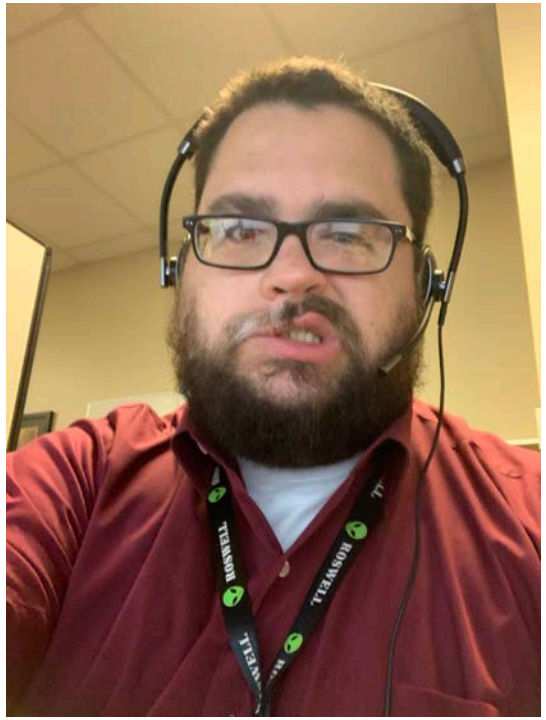
**Candidate: Neil S. Rose, GISP**

**Advisor: Ryan Baxter**

# Understanding Faulty Data

## Methods to Capture, Report, and Score Data Cleanliness

# Who am I?



## Neil S. Rose, GISP

GIS Manager, City of New Braunfels, TX

- BA Sociology
- BA Applied Geography
- Grad Cert, GIS
- Grad Cert, Geospatial Programming and Web Map Development
- 8 years in local government GIS
- Employs a high level of python scripting
- Automate, automate, automate
- Professional interest in data cleansing automation

# The Agenda

## Introduction and Background

What is data? Why is it important? How does it live? What makes data good or bad?

## Goals, Objectives, Methodologies

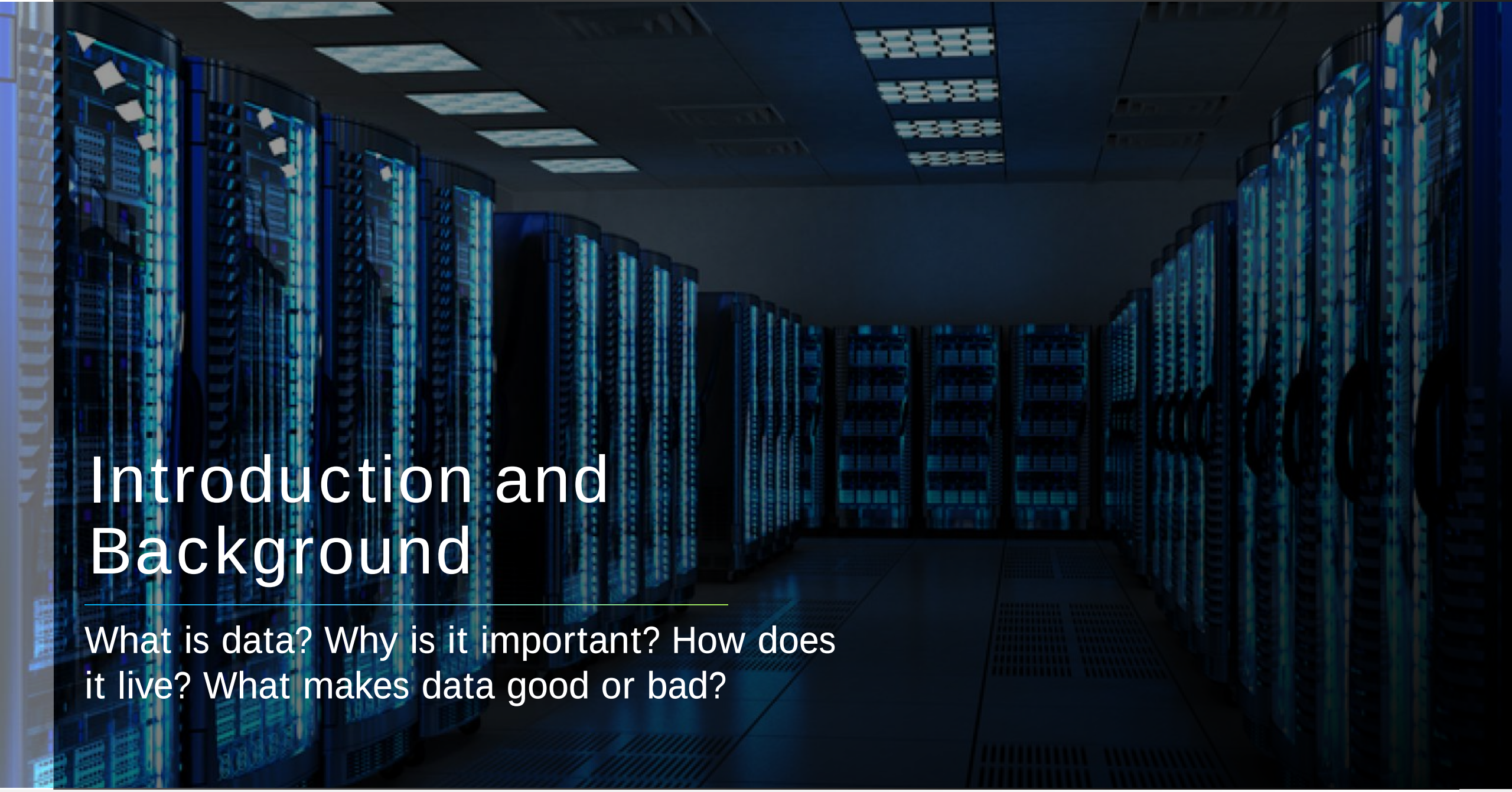
Identify, report, and score data cleanliness using python solutions

