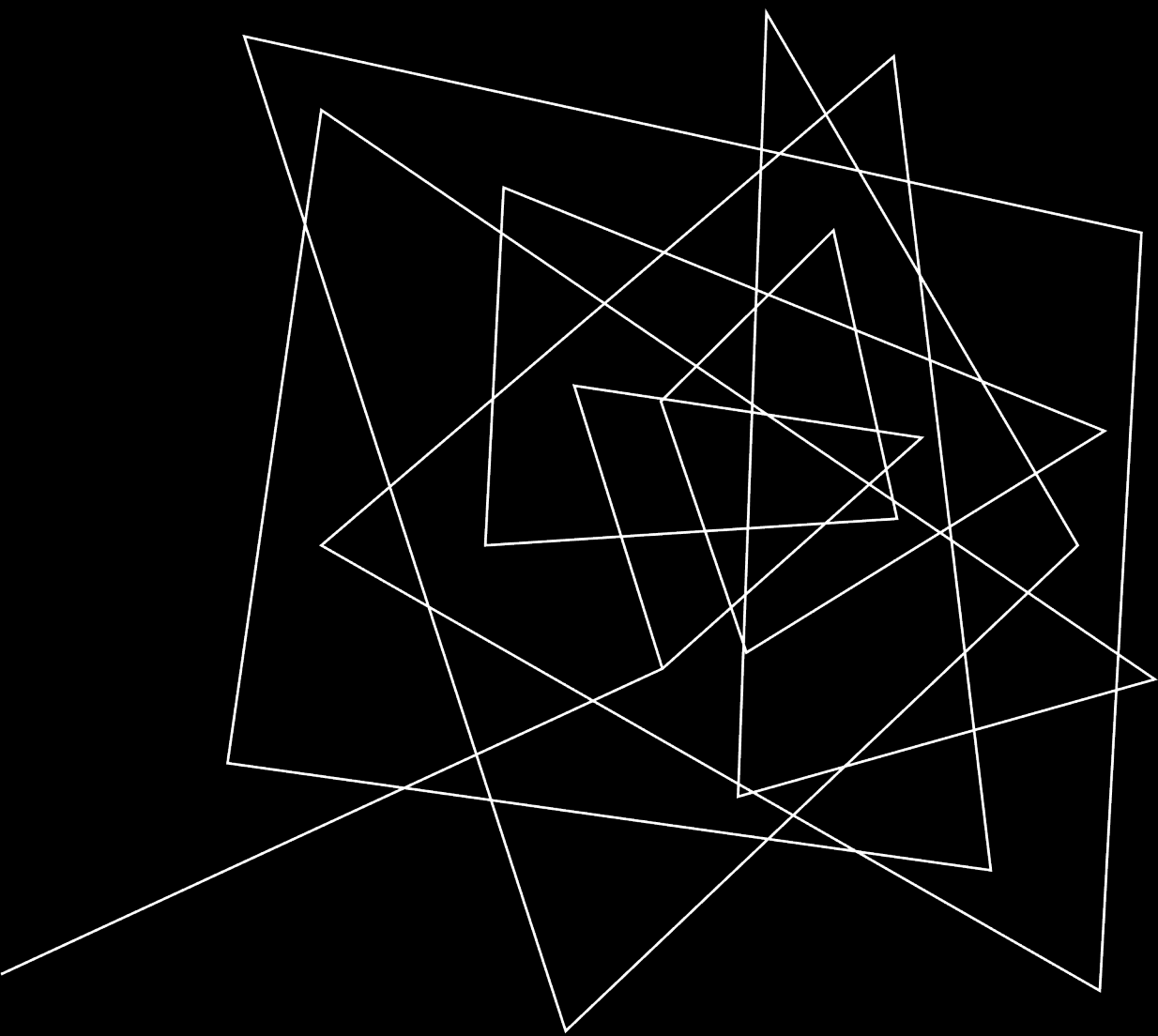