SPATIAL DATA IN R

RACHEL KUZMICH
(not a developer)

Intro

About me

Before

- ➢ BSc in geography and biology at Trent University
- ➢ thesis on time series analysis of forest disturbances in the Alberta oil sands
- ➢ published papers about on too, and uav work for tree species discrimination

Now

- ➢ pursuing a MSc in geography at Queen’s University
- ➢ research project (and eventually thesis) on cerulean warbler habitat preferences using lidar and passive acoustic monitoring

About today’s talk

- ➢ what is gis and remote sensing
- ➢ spatial data types:
  - ○ raster, vector, las, tabular
- ➢ where spatial data comes from and how to find it
- ➢ time series example:
  - ○ analysis and visualization basics in R

GIS and remote sensing

GIS

- geographic information system/science
- antecedents: cartography, navigation, epidemiology
- grandfather of modern GIS is Roger Tomlinson
- storage, analysis, editing, display, sharing of geographic information
- makes location the primary variable
- can use a gis to make maps, but gis is not the same as cartography

Remote sensing

science of acquiring information about the surface of, or objects on, the earth (or another planet) without coming in direct contact with them

- antecedents: surveying, reconnaissance
- earthrise image (Apollo 8, 1968), blue marble image (Apollo 17, 1972)
- sensing and recording of reflected or emitted energy
- reliant on the electromagnetic spectrum (visible and non visible wavelengths)
- involves a sensor (i.e., consumer grade camera, single band, multispectral...) mounted on a platform (i.e., ground-based, uav, aircraft, satellite...)

Why use R?

- language and environment (1993)
- based on S (1976)
- open source
- free to run, share, modify
- versatile
- customization
- statistics
- integration with other languages (c, c++)
- extended capacity via a whole bunch of packages
- and a whole bunch of forums and communities
- download R: http://cran.utstat.utoronto.ca/
- download R Studio: https://www.rstudio.com/products/rstudio/download/

Spatial data

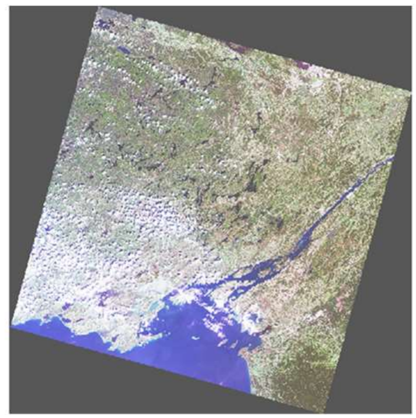
Spatial data standards

(geo)spatial data: data about geographic locations

- ➢ instrumentation calibration
- ➢ data collection
- ➢ naming
- ➢ reporting
- ➢ language
- ➢ sharing
- ➢ assessment
- ➢ metadata

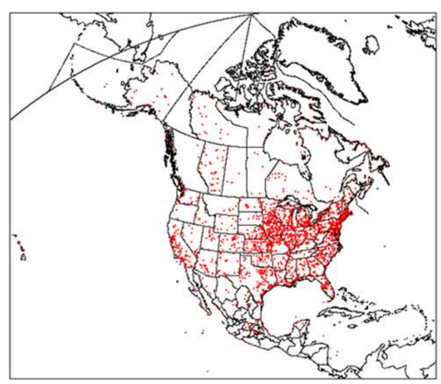
Raster

- ➢ matrix of cells
- ➢ fundamental units are pixels
- ➢ integer (discrete/categorical), floating point (continuous)
- ➢ pixel resolution related to real-world space
- ➢ in addition to location, each pixel has a single value of some attribute class



Vector

- ➢ vertices and paths
- ➢ points: one set of coordinates (x, y, and sometimes z too)
- ➢ lines: connected ordered sets of coordinates
- ➢ polygons: closed line, first and final coordinates are the same
- ➢ organized as shapefile representing a single feature class with different attributes



LAS

- collected using lidar (aka als)
- involves a platform, laser scanner system, GPS, INS
- measures time it takes for pulse return after interacting with surface/object
- output is dense three dimensional spatially explicit point cloud
- each point has x, y, z coordinates and intensity values

