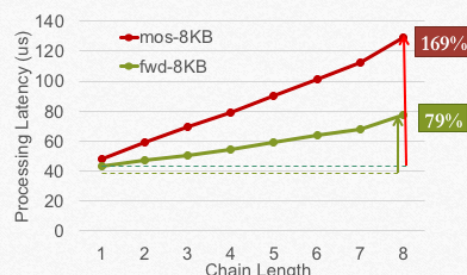
Why Improve Existing NFV Frameworks?

- Existing NFV frameworks are based on a packet-centric model
- Protocol processing becomes part of the NF. Repeated protocol stack processing within a chain - redundant



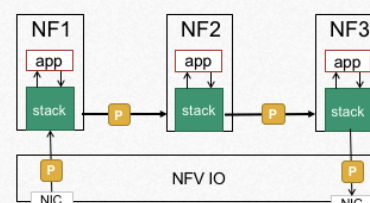
Issue #1: Redundant Stack Processing

- As the chain length increases, the overhead grows significantly when going through stack processing multiple times



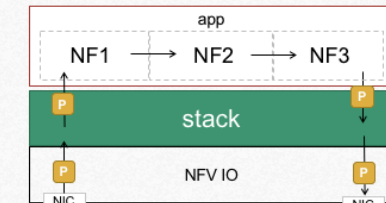
Idea #1: Consolidate Stack Processing

- How can we remove the redundancy within a chain?



Idea #1: Consolidate Stack Processing

- How can we remove the redundancy within a chain?
- Deploy all NFs and the stack as a single, **monolithic process**?



USE A HIERARCHY

- This is text
- This is also text
 - This is even more text
- Why are they all the same size?

Use a hierarchy

This is text

- This is also text
 - This is even more text
- Note that they are not the same size!

White space is important, but **Keynote is absurd**

- And sub bullets with a smaller font size help viewers focus on key points

Make your own template
and keep improving it!

USE A HIERARCHY

- This is text
 - This is also text
 - This is even more text
- Why are they all the same size?

GW PPT Template

This is where I put my content

Here is more content

Wow, this is just awful.

Why is the bar so big at the bottom?

I have so little useful space and it is poorly laid out.

My Template

Text that is reasonably large

- Sub bullets that are smaller
 - Sub-sub bullets that are even smaller, although I rarely use them
 - (Mainly so I can add spacing more flexibly)

Large “before paragraph” spacing so bullets aren’t too tight and smaller line spacing so you can fit denser text when needed (try to avoid multi-line)

A useful footer with your name and affiliation

- Always include the slide number in corner!

Minimal background images

Optional: school / lab logos

Pop up boxes to emphasize key points!

Should we animate?

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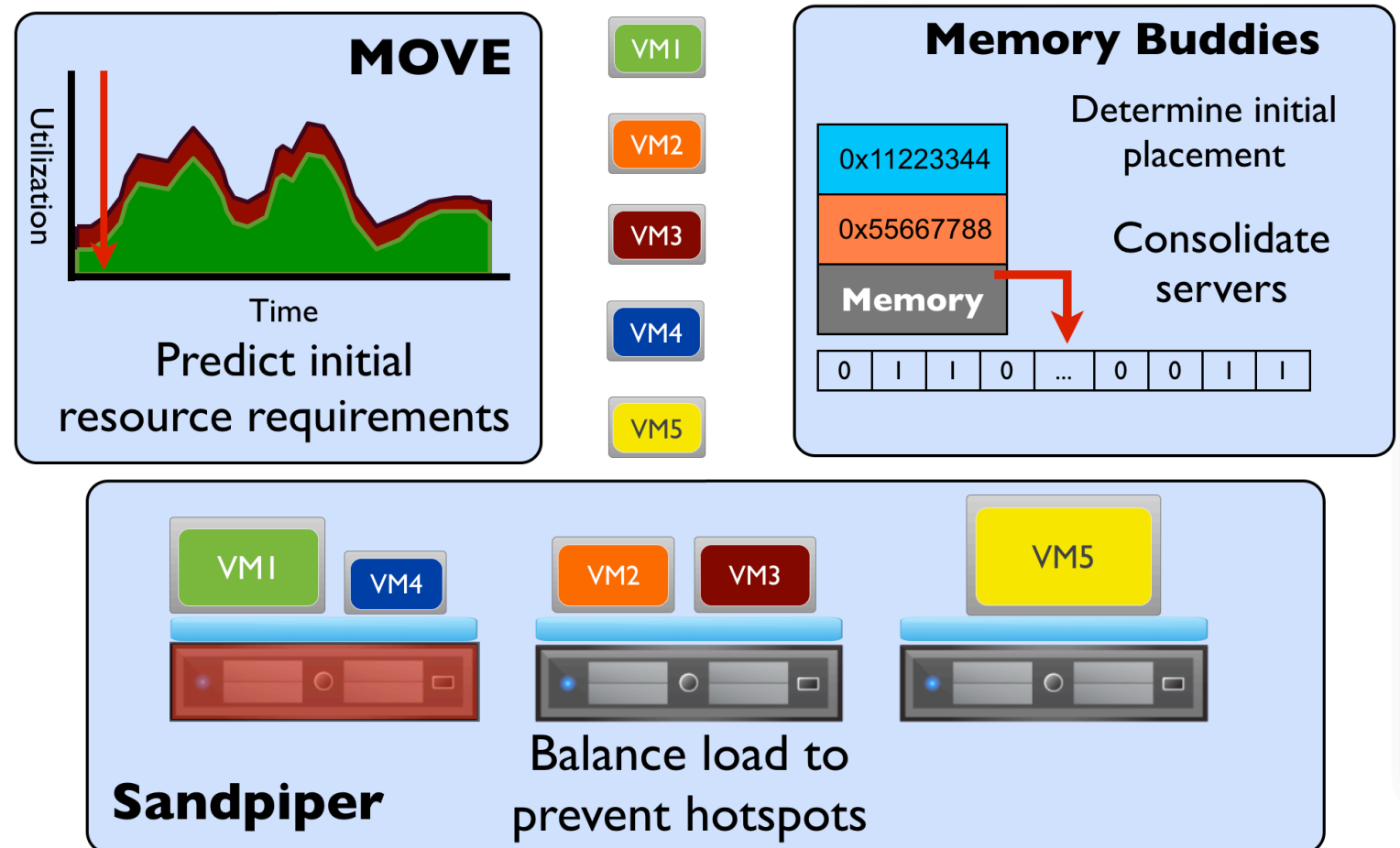
Optional: school / lab logos