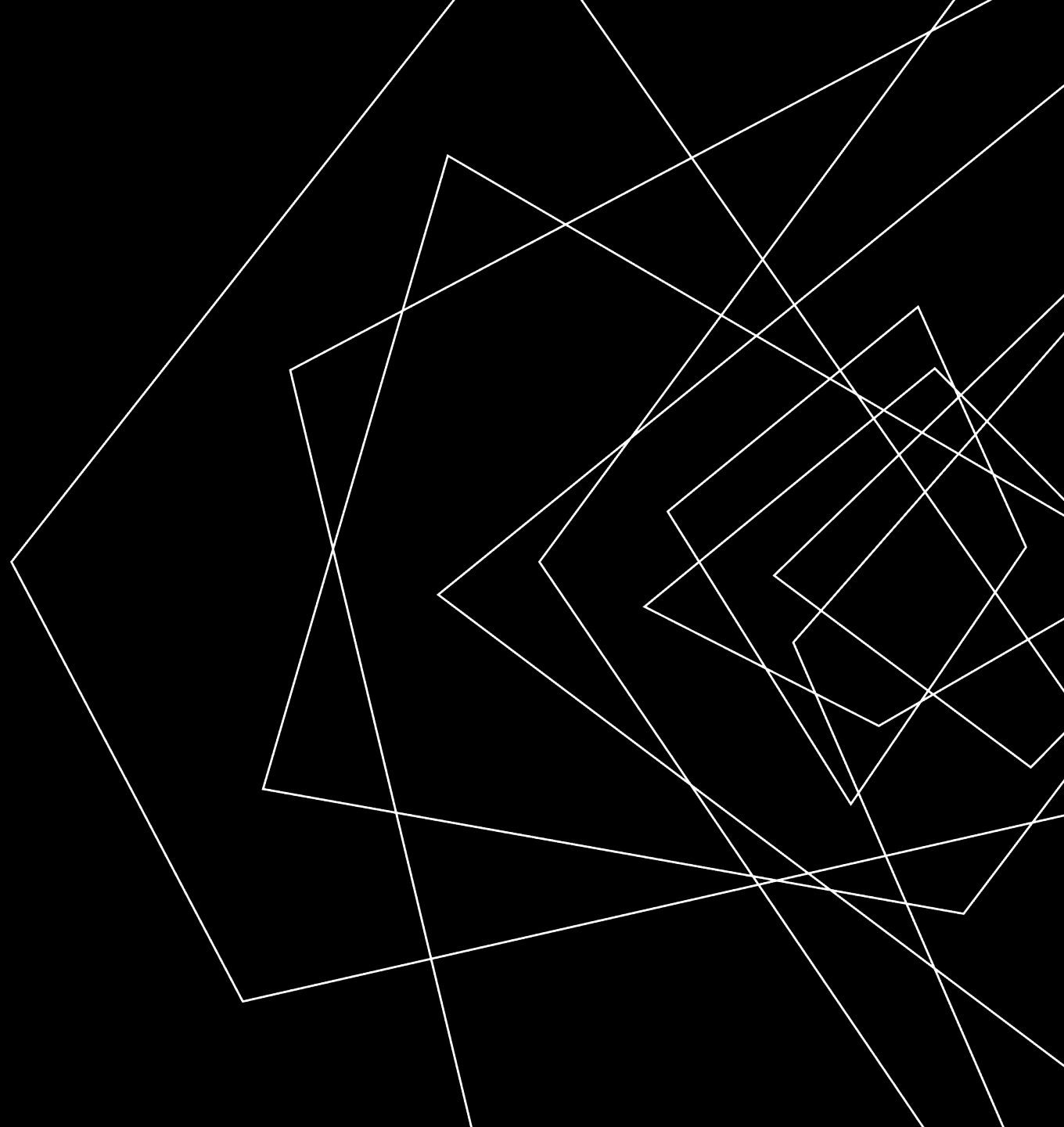# TYLER MILLHOUSE

