Contents

Organization, Information, and Learning Sciences (OILS) 515 Goals, Objectives and Reading Assignments

An understanding of core spatial data concepts and principles is increasingly important in the current world of collaborative, spatially enabled research and applications. We are no longer working in a vacuum as individual researchers that only need to understand and use the data that we create and use in our separate research projects. Successful research depends upon being able to integrate data generated by others with our own and by extension being able to share our data with others, both during our research projects and also for posterity (and to meet the requirements of funding agencies). This class will focus on the following aspects of spatial data management that relate to this need for effective integration, use, collaboration and sharing:

- The *Research* and *Data Lifecycles*
- Types of spatial data
- Spatial database design and management
- Working with and managing gridded data
- Spatial data documentation standards and practices
- Ethical, legal and privacy issues as they relate to spatial data
- Data management planning
- Emerging topics

Upon completion of the course students will have improved their knowledge and skills in the following areas:

- Locating and evaluating spatial data based upon knowledge of formats, content models and documentation standards
- Structuring data (both in terms of format selection and content) from a variety of sources to enable integrated research
- Evaluate data products to determine which elements of a dataset might raise ethical, legal or privacy issues if released or shared with others

- Documenting data as an ongoing process throughout the research cycle
- Producing machine- and human-readable documentation for data to support discovery, understanding, and use of data that they produce

Week 1 - Introductions, Course Overview and Introduction to the Research and Data Lifecycles

This week's required "collaboratory" session (Tuesday afternoon, 5:00-6:30 - method TBA) will allow us to share some background about each other, review the class structure and objectives and have a brief overview of the research and data lifecycles and the linkages beween them. While this week's lecture will be done "live" during our collaboratory session, future lectures will be pre-recorded and accessible at the beginning of each class week.

Reading

Piwowar, Heather A., Roger S. Day, and Douglas B. Fridsma. 2007 "Sharing Detailed Research Data Is Associated with Increased Citation Rate." Plos One 2, no. 3: Science Citation Index, EBSCOhost (accessed January 20, 2014). link

Tenopir, Carol, Suzie Allard, Kimberly Douglass, Arsev Umur Aydinoglu, Lei Wu, Eleanor Read, Maribeth Manoff, and Mike Frame. 2011. "Data Sharing by Scientists: Practices and Perceptions." *Plos ONE* 6, no. 6: 1-21. Academic Search Complete, EBSCOhost (accessed January 19, 2014). link

Week 2 - Introduction to Vector Data

Background

This week we begin our consideration of the different classes of geospatial data that you are likely to encounter - both as you search for data to use in your research and as you produce data with a spatial component that you need to integrate into a spatial data management system or workflow. Our focus is on *vector* datasets this week, with a particular emphasis on the general types of vector data *features* you need to be aware of, and the key linkage between vector *geometries* and the *attributes* that are linked to those features. While the introductory lecture focuses on these aspects of vector datasets, the concepts of *map projections* or *coordinate reference systems* as introduced in the reading are also core concepts that you will need to understand in the context of all spatial data that you work with. Next week's lecture will include a more detailed overview of map projections (and focus on raster data), but for now see what you can also pick up from the reading as it blends both vector and raster data and map projections into a single chapter.

Expected Outcomes

By the end of this week's reading and work you should have an understanding of:

- The types of geometries that are likely to be encountered when working with vector data
- The concept of attributes and attribute types as they are linked to features
- The beginning of an understanding of how you can transform tabular data that may have implicit spatial content into explicitly spatial data
- The importance of map projections in clearly understanding the spatial context for coordinates and geometries based upon those coordinates.

Key Concepts

- Vector Feature Types: *point*, *line*, *polygon*
- Attributes and associated attribute data types
- Map projections

Readings

Westra, E. (2010). Python Geospatial Development : Build a Complete and Sophisticated Mapping Application From Scratch Using Python Tools for GIS Development. Olton, Birmingham: Packt Publishing. (link for access page for downloadable eBook - expires) (link for access page for online eBook). *Chapter 2* and skim *Chapter 1*.

Nikos Mamoulis (2012), Spatial Data Management. Synthesis Lectures on Data Management #21. Morgan & Claypool Publishers. DOI10.2200/S00394ED1V01Y201111DTM021. http://libproxy.unm.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat00503a&AN=unm.b7199537&site=eds-live&scope=site. Review the *Introduction*, keeping in mind that some of the database related issues will come up in a few weeks - so, don't be worried if some of the database terminology is confusing during this initial read through.