Tabular

- often as attributes joined to other data
- sometimes standalone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20800394	URN:catalog:BSC-EOC:OBBA2BE_SUMM:15UP89-ABDU	2008-05-14 17:18:40.157000000	Observation	BSC-EOC OBBA2BE_SUMM	15UP89-ABDU	Anas rubripes	AnimaliaChorda
est Coordinates of the 10x10km square	OBBA2	Breeding Bird Atlas	BBATLAS Breeding birds	NORAC, 2006	http://www.bsc-eoc.org/norac/atlascont
AMGO	2008-05-14 17:18:40.157000000	Observation	BSC-EOC OBBA2BE_SUMM	15UP89-AMGO	Carduelis tristis	AnimaliaChordataAvesPasseriformesFringillidae	Animalia
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0	Observation	BSC-EOC OBBA2BE_SUMM	15UP89-AMRO	Turdus migratorius	AnimaliaChordataAvesPasseriformesTurdidae	Animalia	Chordata	Aves	Passer
rds	NORAC, 2006	http://www.bsc-eoc.org/norac/atlascont.htm	15UP89	10000	SQUARE	10000	10000	0	15UP89	15UP89
ula	AnimaliaChordataAvesPasseriformesIcteridae	Animalia	Chordata	Aves	Passeriformes	Icteridae	Icterus galbula
scont.htm	15UP89	10000	SQUARE	10000	10000	0	15UP89	15UP89	49.883	hours
culidae Animalia	Chordata	Aves	Cuculiformes	Cuculidae	Coccyzus	erythropthalmus	North America
0	0	15UP89	15UP89	49.883	hours
iformes Alcedinidae	Ceryle	alcyon	North America	Canada	Ontario
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9	URN:catalog:BSC-EOC:OBBA2BE_SUMM:15UP89-BRTH	2008-05-14 17:18:40.157000000	Observation	BSC-EOC OBBA2BE_SUMM	15UP89-BRTH	Toxostoma rufum AnimaliaChordataAvesPa
Coordinates of the 10x10km square	OBBA2	Breeding Bird Atlas	BBATLAS Breeding birds	NORAC, 2006	http://www.bsc-eoc.org/norac/atlascont
8:40.157000000	Observation	BSC-EOC OBBA2BE_SUMM	15UP89-CAGO	Branta canadensis	AnimaliaChordataAvesAnseriformesAnatidae	Animalia	Chordata	Aves
BBATLAS Breeding birds	NORAC, 2006	http://www.bsc-eoc.org/norac/atlascont.htm	15UP89	10000	SQUARE	10000	10000	0	15UP89	15UP89
BA2BE_SUMM	15UP89-CHSP	Spizella passerina	AnimaliaChordataAvesPasseriformesEmberizidae	Animalia	Chordata	Aves	Passeriformes	Emberizidae	Spizel
006	http://www.bsc-eoc.org/norac/atlascont.htm	15UP89	10000	SQUARE	10000	10000	0	15UP89	15UP89
la clangula	AnimaliaChordataAvesAnseriformesAnatidae	Animalia	Chordata	Aves	Anseriformes	Anatidae	Bucephala	clangula
ac/atlascont.htm	15UP89	10000	SQUARE	10000	10000	0	15UP89	15UP89	49.883	hours
lgidae	Animalia	Chordata	Aves	Caprimulgiformes	Caprimulgidae	Chordeiles	minor	North America
10000	0	15UP89	15UP89	49.883	hours
olopacidae	Gallinago	gallinago	North America	Canada	Ontario
	1
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What should you use?

Depends on what you are trying to do, what's important, relevant and meaningful to your analysis, where you got your data from and its nature, and how hard you want to make your life.