University of Arizona
School of Information

ABOUT ME

ABOUT ME

- PhD, Philosophy, University of Arizona, 2021

- Postdoc, Santa Fe Institute, Melanie Mitchell, 2021-2022

- Assistant Professor of Practice, University of Arizona, School of Information, 2023-Present

ABOUT ME

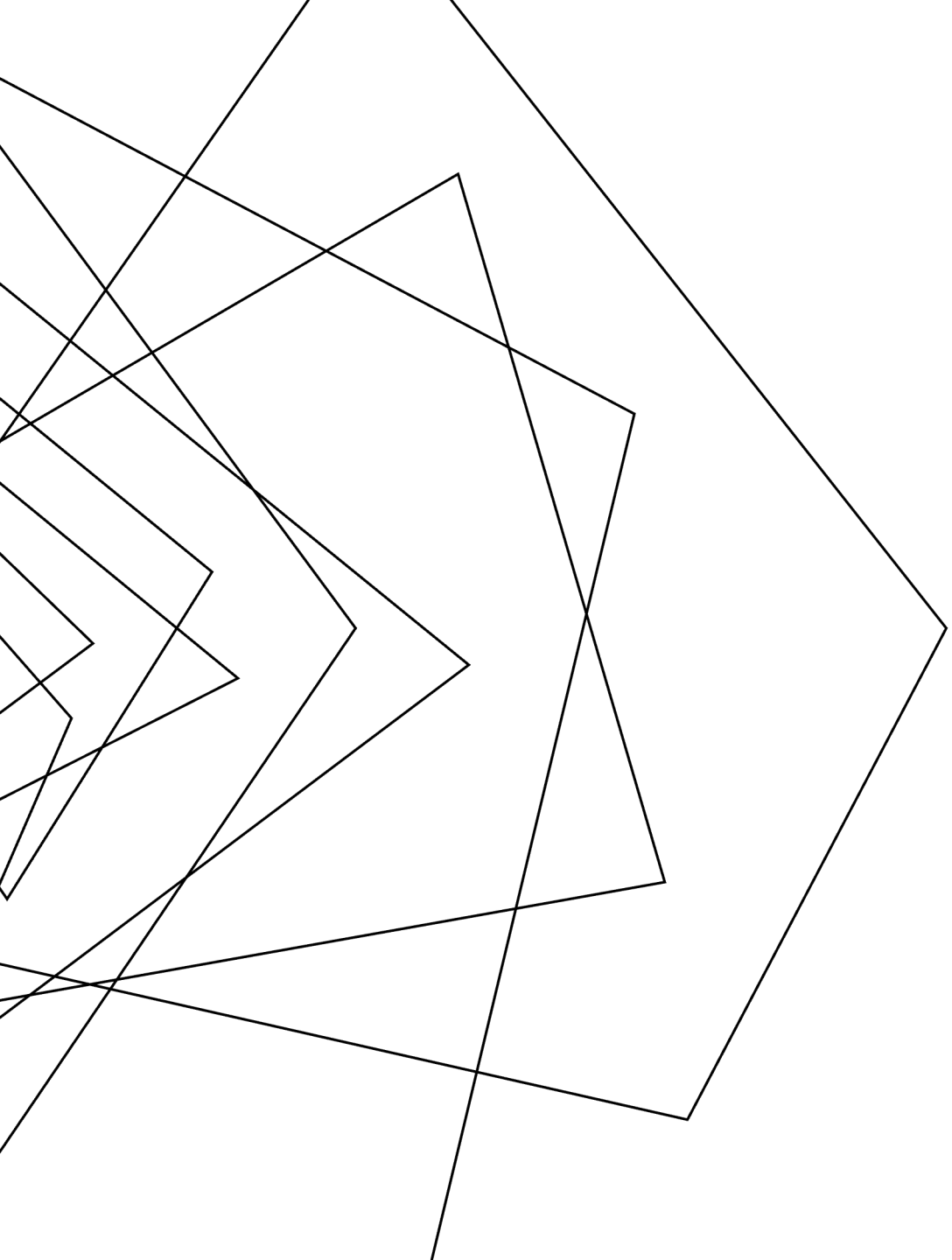## Photography

Space, Wildlife, Landscape

Cooking

Mexican, East Asian, Comfort Food

Making

3d Printing, Electronics, Woodworking

Film & Literature

Classics, Science Fiction, B-Movies

VISUALIZATION BASICS

THE DIVERSITY OF VISUALIZATIONS

Data?