**It depends! Usually only if
~3 bullets on slide**

Animations

Useful, but “expensive” to create

Can be distracting if overused



Suggestion: only use animation for emphasizing most important points

- And you only have at most 3 of those, right?

Color Inspiration



Fig 2



Fig 4



Fig 3



Fig 7



From Boxes and Arrows

Color

Related colors



©Jill Morton - Color Matters



Complementary colors



©Jill Morton - Color Matters



Limit the number
of colors

Max per display: 4

Max across entire
app: 7

Font/Background Color

White background with a black font is easier to read

Black background with white font can look childish

Other colors may not have enough contrast or could look strange depending on the projector

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Fonts

Know the difference between:

Serif fonts: easier to read in print

- Times New Roman

Sans-Serif fonts: more modern on screen

- Arial, Helvetica

Monospaced fonts: only for code

- Courier

Never use Comic Sans!

Ted Talk style?

Should we mimic TED talk slide style?



PREPARING TO FAIL

Photo: Blair Harkness

PEOPLE

CODE

INFRASTRUCTURE

INFRASTRUCTURE

“Success is stumbling from failure to failure
with no loss of enthusiasm.”

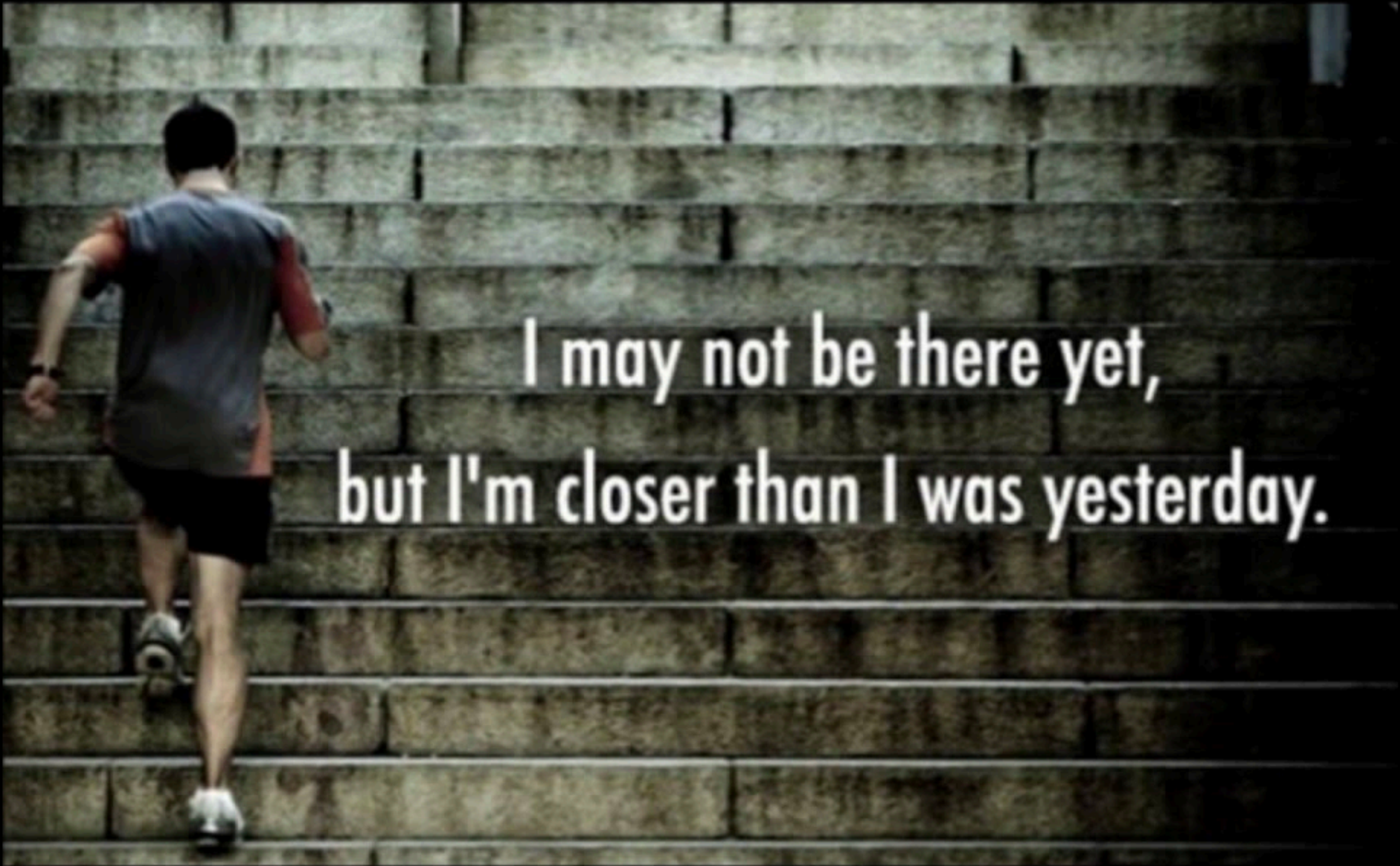
WINSTON CHURCHILL

REDUNDANCY



MULTIPLE HARD DRIVES