Galati, S. R. (2006). Geographic Information Systems Demystified. Boston: Artech House. Link for access to the online and downloadable eBook. Skim *Chapters 1 & 3*

Assignment

Link to this week's assignment

Class Project

Link to this week's task related to the class project

Week 3 - Introduction to Raster Data and Other Related Geospatial Data Concepts

Background

This week we will conclude our overview of geospatial data types and cover some additional core geospatial data concepts that you need to be familiar with as you work with geospatial data in your own research. Beginning with a discussion of *raster* data types, an introduction to the *geodatabase* concept (to be much expanded upon in the coming weeks) our overview of different classes of geospatial data is now complete. This week's lecture also includes a discussion of the key role of *coordinate reference systems* (AKA map projections) in understanding the map coordinates represented in geospatial data, the importance of the consideration of *accuracy and precision* in geospatial (and other) data, and the relationship between accuracy and precision and the concept of map scale.

Expected Outcomes

After reviewing this week's lecture and completing the reading, you should understand the following concepts:

- Raster, vector and tabular data and their respective characteristics in spatial data management

- The importance of coordinate reference systems, and the specific purposes for which they are defined, in characterizing locations encoded in spatial data
- The concepts of accuracy and precision in location data and some of the factors that can contribute to decreased accuracy (bias) in location data.

Key Concepts

- Spatial data types
- Map projects and the tradeoffs in defining them
- Accuracy and precision in location data

Reading

Review the readings from last week as they relate to the raster data and other data concepts that will be covered in this week's lecture and demonstration.

NationalAtlas.gov. *Map Projections: From Spherical Earth to Flat Map.* Online resource: http://nationalatlas.gov/articles/mapping/a_projections.html. Accessed on 2/2/2014.

Quantum GIS (QGIS) Documentation:

- A gentle introduction to GIS
- User's Guide (skim for reference and familiarity with content and organization)

Assignment

Continue your work on the literature review that you began last week.

Class Project

Continue your work on defining your data management focus for the term

Data Links

Here are the links to the datasets that were used in this week's QGIS demonstration:

- http://kkb-classes.s3.amazonaws.com/2014/OILS515/data/bernalillo_tm2011_img.zip
- http://kkb-classes.s3.amazonaws.com/2014/OILS515/data/gnis_nm_all09.zip
- http://kkb-classes.s3.amazonaws.com/2014/OILS515/data/hyp2shp_shp.zip
- http://kkb-classes.s3.amazonaws.com/2014/OILS515/data/NM_Features_20130811.zip
- http://kkb-classes.s3.amazonaws.com/2014/OILS515/data/nm60mdem.zip
- http://kkb-classes.s3.amazonaws.com/2014/OILS515/data/tl_2010_35_state10_shp.zip
- http://kkb-classes.s3.amazonaws.com/2014/OILS515/data/tl_2010_35_zcta510_shp.zip

Week 4 - Database Design I

Background

This week we begin our consideration of database design, beginning with the basic terminology, concepts and types of databases that have been developed to date. We will have a short in-class presentation during this week's collaboratory session relating to the considerations you want to keep in mind when starting the process of *modeling* your data to meet a specific analytic and management goal.

Expected Outcomes and Key Concepts

After completing this week's reading and participating in the collaboratory you should understand the following concepts:

- What the *relational database model* is
- What *Structured Query Language (SQL)* is
- What the *Objectives* and *Benefits* of good database design are
- What the distinction is between *data* and *information*
- What *null* values are and why consideration of nulls is important in your database design
- What *tables*,*rows*, *fields* and*views* are when designing a database
- What *Primary* and *Foreign* keys are in a database
- What *one-to_one*, *one-to-many* and *many-to-many* relationships are within a database
- What *data integrity* is and why you must design your database to maintain it

Reading

This week's readings in *Database Design for Mere Mortals* cover the basic concepts of database terminology, leading into the design process as you consider the "model" for your data. Both editions are on 1-day reserve at the Centennial Science and Engineering Library.

Michael J. Hernandez (2003). Database Design for Mere Mortals: a Hands-on Guide to Relational Database Design. 2nd ed. Addison-Wesley. *Chapters 1-3*

or

Michael J. Hernandez (2013). Database Design for Mere Mortals: a Hands-on Guide to Relational Database Design. 3rd ed. Addison-Wesley. *Chapters 1-3*

As some technical background for the database platform that underlies the geodatabase (SpatiaLite) we will be working with as part of this class, skimming the following materials will be helpful.