Many visualizations depict data collected for a number of feature variables. The emphasis is typically on showing the changes in these variables over time or the relationships between them.

Processes?

Other visualizations depict a process (e.g., an algorithm). Any data here is usually the input or output of the process. The emphasis is on showing how the process works.

Both?/Neither?

Other visualizations blur this line. One case is where data is generated by a process you hope to model. Here you will likely want to highlight patterns in the data (e.g., data about human migration) that are relevant to modelling. You might even want to compare observed data to data generated by a model.

SPACE

Every visualization will occupy some physical space. This could be an area on a journal page, a window within a webpage, or a presentation slide. Identifying this space and sketching your layout is a good place to begin.

APPEARANCE

You will have at least some control over how the elements of your visualization look (e.g., size, color, line weight, etc.) Common restrictions involve color (e.g., due to grayscale printing) or style (e.g., matching fonts to surrounding material).

TIME

Some media allow dynamic visualizations. Web- or video-based visualizations can use time to represent changes (often temporal) or to jump between relevant contrast cases. Judicious use of such changes can be extremely helpful.

INTERACTION

Web-based visualizations can allow for rich user interactions. Where the visualization can be shared, your audience is the user. Where the visualization is part of a presentation, you are the user and your interactions can facilitate your presentation.

THE TOOLS OF THE VISUALIZER
(IN ORDER OF AVAILABILITY)

SELECTION

The most fundamental choice you face is what data (or aspects of a process) you will visualize. Everything you include in a single visualization must compete for attention. Every additional visualization you require must compete for space.

GRANULARITY

You must choose what size differences your audience will be able to detect. The limits of the format (e.g., print resolution), the limits of the viewer (e.g., visual acuity), and your choices (e.g., discretization or using log vs. linear plots) all matter.

COMPARISON

The simultaneous display of information can allow for useful comparisons. You must ensure that relevant comparisons are accessible to your viewer by choosing appropriate scales, locations, modalities, etc.

FOCUS

The choices you make will (whether you think about it or not) guide the viewer's attention to certain elements of your visualization. It is critical that viewers naturally attend to the most important elements of the visualization.