A person is seen from behind, running up a wide set of stone stairs. They are wearing a grey t-shirt with red accents on the sleeves, black shorts, and white sneakers. The stairs are made of large, weathered stone blocks. The background is dark, suggesting an outdoor setting at night or in a shaded area.

I may not be there yet,
but I'm closer than I was yesterday.

TED Slide Style

Don't use this for a technical talk

TED is great inspiration for **speaking** style

- but the slide format is mainly relevant for “motivational” talks

Similarly, much of the advice for making great slides online is not relevant!

- They are for a business audience!

Know your audience!

Slide format will be very different...

Classroom tutorial

- lots of text, slides need to be able to stand on their own

Talk at CS conference

- Precise, technical material. Mix of text and visuals

Pitching a startup or product

- Focus on excitement and innovation, advertising not science

Talk at Department of Defense

- They love text heavy slides for some reason...

Each company / org will have its own “culture”

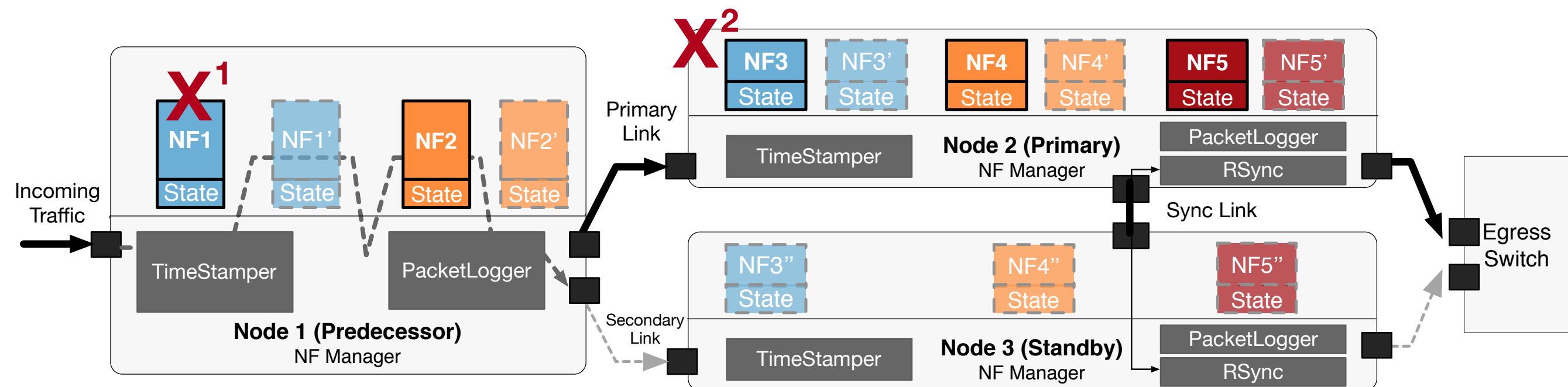
Diagrams and Graphs

Tips

Diagrams

Visual representations of your algorithm, system, or approach are always helpful

- Make the paper easier to understand
- Break up large chunks of text



Find a tool that works for you

- My lab uses Omnigraffle (mac only)
- Use something consistently so you become more efficient