Grant Allen and Mike Owens (2010). *The Definitive Guide to SQLite*. 2nd ed. Apress. http://www.books24x7.com.libproxy.unm.edu/marc.asp?bookid=37960 (you will need to create an account with Books 24x7 to access this digital resource). *Chapters 1-3* - skim 2, the installation process of SQLite is taken care of through the SpatiaLite installation process you perform.

and, as a beginning of our Python thread for the class, I recommend the following two iPython notebooks (an emerging technology that enables the development, execution and sharing of Python code through a web interface - http://ipython.org/notebook.html - both run on your local computer, but also potentially hosted on other systems, such as Wakari) developed by J.R. Johansson (robert@riken.jp) http://dml.riken.jp/~rob/:

Lecture 0 - Scientific Computing with Python

Lecture 1 - Introduction to Python Programming

Assignment

Please be prepared to give an ~10-minute presentation to the class over our Google Hangout during the Collaboratory Session this week on Tuesday from 5:00-6:30 pm. The presentation should address the requested information in the assignment for each of the items you addressed in your literature review:

Complete Citation A complete citation that would allow another researcher to locate the publication that you used. If available, provide the DOI (Digital Object Identifier) and online link for the publication.

Summary A brief summary of the publication's focus and conclusions.

Relevance A discussion of the relevance of the publication's findings to your interest in spatial data management in your research area/project.

Please post your writeup as a new "Thread" in the class's "Literature Review Results" discussion forum in Learn.

Class Project

Please continue your work in defining your data management focus for the term. Please schedule a time for us to "meet" to discuss your thoughts on this before 2/19 so we can make sure you are on track to be able to begin defining the specific datasets that you will be producing and documenting as part of your term project.

Week 5 - Database Design II

Background

This week you will be digging deeper into the concepts that you began working with last week in the context of relational database design.

Expected Outcomes and Key Concepts

Similar to last week, just in more detail as the readings for this week go into much more depth relating to these concepts.

Reading

Michael J. Hernandez (2003). Database Design for Mere Mortals: a Hands-on Guide to Relational Database Design. 2nd ed. Addison-Wesley. *Chapters 4, 5 (skim as you are most likely both the interviewer and interviewee in the context data that you are creating yourself), 6 & 7*

or

Michael J. Hernandez (2013). Database Design for Mere Mortals: a Hands-on Guide to Relational Database Design. 3rd ed. Addison-Wesley. *Chapters 4, 5 (skim as you are most likely both the interviewer and interviewee in the context data that you are creating yourself), 6 & 7*

Continuing the technical background for creating and adding data to SQLite (the database upon which SpatiaLite is based)

Grant Allen and Mike Owens (2010). *The Definitive Guide to SQLite*. 2nd ed. Apress. http://www.books24x7.com.libproxy.unm.edu/marc.asp?bookid=37960 (you will need to create an account with Books 24x7 to access this digital resource). *Chapter 4*

Also, related to data resources,

Westra, E. (2010). Python Geospatial Development : Build a Complete and Sophisticated Mapping Application From Scratch Using Python Tools for GIS Development. Olton, Birmingham: Packt Publishing. (link for access page for downloadable eBook - expires) (link for access page for online eBook). *Chapter 4*.

Assignment

Start working on the assignment to locate and describe data and review for documentation, usability and understanding.

Week 6 - Geodatabase Design

Background

This week we introduce the concepts related to the integration of geospatial data into relational database systems. This integration includes both the introduction of new data types into the database (i.e. the `geometry` data type), specialized indices that are optimized for working with those data, and additional functions that extend the SQL foundation of these databases to support additional query types that are explicitly spatial.

Expected Outcomes and Key Concepts

At the end of this section of the course, you should understand the following:

- The model for expanding standard relational databases to include support for geometries and their associated attributes
- The range of specialized spatial queries that can be used within a geospatially enabled database

Reading

For a more "cookbook" style presentation of the processes of working with SpatiaLite, check out:

The SpatiaLite Cookbook

For an overview of geospatially enabled databases and a description of the capabilities of three geodatabases, including SpatiaLite.