THE (CONCEPTUAL)
TOOLS OF THE VISUALIZER
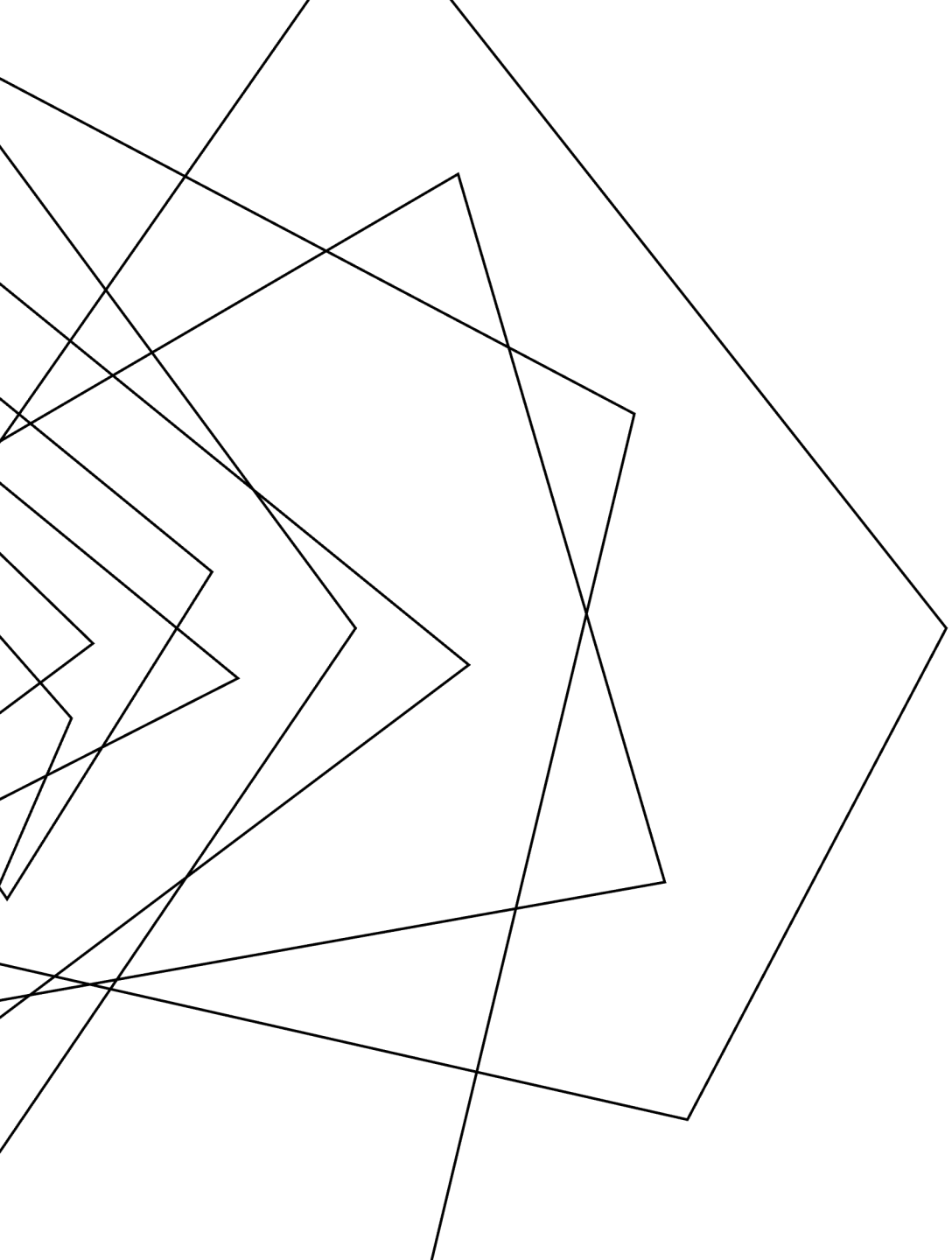
VISUALIZATION TIPS

Legibility

Ensure that everything is big enough for people of varying visual acuity (or distance from the screen) to easily see and understand. More important data should be more legible to guide *focus*.

Space as Data/Space as Canvas

Clearly distinguish between your use of space to convey information and your use of space to organize information. For example, how should you group bars in a bar graph? Should it be notable if quantity P for group A is very different than quantity Q for group A?

Data Area

Maximize the area you use to convey information. This is closely connected to *selection*.

SPACE

Multi-Modality

Use multiple modalities to convey information, especially when that information is important or otherwise difficult to distinguish. This is connected to selection and focus. It can also be used to enhance effective granulation—e.g., by blending continuous and categorical information.

Accessibility

Wherever possible choose fonts and color schemes that are accessible. For example, choose a color palette that holds up well in black and white (e.g., a sequential palette that is monotonic in brightness.

Comparability

Ensure that variables with relevant comparisons are comparable. Scales are often relevant in this area, but it applies elsewhere. For example, color and location are more comparable than color and line weight. The latter also interact destructively.

APPEARANCE

TIME

Speed

Ensure that changes are slow enough to be visible, but fast enough not to be boring or test memory.

Automaticity

Wherever possible, give the user the ability to initialize (and re-initialize) any automated sequence. This ensures that they are paying attention when the sequence begins.

Time and Temporality

Don't use animations to cycle through data that isn't temporally ordered. Let users control what they are seeing and when they see it unless the order *is* part of the data. The same goes for other modalities—use size for size, color for color, and so on.