Raster

- continuous phenomena
- categorical data

Vector

- discrete locations
- extents of spatial objects

LAS

- 3d environments
- surfaces

Assumptions, pros and cons

Raster

- data collected by remote sensing
- assumes the world is full, up to you to partition it
- display sensitive to resolution

Vector

- data collected by surveying
- assumes the world is empty, up to you to add elements
- simplification and data reduction

LAS

- data collected either by remote sensing or surveying
- assumes the world is 3d
- more point data than can be used

Spatial data sources

Spatial data sources

Conventional data collection

- typically done by (or with support from) government agencies

Crowdsourcing

- common in emergency situations, study of species occupying a wide area

“Volunteered geographic information”

- data collected through apps when you agree to the terms and conditions

Create your own

Accessing spatial data

Landsat satellite archive: earthexplorer.usgs.gov

Government

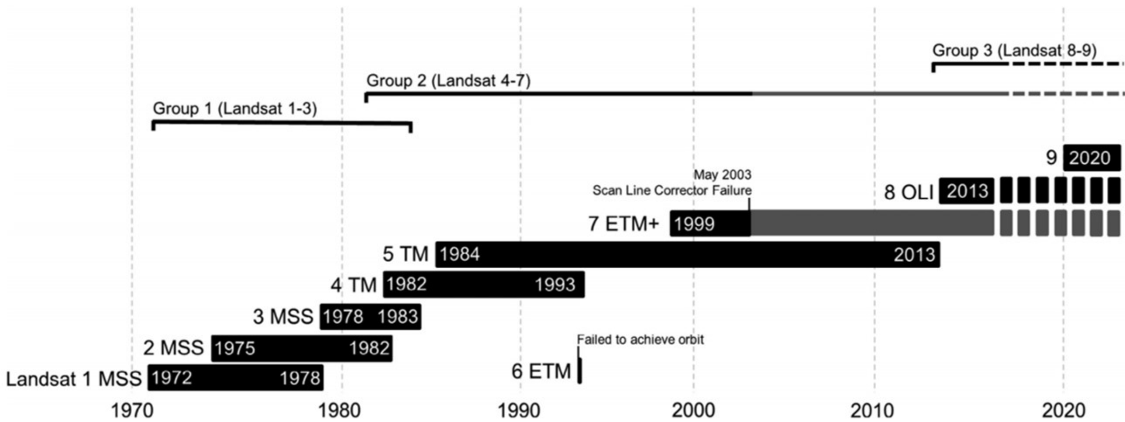
- ➢ Canada: open.canada.ca/data/en/dataset
- ➢ Ontario: ontario.ca/search/data-catalogue
- ➢ Kingston: cityofkingston.ca/explore/data-catalogue

Other places

- ➢ agencies, libraries and repositories: fao, un, cec, usgs, statscan, conservation authorities, land inventory ontario, scholars geoportal, esri
- ➢ private (paid): digital globe

Time series example

Background and context



Band	Name	Wavelength	Applications
1	Ultra blue	0.435 - 0.451	Coastal and aerosol studies
2	Blue	0.452 - 0.512	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
3	Green	0.533 - 0.590	Emphasizes peak vegetation, which is useful for assessing plant vigor
4	Red	0.636 - 0.673	Discriminates vegetation slopes
5	Near infrared	0.851 - 0.879	Emphasizes biomass content and shorelines
6	Shortwave infrared I	1.566 - 1.651	Discriminates moisture content of soil and vegetation; penetrates thin clouds
7	Shortwave infrared II	2.107 - 2.294	Improved moisture content of soil and vegetation and thin cloud penetration
8	Panchromatic	0.503 - 0.676	15 metre resolution, sharper image definition
9	Cirrus	1.363 - 1.384	Improved detection of cirrus cloud contamination
10	Thermal infrared I	10.60 - 11.19	100 metre resolution, thermal mapping and estimated soil moisture
11	Thermal infrared I	11.50 - 12.51	100 metre resolution, Improved thermal mapping and estimated soil moisture

Scene ID

LXSPPPRRRYYYYDDDGSIVV

L = Landsat
X = Sensor
S = Satellite
PPP = WRS path
RRR = WRS row
YYYY = Year
DDD = Julian day of year
GSI = Ground station identifier
VV = Archive version number