Westra, E. (2010). Python Geospatial Development : Build a Complete and Sophisticated Mapping Application From Scratch Using Python Tools for GIS Development. Olton, Birmingham: Packt Publishing. (link for access page for downloadable eBook - expires) (link for access page for online eBook). *Chapter 6*.

Finally, for a higher-level overview of some issues related to the development and performance of geodatabases:

Nikos Mamoulis (2012), Spatial Data Management. Synthesis Lectures on Data Management #21. Morgan & Claypool Publishers. DOI10.2200/S00394ED1V01Y201111DTM021. http://libproxy.unm.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cat00503a&AN=unm.b7199537&site=eds-live&scope=site. Review the *Chapter 2*.

Assignment

Continue working on data review assignment

Week 7 - Managing Raster Data

Background

Much of our focus thus far has been on database development, and concepts related to the management of data that link most directly into the vector data model - geometries and their associated attributes. This week we will concentrate on the characteristics of raster data, and highlight some tools and strategies for creating and managing raster data products.

Expected Outcomes and Key Concepts

Following this week's work you should understand the following:

- The circumstances in which you might use a raster as opposed to vector data model for you data
- The concept of spatial resolution as it relates to raster data
- Some of the processing and analysis functions that may be applied to raster data
- The basic functionality of the GDAL utilities for characterizing and transforming raster datasets.

Reading

"Raster" in the Encyclopedia of Geographic Information Science

Revisit the Quantum GIS User Guide - particularly the section on Raster Data.

Review the documentation for the GDAL Utilities, particularly

- `gdalinfo`
- `gdal_translate`
- `gdalwarp`

as these utilities based upon the GDAL library for processing Raster datasets provide very useful tools for interrogating and transforming raster data. For complementary capabilities for vector datasets, review the documentation for the OGR-related utilities:

- `ogrinfo`
- `ogr2ogr`

All of these GDAL and OGR utilities are included as part of the installation process of QGIS on your computer, and are accessible through the OSGEO4W shell in Windows, or from the terminal under the Mac OS.

Westra, E. (2010). Python Geospatial Development : Build a Complete and Sophisticated Mapping Application From Scratch Using Python Tools for GIS Development. Olton, Birmingham: Packt Publishing. (link for access page for downloadable eBook - expires) (link for access page for online eBook). *Chapter 3*. With a particular focus on the discussion around GDAL and OGR as both of these libraries provide powerful capabilities for working with raster and vector data, both outside of and within Python.

Assignment

Continue working on data review assignment

Week 8 - Data Formats for Analysis and Archiving

Background

Thus far we have concentrated on data formats in general as they relate to the storage and use of different types of geospatial data. This week, we consider a set of considerations that relate to the long-term archival storage, access and use of geospatial data. Specifically, this week's reading and discussion in this week's collaboratory focus on the diversity of geospatial data formats, with a particular emphasis on the characteristics of those formats that make them good (or not good) candidates for use when transitioning geospatial data into a long-term archive.

Expected Outcomes and Key Concepts

Following this week's work you should understand the following:

- The factors that influence the utility of various digital geospatial formats for archival use
- The particular characteristics of digital geospatial formats that relate to their usability in geospatial analysis and visualization work
- The capabilities of key digital geospatial formats relative to these factors and characteristics

Reading

Sustainability of Digital Formats - Planning for Library of Congress Collections. Link

- Quality and functional factors
- Introduction to Geospatial Resources and Formats
- Format description documents

The National Geospatial Digital Archive Project documents. Link, Especially:

- The NGCA Final report
- The Report to National Geospatial Digital Archive Regarding Geospatial Data Treatment in Data Format Registry Efforts

Assignment

Present results of data review assignment in required collaboratory session

Class Project

Enumerate the specific datasets that you will create and document as part of your class project

Week 9 - Spring Break

Week 10 - Documenting Data - The Interview

Background

When approaching the problem of documenting data during analysis, for sharing with collaborators, and for long-term sharing and access through an archive, multiple dimensions of information and structure must be considered. The readings introduced this week (and continuing for the next several weeks) cover the diverse issues, challenges and initiatives related to metadata creation and data curation. Whether you are working with others in support of metadata creation, or are creating you own metadata, the process of metadata development can be conceptualized in terms of an interview - with you playing either the role of the interviewer or interviewee. In the context of the metadata development interview, the following questions should be asked and answered:

- Data content and structure
  - What do the data represent (measurements/observations)
  - How are they structured (i.e. format)
  - What are the accuracy and precision of the data
- Context
  - Where, when and how were the data collected
  - What processing steps were followed in the production of the data
  - Who was responsible for data collection and how may they be contacted
  - What is the research domain for which the data were collected
  - For what purpose were the data collected/produced
  - Are the data part of a larger collection (e.g. an ongoing series of measurements or a set of otherwise related data products)
- Related Standards, Practices and Resources
  - Are there existing archives that specialize in the preservation of the data
  - Are there existing documentation standards that are commonly used by those archives or the research domain to which the data pertain
  - What data citation standards are practiced within the specific research domain - what information is required to support those data citation standards
  - How do the data products align with the norms, protocols or standards for integration into the target archive(s)

Reading (for weeks 10-13)

Kervin, Karina, William Michener, Robert Cook (2013). "Common Errors in Ecological Data Sharing". *Journal of eScience Librarianship.* Vol. 2, Issue 2. http://escholarship.umassmed.edu/jeslib/vol2/iss2/1/

DCC Curation Reference Manual - *Appraisal and Selection* chapter. http://www.dcc.ac.uk/resources/curation-reference-manual/completed-chapters/appraisal-and-selection

DCC Curation Reference Manual - *Metadata* chapter. http://www.dcc.ac.uk/resources/curation-reference-manual/completed-chapters/metadata

DCC Curation Reference Manual - *Preservation Metadata* chapter. http://www.dcc.ac.uk/resources/curation-reference-manual/completed-chapters/preservation-metadata

DCC Curation Reference manual - *Preservation Scenarios for Projects Producing Digital Resources* http://www.dcc.ac.uk/resources/curation-reference-manual/completed-chapters/preservation-scenarios-dh

DCC Curation Reference Manual - *Scientific Metadata* chapter. http://www.dcc.ac.uk/resources/curation-reference-manual/chapters-production/scientific-metadata

Class Project

Begin creating class project datasets

Week 11 - XML Document Creation, editing and validation

Background

The World Wide Web Consortium's (W3C) specification of the `Extensible Markup Language` (XML) has become the common standard format for many documentation (metadata) standards. As a machine readable (and validatable) data format that is also *somewhat* human-readable, XML is a core technology in the exchange of structured data in a platform-independent, standards-based format. The XML standard defines both core *structural* requirements that any XML file must meet to be considered *well-formed* XML, and provides for extensibility and validation using either *document type definition* or *schema* definitions. This extensibility allows for the definition of application-specific XML data content models that may be validated both in terms of structure and content, using a variety of XML *validation* technologies. Before embarking on the creation of XML-based spatial metadata over the next two weeks, we must first become familiar with the basics of the XML specification - that is the goal of this week's work.

Expected Outcomes and Key Concepts

Following this week's work you should understand the following

- XML is a standard upon which structured data may be exchanged between computer systems
- XML may be created using any standard text editor, but specialized editors make this process easier
- XML may (and should) be validated, both for consistency with the XML structural requirements (well-formed) and with any defined content specification (valid as defined by a DTD or Schema)

Reading

Continue metadata readings from Week 11.

View the *XML Essential Training* Course on Lynda.com: http://www.lynda.com/XML-tutorials/XML-Essential-Training/145930-2.html?org=unm.edu

Class Project

Continue creating class project datasets

Note on Software

This week you may want to consider downloading an XML editor (such as Aptana Studio as used in the Lynda.com tutorial, or Oxygen for which I can provide you with a Student License) as an alternative to creating your XML documents in a standard OS-provided text editor such as `notepad` (Windows) or a freely downloadable text editor such as `notepad++` (download link for Windows) or `textwrangler` (download link for Mac).

Week 12 - Metadata Standards - FGDC

Background

Following our introduction to general metadata concepts and principles two weeks ago, and the overview of XML technologies last week, we are now ready to begin our consideration of specific metadata standards that are relevant to the documentation of geospatial data products. This week we focus on the Federal

Geospatial Data Committee's *Content Standard for Digital Geospatial Metadata* (CSDGM), the continuing but aging US Federal geospatial metadata standard. While it is slowly being replaced by the ISO 19115-2 and related standards (our focus for next week), there remain a large number of FGDC metadata records and tools "in the wild", and because of this remains very relevant when considering metadata standards related to geospatial data.