FOCUS

Data and Emphasis

Use care with modalities that can convey both data and emphasis. For example, if you use the size of a dot on a map to convey COVID deaths in a location, the implied emphasis is appropriate.

Priorities

Some comparisons will be more obvious than others. You can often choose which are easiest. A common case is a scatter plot, whose dots have X/Y coordinates and, perhaps, size and color. X/Y will be the most obvious and comparable features.

Clutter/Comparisons

Don't include unimportant information, and don't choose modes of representation that invite flawed comparisons (e.g., spurious correlations). For example, when should lines connect points in a plot or the tops of bars? What *comparisons* does your use of lines invite?

Reset-ability

Everybody needs a do-over now and again. Make sure it is easy to switch back to a previous view or the default view.

State Transparency

Make sure it is obvious what changes the user has made. If there are buttons, show which are engaged. If you can zoom, indicate the present scale. If an interaction is not currently possible, show that (e.g., by graying out).
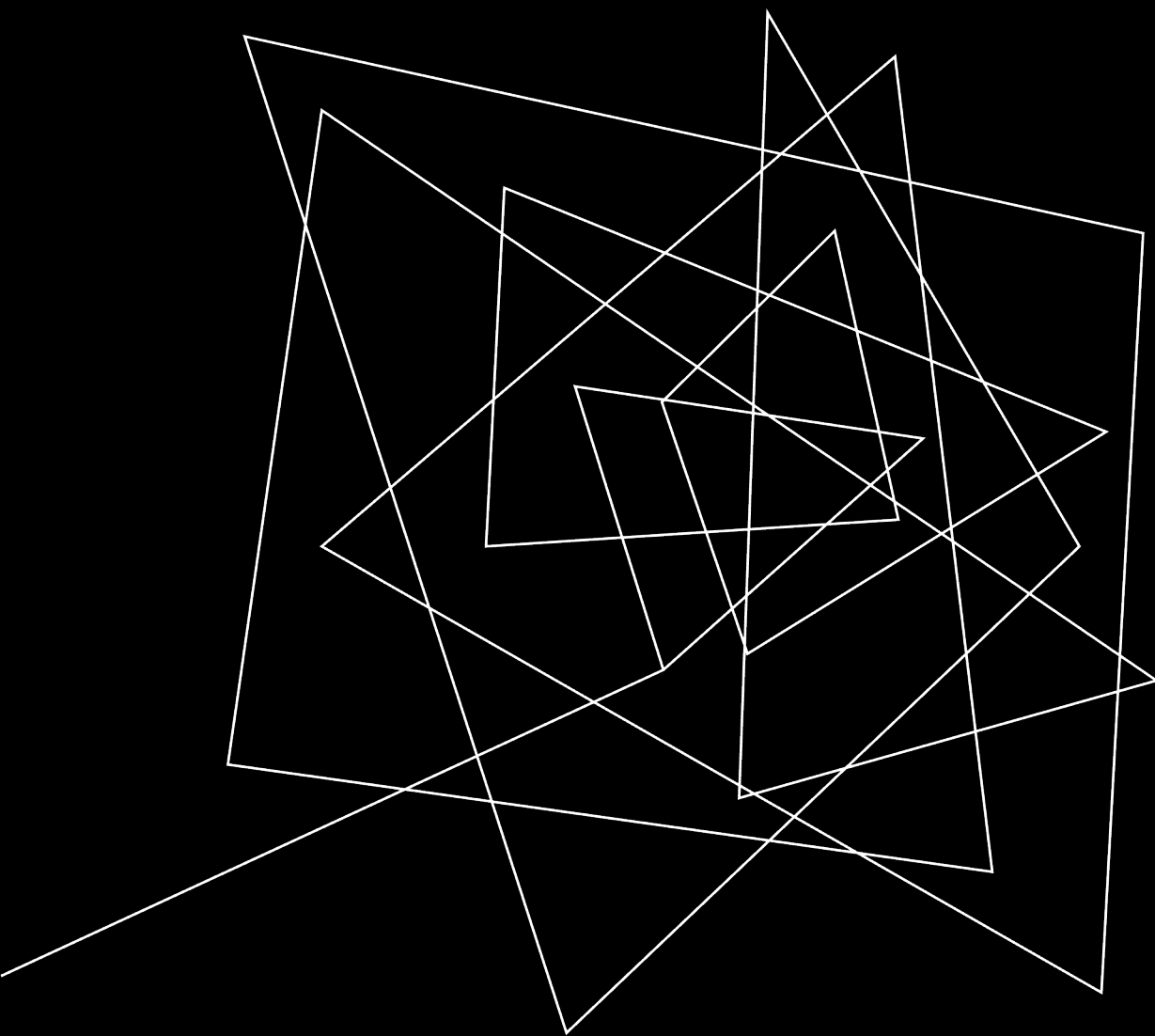
Combination and Default Options