Bad Diagrams

Is this a good system diagram?



Common Problems

Useless content

Bad color choices

- Indistinguishable, childish, etc

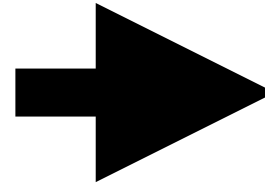
Fonts need to be bigger!

No caption to explain

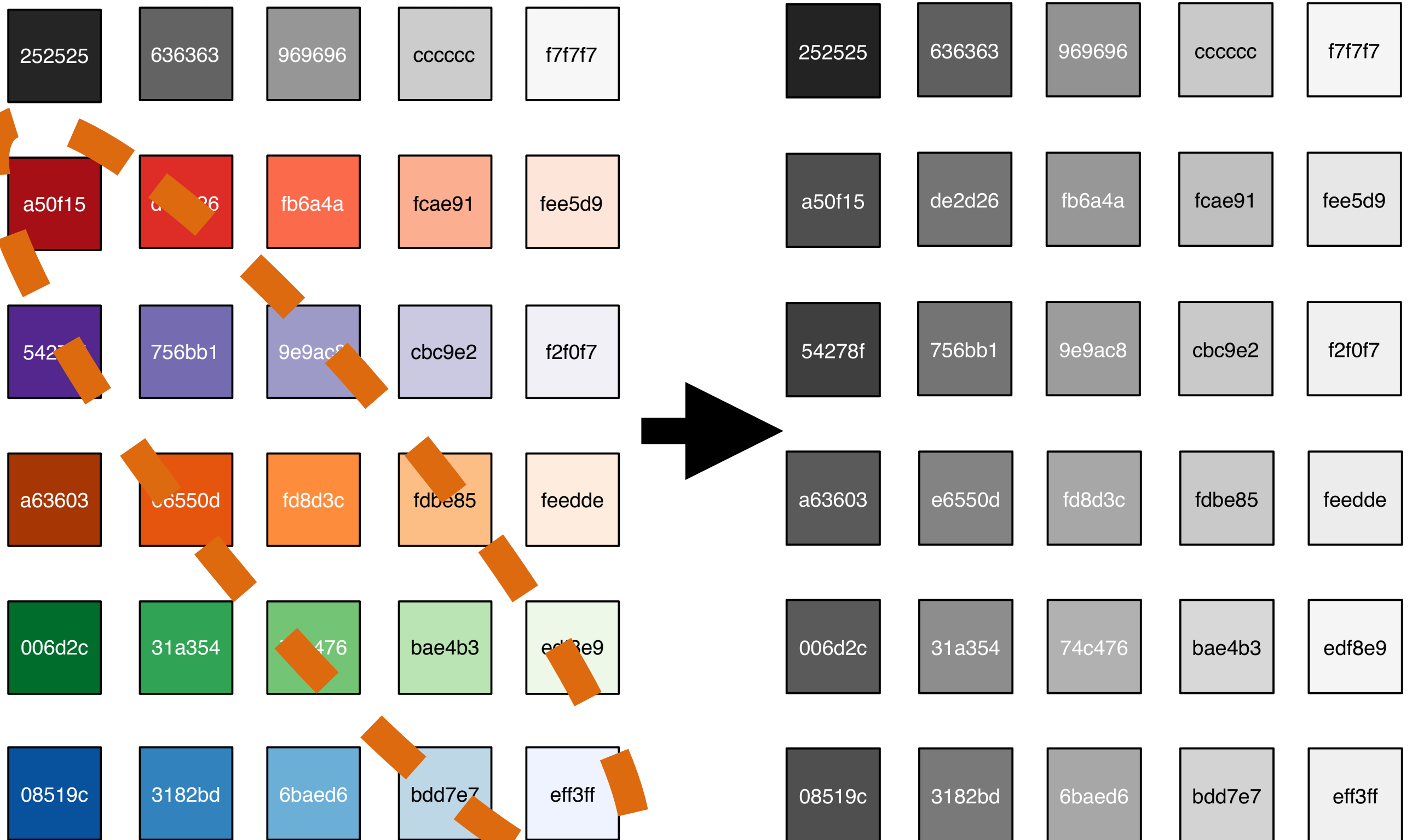
- I prefer useful captions instead of “title” captions

