

# Data Collection & Analysis

Basic tools and techniques for collecting and analyzing different types of data

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## Data “in the wild”

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- Domain expertise needed
- May require special handling (ethics approval, privacy, IP)



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## “Domesticated” data

- Clean!
- Well studied benchmarks
- May be simulated, or otherwise not representative of the real world



# Think about your problem setting

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Depending on your research area, standards for how to treat data will vary widely...

Some examples:

- A statistical theory researcher using linear regression as a toy model
- A HCI researcher using survey data and eye tracking to understand how users interact with their product
- A climate researcher using meteorological data from weather stations
- A computational social science researcher scraping twitter posts

# Think about your problem setting

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Much in the way a not-so-complicated research question gets increasingly complicated the more you look at it, datasets tend to have hidden complexities that only reveal themselves once you've spent some time with them.



# Exploratory data analysis

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Spend some time poking around to understand the type of data you have, and what kinds of approaches might be appropriate.

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**Identify the type of data you are working with**, and standards of handling you should be aware of...

- tabular data
- images
- text / natural language
- graphs or other representations



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**Think about the data collection process.** If you have access to domain experts, ask them to describe how they think about the data, and what limitations exist in how it was collected.

- How much control do the domain experts have over the data? Is it experimental, observational, or synthetic? Is it reproducible?
- Is the collection process stable over time?
- What kinds of features are available to you? What dependencies might exist among them? Are there redundancies?
- How is data missingness treated?
- How generalizable is this data? Is it representative of the “real world”?

# Data collection

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When it's time to create a research proposal, you need to demonstrate to your reader that your research is both necessary and feasible. You should be able to describe the data collection process, and details on data processing that show you **understand your data's limitations**.

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Some places to look for data:

- Previously published research. Critically read their description of data collection!
- Government-curated open access data is often well-documented and longitudinal
- Curated benchmark datasets (ex. MNIST, ImageNet, Kaggle datasets)
- New data generated by you or a collaborator may require a description of the validation process

See the end slide for some links to datasets you might find useful 😊

# How to approach a new dataset

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**Start small.** Try to write down some rules about the data that you can observe from just looking at a few examples.

**Make a data exploration plan.** Write down some questions you have about the data, and how you might answer them.

**Explore.** Answer the questions you wrote down! Write down results as you go for you to reference later. (This can also be important for reproducibility)!

This is an iterative process!

By answering your initial questions, you will be able to come up with the next set. You don't need to come up with The Perfect<sup>TM</sup> set of questions to get started.

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In my research, I need to find cells in an image. These images have been prepared for me in the lab by my collaborator.

1. Start small: I picked one image, and chose segmentation settings that look good.
2. Make a data exploration plan: Can I use the same segmentation settings for all the images? Are all the cells in all images approximately the same size? Do they all have similar brightness?

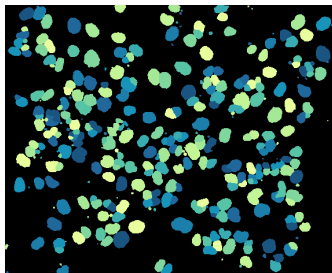


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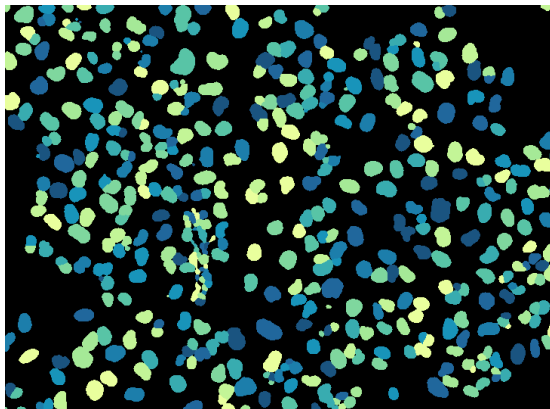
1. Start small: I picked one image, and chose segmentation settings that look good.
2. Make a data exploration plan: Can I use the same segmentation settings for all the images? Are all the cells in all images approximately the same size? Do they all have similar brightness?
3. Explore:



# Iterate with new questions

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What would it look like if my  
segmentation failed?  
What are the failure modes?



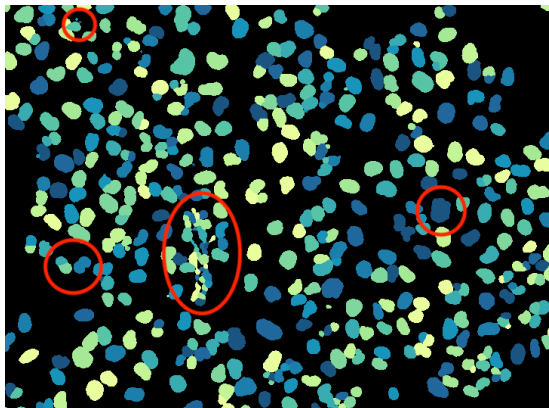
# Iterate with new questions

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What would it look like if my segmentation failed?

What are the failure modes?

- cells that were not distinguished (doublets)
- cells that are a weird shape
- segmented objects that are not cells



# Today's activity

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Pick a paper. Identify summarise the elements of scientific problem solving and data collection as discussed by Sheldon and Cait. You can use this worksheet again when preparing your research proposal, and summarising papers for your literature review!

# Some datasets for you

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- Kaggle competition [datasets](#)
- Toronto [open data](#)
- British Columbia [open data](#)
- Ontario [Data Catalogue](#)
- Los Angeles [city data](#)
- Google [Earth Engine](#)
- Google [Dataset Search](#)
- FiveThirtyEight [open data](#)
- World Bank [open data](#)
- US Open Data Initiative [DATA.GOV](#)
- US [National Historical Geographic Information System \(NHGIS\)](#)
- Canada [Census Data](#)

# Some more datasets for you

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Many of these websites have API to download the data. It's recommended you use these when available!

## Health and Biological data

- NIH [Cancer Surveillance](#)
- NCBI [Gene Expression Omnibus](#)
- World Health Organization [data](#)
- UniProt [data](#)
- The Gene Ontology [Project](#)
- US Center for Disease Control and Prevention [Data](#)
- California Health and Human Services [Open Data Portal](#)
- Covid Data [CovidTracker](#)

## Academic Publications and related

- Figshare data [repository](#)
- Zenodo data [repository](#)
- Harvard [Dataverse](#)
- Elsevier [Developers API](#)

## Social Networks

- Twitter [Developers API](#)
- GitHub [Developers API](#)
- Instagram [Developers API](#)
- LinkedIn [Developers API](#)
- Zillow [Developers API](#)