## Anticipated Results

What will work? What won't?

## Timeline

Project completion and presentation



# Introduction and Background

What is data? Why is it important? How does it live? What makes data good or bad?

# What is "data"?

| | |
|---|---|
| Data quantifies or qualifies a phenomena | • Temperature, location, cost, distance, color |
| Data != Information | • Information is derived from the analysis and interpretation of data |
| GIS data isn't special, only spatial | • Vector and raster data structures |
| Vector consists of points, lines, and polygons | • Acquired by heads up digitization or device capture |
| Raster consists of a grid of values | • Represents a continuous view of real-world phenomena |
| Attributes contextualize the spatial | • Non-spatial data that describes the spatial feature |

# Why is data important?

| | | |
|---|---|---|
| Improve people's lives | Make informed decisions | Stop molehills from turning into mountains |
| Get the results you want | Find solutions to problems | Back up your arguments |
| Stop the guessing game | Be strategic in your approaches | Know what you're doing well |
| Keep track of it all | Make the most of your money | Access the resources around you |

*Council on Quality and Leadership*

# From planning to destruction, the lifecycle of data

- Data Planning
- Data Generation
- Data Collection or Acquisition
- Data Processing
- Data Storage or Preservation
- Data Management
- Data Analysis
- Data Publishing or Sharing
- Data Visualization
- Data Interpretation
- Continual Actions
- Archiving/Destruction

USGS
science for a changing world

HDSR
HARVARD DATA SCIENCE REVIEW

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UK • DATA ARCHIVE

# Data Planning

| |
|---|
| **Data Planning** |
| Data Generation |
| Data Collection or Acquisition |
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**The First Step**

- Why is the data important?
- How is it being collected?
- How will it be stored?
- Determine data parameters
  - Schema
  - Storage
  - Access
  - Maintenance

# Data Generation, Collection, or Acquisition

- Data Planning
- **Data Generation**
- **Data Collection or Acquisition**
- Data Processing
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## Generation

- Generating data is more applied to big data
- Large, unstructured datasets
- Doesn't work well for GIS without data wrangling
- *Not considered a core phase of the data lifecycle*

## Collection/Acquisition

- Data collected through field operations, digitization, or from an external source
- Field operations and digitization draw directly from **Data Planning**
- Acquisition may require data wrangling

# Data Processing

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- **Data Processing**
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**Also known as...**

- Data wrangling
- Data preparation
- Data munging

**How to process data...**

- Transforms raw data into desired data through:
  - Cleaning
  - Structuring
  - Enriching
- Differs from data cleansing