Color to BW

252525	636363	969696	cccccc	f7f7f7		252525	636363	969696	cccccc	f7f7f7
a50f15	de2d26	fb6a4a	fcae91	fee5d9		a50f15	de2d26	fb6a4a	fcae91	fee5d9
54278f	756bb1	9e9ac8	cbc9e2	f2f0f7		54278f	756bb1	9e9ac8	cbc9e2	f2f0f7
a63603	e6550d	fd8d3c	fdbe85	feedde		a63603	e6550d	fd8d3c	fdbe85	feedde
006d2c	31a354	74c476	bae4b3	edf8e9		006d2c	31a354	74c476	bae4b3	edf8e9
08519c	3182bd	6baed6	bdd7e7	eff3ff		08519c	3182bd	6baed6	bdd7e7	eff3ff



Color to BW



Let's make a diagram...

Goals:

Clean, consistent shapes

Clear connections between components

Useful colors

Looks good in print

Graphs

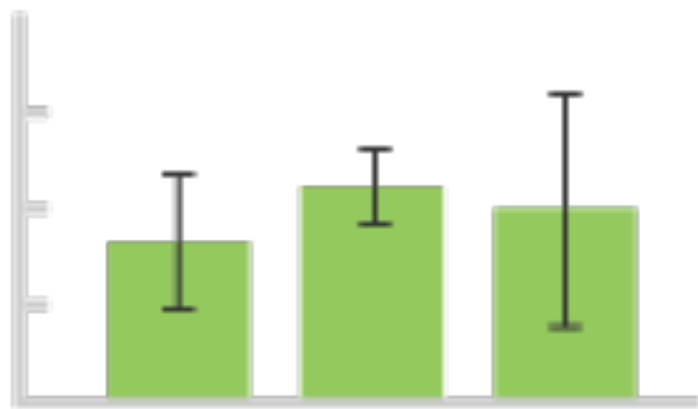
Stick with “standard” graph types

- Unless you have a good reason
- Standards: Scatter plot, line plot, bar plot
- Avoid pie charts and “infographic” look

Include error bars!

- Use standard deviation or confidence interval

Bar Chart



Line Graph



Every graph in this paper was a radar chart... odd

Graphs

What tool do you use to make plots?

- gnuplot, matplotlib, seaborn, tableau, matlab, R...

Avoid tools like Excel

- Most papers I review with Excel graphs I reject (not usually because of the graphs, but it is a sign of amateur-ness)