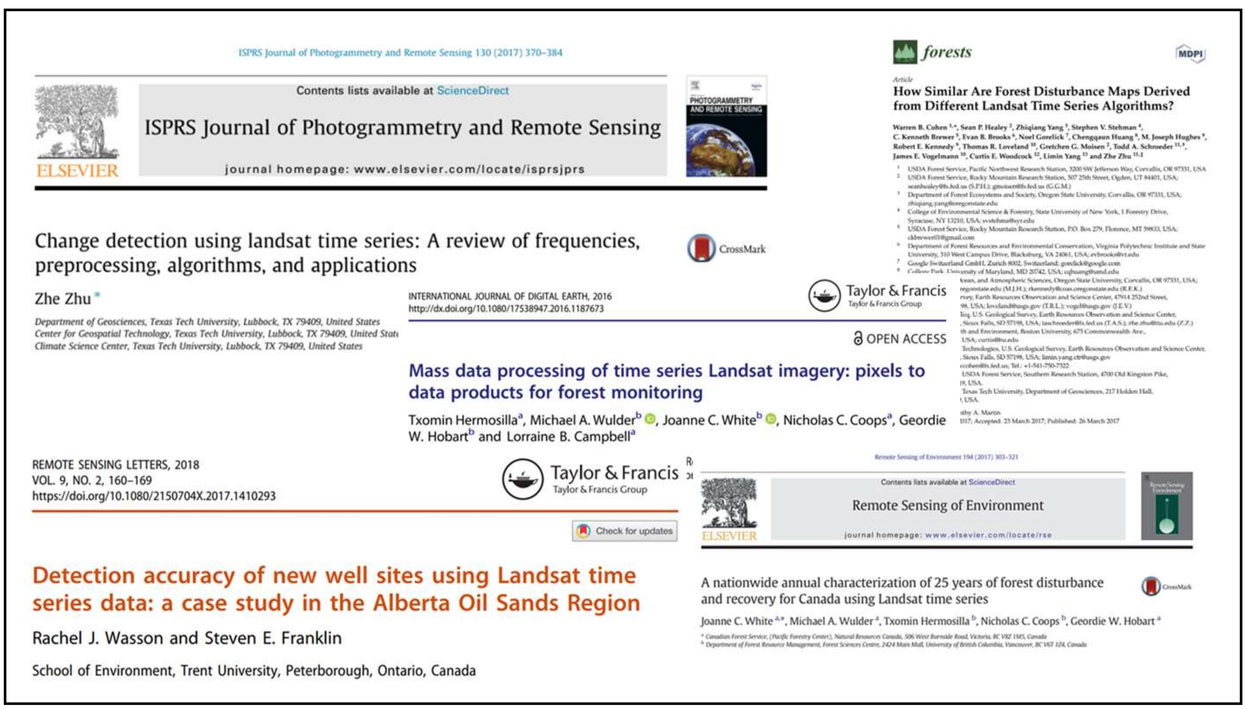
Examples:
LC80290302015343LGN00
LE70160392004262EDC02
LT40170361982320XXX08
LM10170391976031AAA01

Landsat Product Identifier

LXSS_LLLL_PPPRRR_YYYYMMDD_yyyymmdd_CC_TX

L = Landsat
X = Sensor (“C” = OLI/TIRS Combined, “O”= OLI-only, “T” = TIRS-only, “E” = ETM+, “T” = TM, “M”= MSS)
SS = Satellite (“07” = Landsat 7, “08” = Landsat 8)
LLLL = Processing correction level (“L1TP”: Precision Terrain, “L1GT”: Systematic Terrain, “L1GS”: Systematic)
PPP = WRS path
RRR = WRS row
YYYYMMDD = Acquisition year (YYYY) / Month (MM) / Day (DD)
yyyymmdd = Processing year (yyyy) / Month (mm) / Day (dd)
CC = Collection number (“01”,”02”)
TX = Collection category: ("RT" for Real-Time, “T1” for Tier 1 , or "T2" for Tier 2)

Examples:
LC08_L1GT_029030_20151209_20160131_01_RT
LE07_L1TP_016039_20040918_20160211_01_T1
LT04_L1GS_017036_19821115_20160315_01_T2
LM01_L1GS_017039_19760131_20160225_01_T2



Over to R....

Thanks dudes