# Data Storage or Preservation

- Data Planning
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- **Data Storage or Preservation**
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**Outside of data planning...**

- Builds data storage based on generated and wrangled data
- Can result in schema, field naming, accuracy, precision, and naming convention errors
- *Not considered a core phase of the data lifecycle*

# Data Management

- Data Planning
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- **Data Management**
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| Jeanette Wing | Sanborn |
| --- | --- |
| • Optimized storage process<br>• Varies based on data generated<br>• *Not considered a core phase of the data lifecycle* | • Analysis<br>• Data updates<br>• *Not considered a core phase of the data lifecycle* |

# Data Analysis

- Data Planning
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- **Data Analysis**
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**Creates new data...**

- Through analysis, derivative data is created
- Initial data input is not changed
- *Not considered a core phase of the data lifecycle (but is closely related)*

# Data Publishing or Sharing

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- Data Management
- Data Analysis
- **Data Publishing or Sharing**
- Data Visualization
- Data Interpretation
- Continual Actions
- Archiving/Destruction

**Providing access to data…**

- Whether by open data, ftp, REST, or other means of sharing
- Data can be viewed, downloaded, and accessed
- Data doesn't change
- *Not considered a core phase of the data lifecycle*

# Data Visualization

- Data Planning
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- **Data Visualization**
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**Seeing the data…**

- Symbolizes the data, whether on a map, chart, or graph
- The data doesn't change
- *Not considered a core phase of the data lifecycle*

# Data Interpretation

- Data Planning
- Data Generation
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- Data Processing
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- Data Analysis
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- Data Visualization
- **Data Interpretation**
- Continual Actions
- Archiving/Destruction

**What does it all mean?**

- Provides explanation to data analysis and visualization
- The data doesn't change
- *Not considered a core phase of the data lifecycle*

# Continual Actions

- Data Planning
- Data Generation
- Data Collection or Acquisition
- Data Processing
- Data Storage or Preservation
- Data Management
- Data Analysis
- Data Publishing or Sharing
- Data Visualization
- Data Interpretation
- **Continual Actions**
- Archiving/Destruction

## Repeatable processes...

- Describe data
  - Metadata creation
  - Data dictionaries
  - Data discovery
- Data cleansing
  - “ensures that data are properly collected, handled, processed, used, and maintained at all stages” USGS

- Data security
  - Backups
  - Cyber security

# Archiving/Destruction

- Data Planning
- Data Generation
- Data Collection or Acquisition
- Data Processing
- Data Storage or Preservation
- Data Management
- Data Analysis
- Data Publishing or Sharing
- Data Visualization
- Data Interpretation
- Continual Actions
- **Archiving / Destruction**

## The Last Step

- What to do with data when it's being replaced or becomes irrelevant?
- None of the sources reviewed discussed this step
- Depends on organizational policies and practices

## How to...

- There are several ways to archive or destroy data:
  - Stored as a read-only
  - Transferred to external media
  - Server snapshot
  - Deleted
- Census vs Municipal

# The Core Data Lifecycle

- Data Planning
- Data Acquisition
- Data Wrangling
- Maintenance Operations
- Data Archival and Destruction

- Having bad data results in bad analyses, maps, interpretations, and results
- This can be prevented by utilizing data maintenance operations:
  - Backups
    - Prevents loss of data caused by degradation, accidents, corruption, or malicious actions
  - Documentation
    - Metadata creation and management
    - Data dictionaries
    - Keyword data discovery
  - Quality management
    - Data cleansing
    - In-place tools
    - Scheduled operations