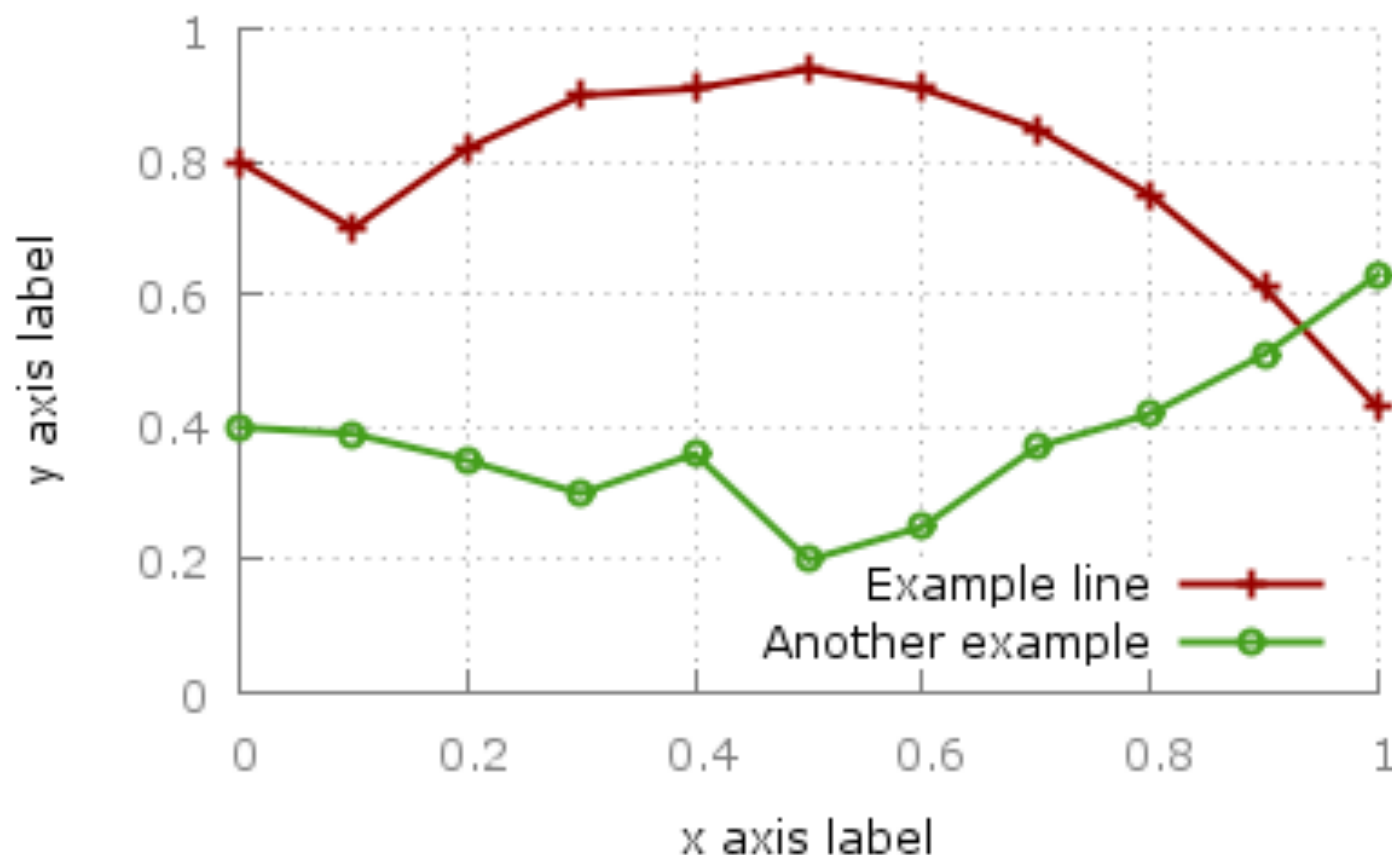
Use the same tool as your lab-mates

- Have lab scripts for making beautiful graphs

Graph Tips

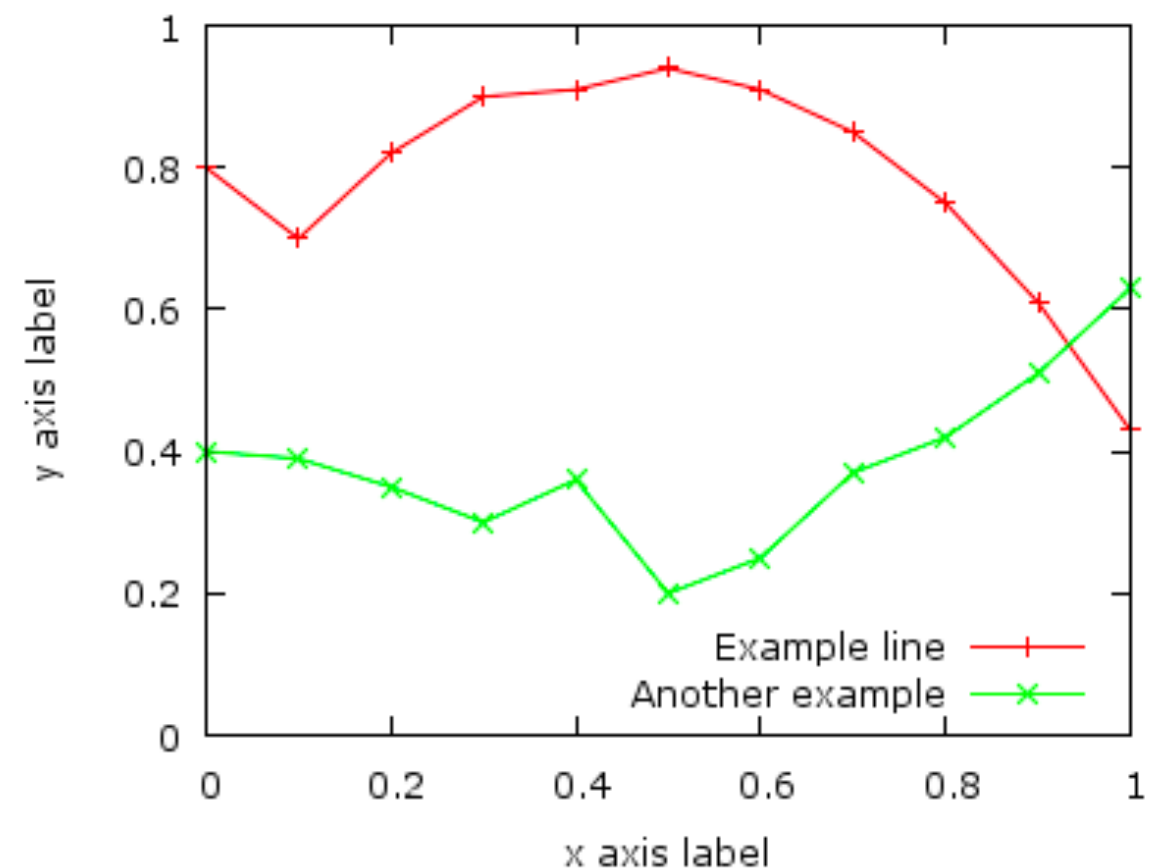
Use:

- Thick lines
- Very large fonts
- Axis labels
- Wide format



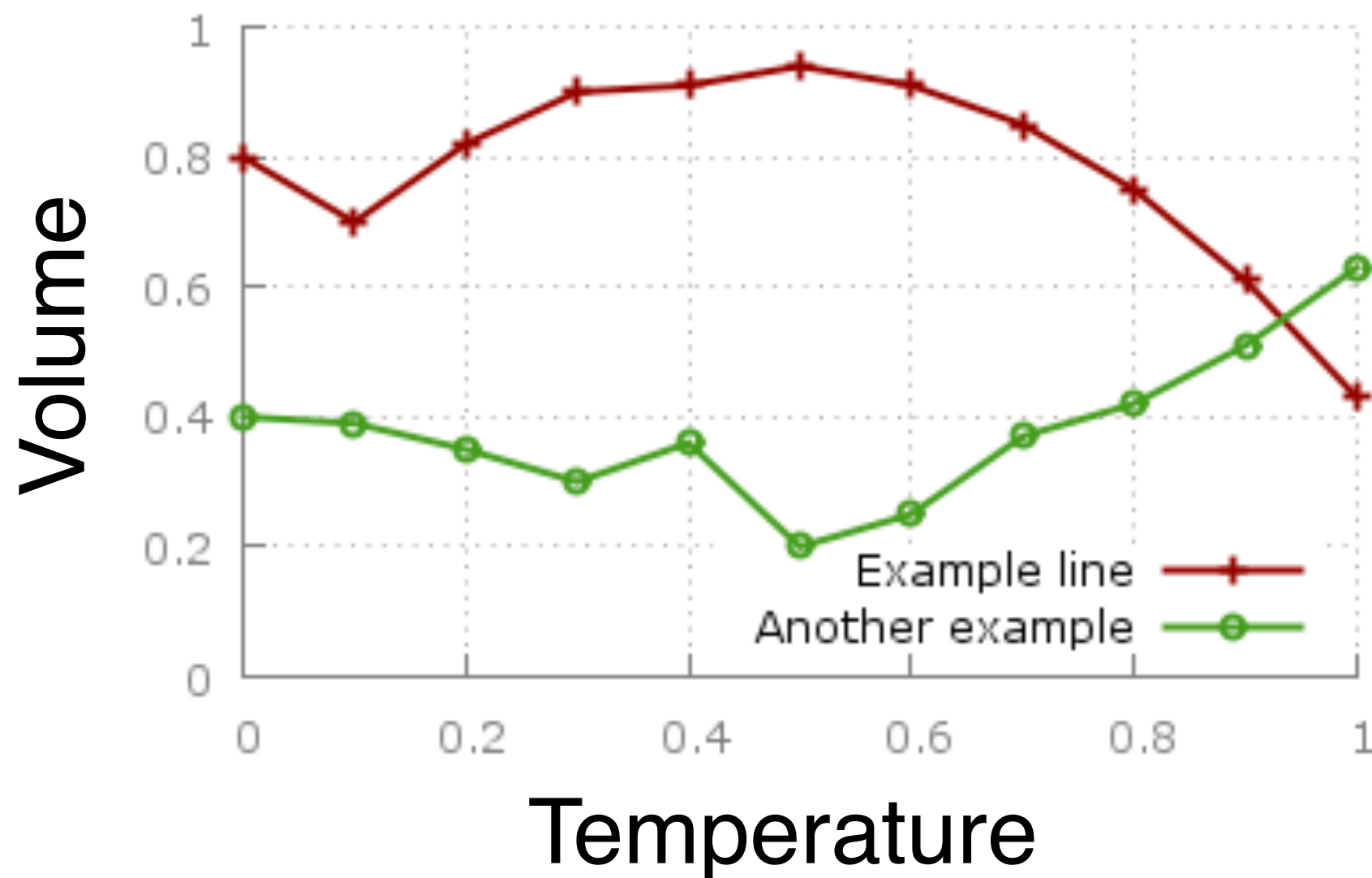
Avoid:

- Similar colors (check BW!)
- Non-0 starting axes
- Titles (if you have caption)
- Square aspect ratio