Combine default options and free combination judiciously. It's great if you suggest comparisons on a scatter plot, and it's great if you can compare any variables you like. It's best if you combine both. Where one comparison is especially salient, make it the default.

INTERACTION
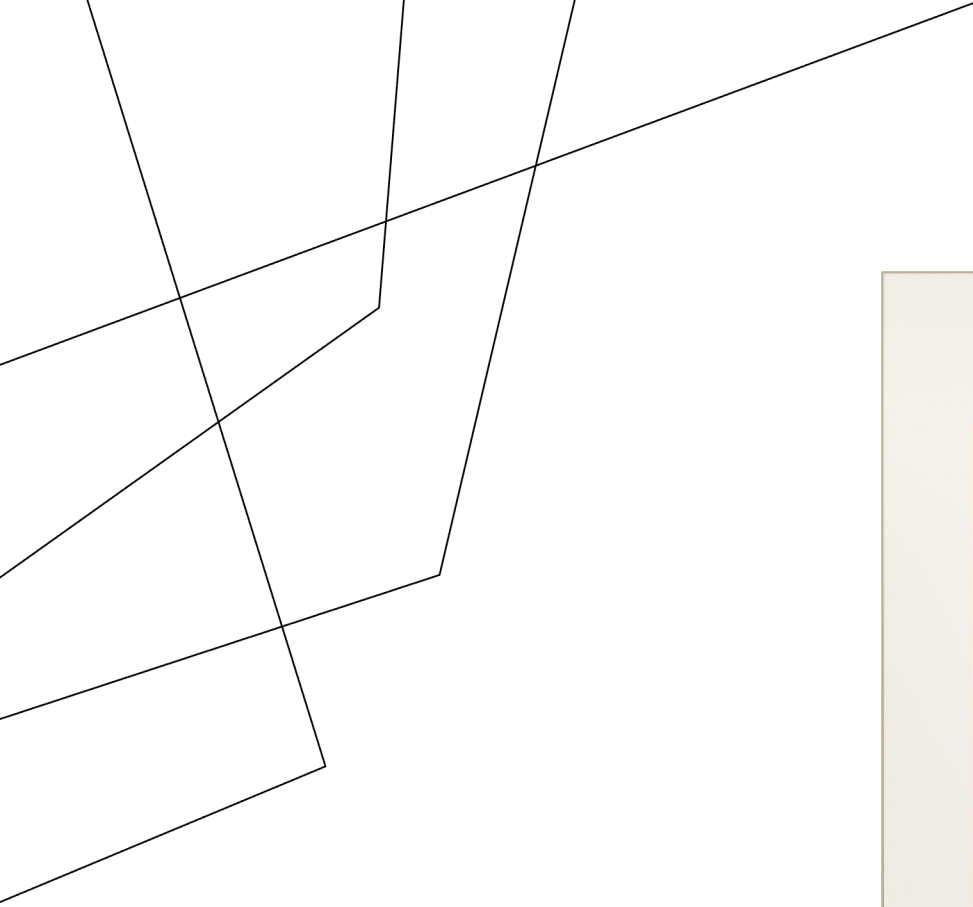
LEARN MORE
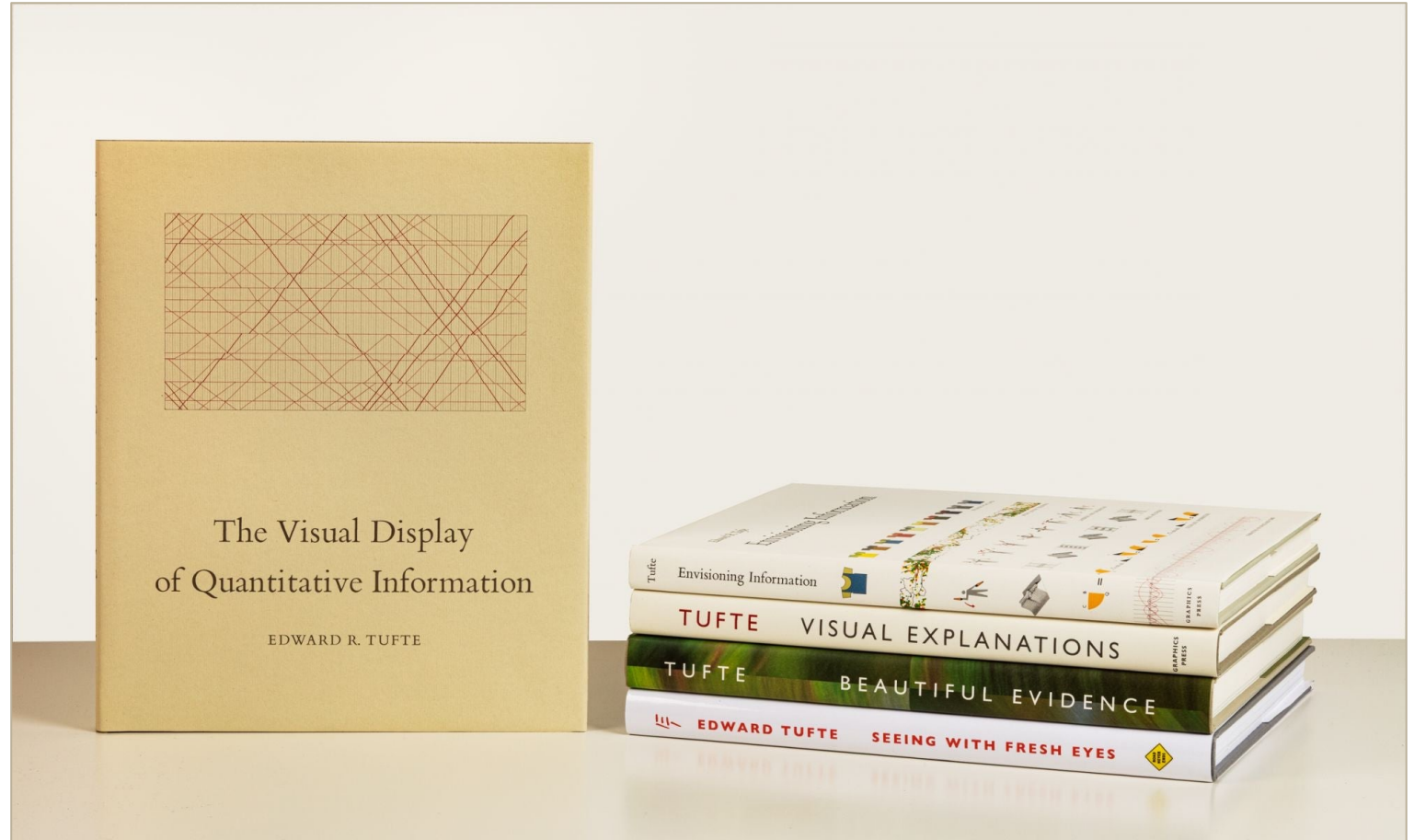
THANK YOU!

QUESTIONS?

Think of one later?
tylermillhouse@arizona.edu