# Garbage In, Garbage Out

Having data is good, having good data is better

# Existing Tools

### Topology

Rules set by the user to define a geospatial relationship

### Domains

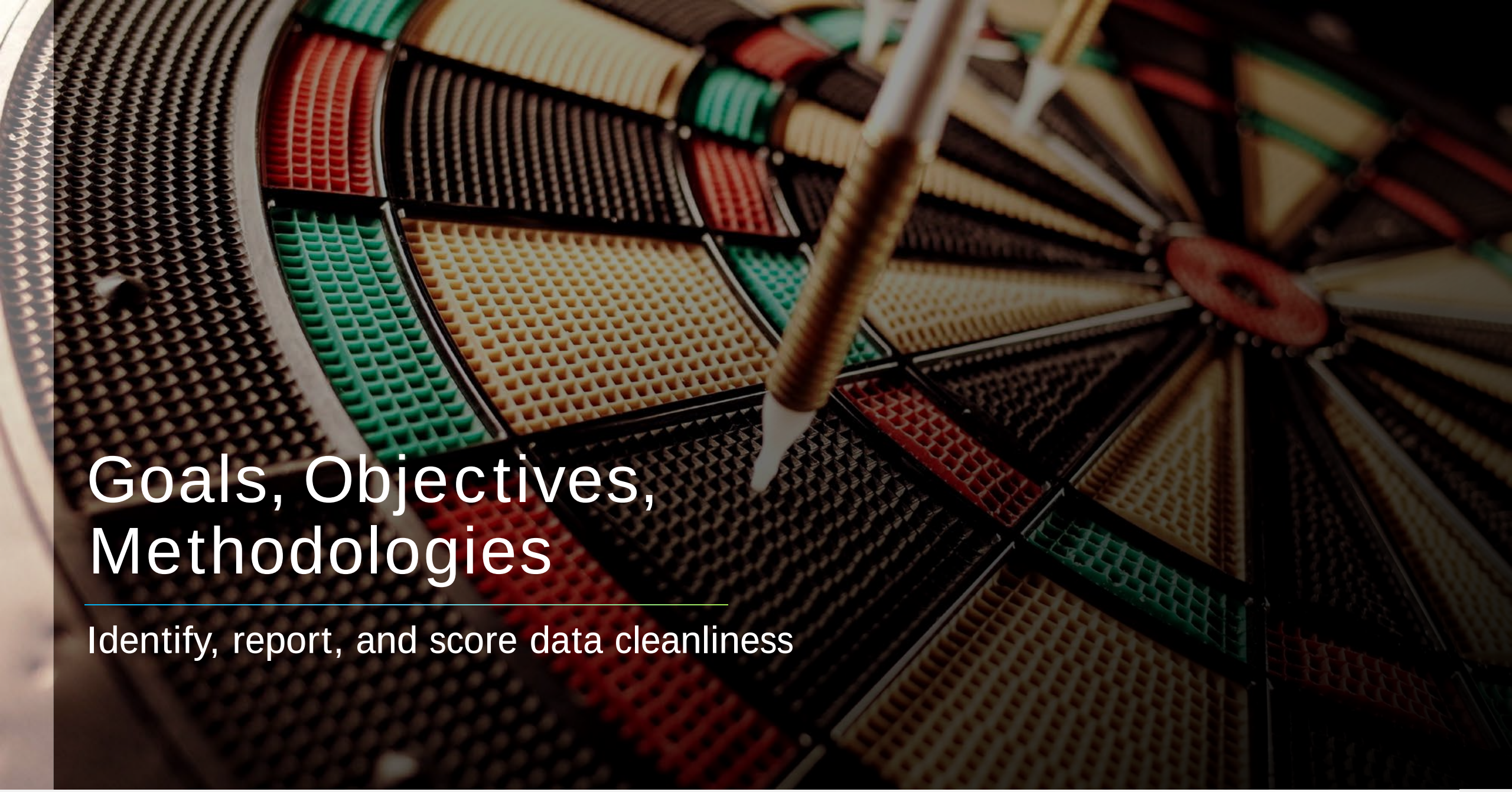
Set inputs for specified fields

### Data Reviewer

Semi-automated data review to identify errors and issues

### Attribute Assistant

Aids users in data entry based on intersecting features



# Goals, Objectives, Methodologies

Identify, report, and score data cleanliness

# Identify Known Issues

- Naming conventions
- Field name truncation
- Alias utilization
- Field attribute policies
  - NULL vs blank or 0
  - Empty data
  - Domain likeness, duplication, use
  - Field type vs data entered
- Metadata

- Bad/illegal characters
- Leading and ending spaces
- Double (or more) spaces
- Mixed coordinate systems
- Reserved words
- Hosted feature last edits
- Published feature metadata
  - Naming, summary, description, terms of use, tags, credits

**Your input needed!**

- Don’t see an issue you deal with on this list?
- Let me know about it!