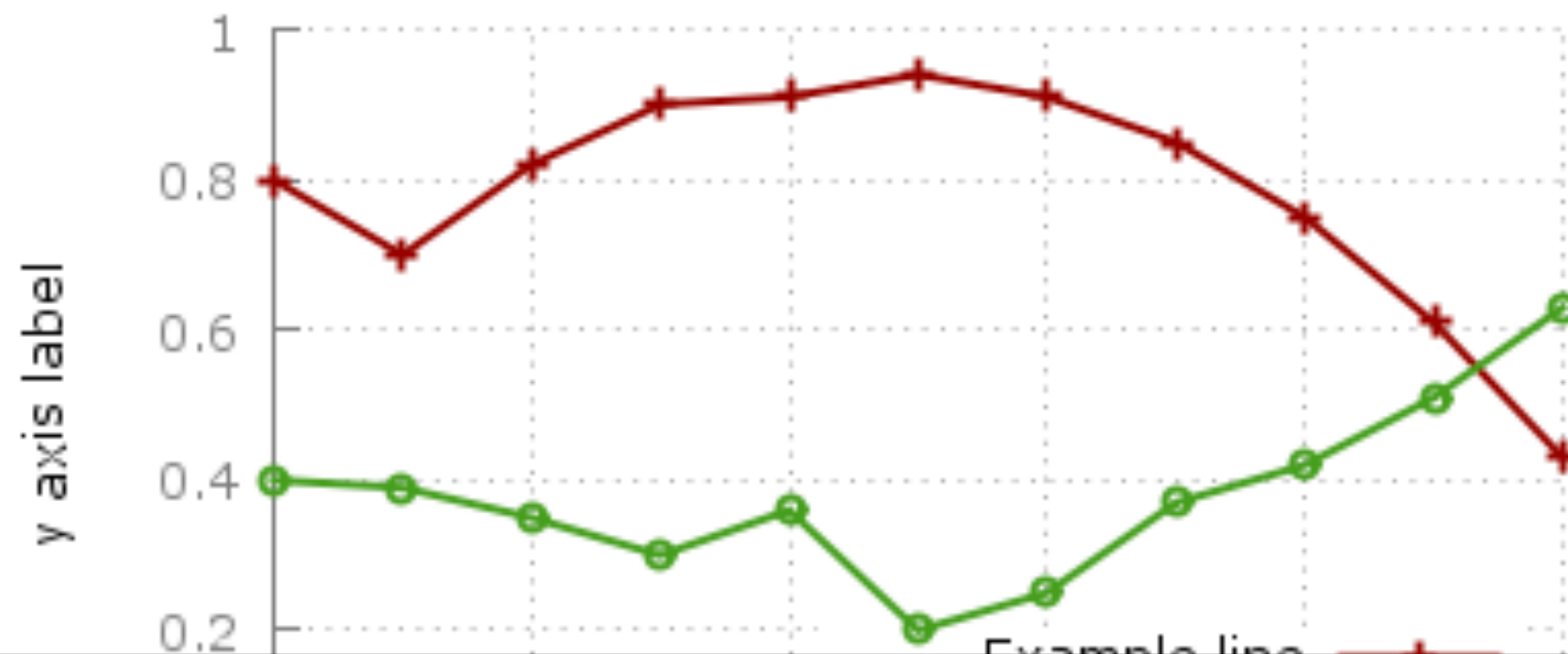
Line Graphs...

My high school science teacher would (correctly) fail me for making this graph... why?



Line Graphs...

My high school science teacher would (correctly) fail me for making this graph... why?



“Connect the dots” is really unscientific!
Trend lines are way better!

But this is what the community expects!

Accessibility

Color blindness

- 1 in 12 men, 1 in 200 women



THE AMERICAN FLAG
AS SEEN

- I- BY MOST PEOPLE
- II- BY RED-BLIND PERSONS
- III- BY GREEN-BLIND PERSONS
- IV- BY VIOLET-BLIND PERSONS
- V- BY TOTALLY COLOR-BLIND PERSONS

Accessibility

Color blindness

- 1 in 12 men, 1 in 200 women

Blindness

- about 8 million people in the US have a visual disability

Many types of disabilities to be aware of: sight, sound, touch, mobility



THE AMERICAN FLAG
AS SEEN

I- BY MOST PEOPLE
II- BY RED-BLIND PERSONS
III- BY GREEN-BLIND PERSONS
IV- BY VIOLET-BLIND PERSONS
V- BY TOTALLY COLOR-BLIND PERSONS

Visual Recipes

Slides:

- Mixture of text and images
- Keep bullets simple, fonts clear
- Use animation sparingly for emphasis

Diagrams:

- Pick the right level of abstraction; focus on relationships
- Use LARGE fonts!
- Be sure colors work in B&W

Graphs:

- Use easy to understand plot types
- Use thick lines and be sure they are distinguishable
- Use LARGE fonts!
- Be sure colors work in B&W