

# Uncertainty Visualization

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# Preface

This book<sup>1</sup> aims to provide the *why* and the *how* of uncertainty visualization. The *why* is based on what we currently know about how people interpret and make decisions from uncertainty visualizations, and the *how* is structured around generating uncertainty visualizations using the R programming language and the grammar of graphics.<sup>2</sup>

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<sup>1</sup>or what it will be—it is a work in progress

<sup>2</sup>as implemented in the *ggplot2* package (?)



# Chapter 1

## Introduction

TBD





## Chapter 2

# Why uncertainty visualization is hard

- Efficient encodings for uncertainty can be hard to find
  - try putting mean, variance, and interval estimation in one plot + doing this when useful channels are already used up
- Even if you get the encoding right have to contend with making sure people understand it
  - explain a CDF to someone
- Even if people understand have to deal with how people perceive uncertainty
  - linear-in-log-odds and other perceptual models of probability
- Even if people correctly perceive the uncertainty have to deal with how people make decisions under uncertainty
- Even if you solve all these problems in one context a new context may cause your solution to break
  - see e.g. deterministic construal errors
- Plus, you still have to build the damn thing
  - But some strategies for building uncertainty vis using the grammar of graphics helps a lot here (the **how** of this book)



## Chapter 3

# Foundations: Uncertainty as we'll see it

- primarily Bayesian perspective
  - unifies aleatory and epistemic
  - gives us one framework to work in
  - simplifies building things
  - simplifies communicating things (see e.g. confidence fallacy)
- will still occasionally touch on frequentist, usually as a subsection at the end of each chapter:
  - tips on how to translate the visualization techniques presented into that mode
  - at times, visualizations unique to the frequentist approach that might be useful



## Chapter 4

# Foundations: Uncertainty and the grammar of graphics

- basic strategies for applying uncertainty visualization within the grammar of graphics
- visual channels, marks, etc. (and mapping onto ggplot)
- simple prediction grid example



## Chapter 5

# Discrete data

- categorical
  - proportions
    - \* product plots / mosaic plots
  - icon arrays
    - \* unit visualizations
  - HOPs-like stuff
  - entropy-based approaches
- ordinal / integer
  - proportions
  - histograms
  - CDFs
  - dotplots
  - ...





# Chapter 6

## Continuous data

*not sure of the organization here, especially within multivariate...*

- univariate
  - densities, gradients
  - CDFs
  - intervals
  - quantile dotplots
  - HOPs
- multivariate
- the joint case
  - gradients
  - contour plots
- the conditional case
  - gradients
  - bands
- generalizing quantile dotplots to multiple dimensions: representative sampling approaches
  - scatterplots
  - spaghetti plots
- HOPs
- frequentist addendum
- interpreting in a Bayesian mode: advantages and pitfalls (and what it reveals)
  - *this maybe goes elsewhere*
- those double-sided p value plot things



## Chapter 7

# Dealing with multiple uncertainties

- a note on comparisons
- univariate marginals might bite you...
- aleatory / epistemic (or parameter space / data space)
- frankenplots maybe (product plots / mosaic plots / unit visualizations)
- animation
  - NYT needle
  - Galton boards
- mixing discrete and continuous
- color with densities
- HOPs
- some hurricane stuff



# Bibliography