# Determine Solutions for Reporting Known Issues

## Conceptual Solution Examples

### Reserved Words

- Using python and arcpy to compare a list of field names to the list of reserved words
- Using a looped if-then statement to flag uses of any reserved words

### Naming Conventions

- Types of cases…
  - flatcase
    UPPERFLATCASE
    lowerCamelCase
    UpperCamelCase
    snake_case
    SCREAMING_SNAKE_CASE
    Camel_Snake_Case
- Using python, regex, arcpy, and machine learning to identify whether the naming convention matches the user-selected convention

### Mixed Coordinate Systems

- Using python and arcpy to describe the spatialReference property and flag datasets that don't match the user-selected coordinate system

# Scoring Cleanliness, Summary Report and Appendix

## Flag and report the issues

- The tool will flag all known issues based on what the user wanted to run
- A summary report template will be filled in with the appropriate data about the issues observed

## Scoring cleanliness of data

- Using the reported issues, score the cleanliness of data
- Not yet determined formula for weighting and scoring issues, errors, and inconsistencies

## Provide appendix of issues

- To aid the user, an appendix of all issues will be generated
- The appendix will include feature dataset, feature, field name, and OID, grouped by issue

# Anticipated Results

What will work? What won't?

Unique Solutions for Unique Issues

Simple Solutions

- Reserved Word List Compare

Complex Solutions

- Naming Conventions

Philosophical Choice

- NULL vs Blank

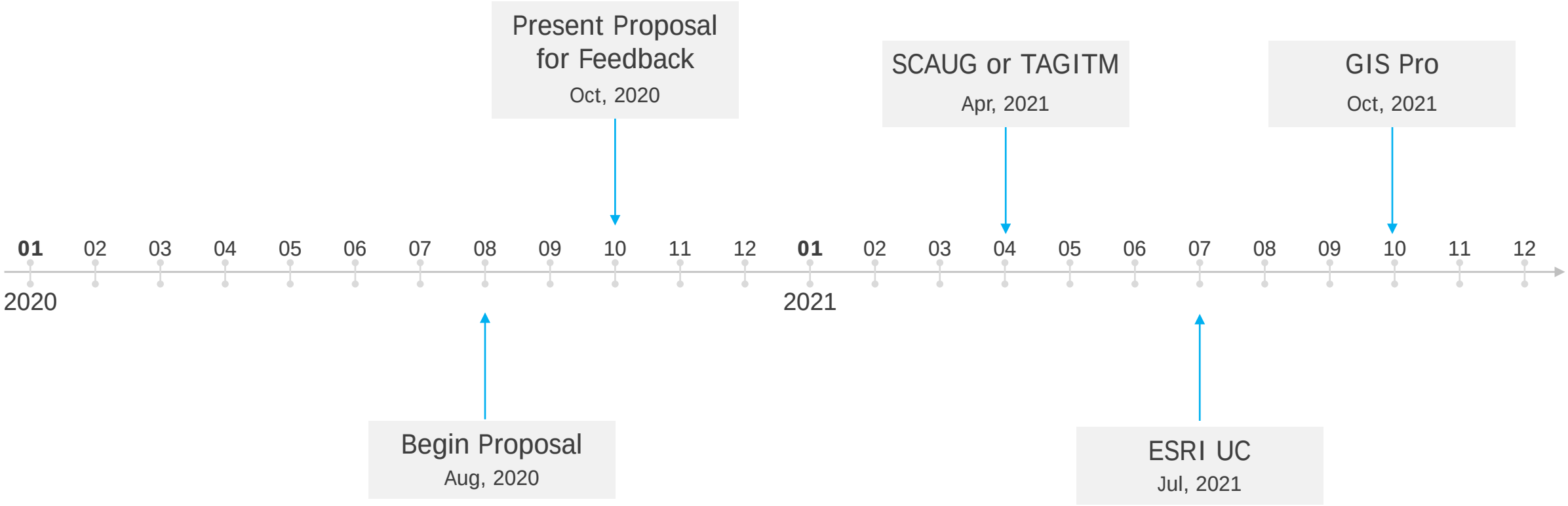
Data Cleanliness Score Formula

# Timeline

Project completion and presentation

# Timeline

From starting proposal to potential presentation venues



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# Questions?

# Thank You

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