Expected Outcomes and Key Concepts

Following this week's work students should understand the following:

- The basic structural and content model for FGDC metadata

Reading

FGDC Geospatial Metadata Standards web page and related materials. This page is an access point for both the FGDC CSDGM and other FGDC approved standards.

Graphical Representation of the FGDC CSDGM

FGDC (2000). *Content Standard for Digital Geospatial Metadata Workbook.* Version 2.0, May 1, 2000. http://www.fgdc.gov/metadata/documents/workbook_0501_bmk.pdf

Class Project

Begin creating documentation for class project datasets

Note on Software

When creating FGDC metadata your can use an online validation tool as a complement to local validation with your XML tool of choice.

Week 13 - Metadata Standards - ISO and Dublin Core

Background

The FGDC's CSDGM was an early structured metadata standard from which lessons have been learned, contributing to the thinking that has gone into the development of the family of geospatial metadata standards developed by the International Standards Organization's Technical Committee 211. Of specific relevance in the context of our work here are the ISO 19115, ISO 19115-2 and ISO 19139 standards for documenting geospatial data. While the actual standards must be purchased from ISO, a large amount of documentation has been developed by a number of organizations - particularly the National Oceanographic and Atmospheric Administration (a number of their resources are included in this week's reading). While a large number of FGDC metadata records exist as legacy products from many geospatial organizations, new metadata creation is probably best done in the context of the ISO standards as they provide a more structured and complete model for capturing more detailed information if it is available.

In contrast with the FGDC and ISO metadata standards that we have already discussed, Dublin Core is a more general documentation standard that is widely used in the library community and beyond. Dublin Core is a documentation standard that is based, in contrast to the XML-based FGDC and ISO standards, on the W3C's Resource Description Framework (RDF), the foundation for the emerging open linked data model for data integration across the web. RDF is explicitly built upon the construction of linkages between semantically linked information pieces that are defined in a way that allows for their reuse and integration, by reference, into knowledge about other resources (i.e. datasets, measurement types, units, people, objects, publications, etc.). While the FGDC and ISO standards include robust specifications for defining spatial references, Dublin Core's `coverage` property provides for only very basic geospatial reference information.

Expected Outcomes and Key Concepts

Following this week's work, the following concepts should be understood:

- The relationship between the FGDC and ISO geospatial metadata standards for documenting geospatial data
- The basic strategies for developing ISO metadata and the overall structural and content model for ISO metadata
- The distinction between the XML and RDF structural models for metadata
- The high-level content types for Dublin Core metadata

Reading

NOAA EDM ISO FAQ - this wiki page provides some useful points of information (particularly this one regarding getting started creating ISO metadata) about the ISO geospatial metadata standard and includes links to other helpful sites.

NOAA National Coastal Data Development Center Metadata standards page - particularly the linked reference materials for the

- ISO 19115:2003 Geographic Information - Metadata Workbook - scan for reference
- ISO 19115-2:2009 Geographic Information - Metadata - Part 2: Extensions for imagery and gridded data - scan for reference

FGDC Geospatial Metadata Standards page web page with basic information and associated links to related materials for the ISO and related standards in addition to the CSDGM.

The Dublin Core Users Guide describes the basic concepts behind the Dublin Core standard, its use of the W3C RDF Open Linked data model, and its role in the broader global system of metadata. Of specific interest in the context of geospatial metadata in the Dublin Core standard is the coverage property.

Assignment

Create a data management plan (start)

Notes on Software

ArcGIS ArcCatalog includes a basic editor for creating ISO metadata that can then be brought into a dedicated XML editor for completion or further editing. Information about the ISO standards and ESRI's support for them is available here.

Quantum GIS also has an experimental plugin called metatools that supports the import, viewing and editing of FGDC and ISO metadata. As an experimental plugin your mileage may vary.

Required Collaboratory Session

Data management planning Q&A

Week 14 - Data Management Planning

Background

TBA

Expected Outcomes and Key Concepts

TBA

Reading

TBA

Week 15 - Ethical, legal and privacy issues

Background

TBA

Expected Outcomes and Key Concepts

TBA

Reading

TBA

Assignment

Data management plan and Class project dataset and documentation peer review

Class Project

Share class project datasets and documentation with peers for review

Week 16 - Emerging Concepts

Background

TBA

Expected Outcomes and Key Concepts

TBA

Reading

TBA

Class Project

Present class project results and peer review outcome