OWP | OFFICE OF WATER PREDICTION

AGU Fall Meeting 2021

H54G-01

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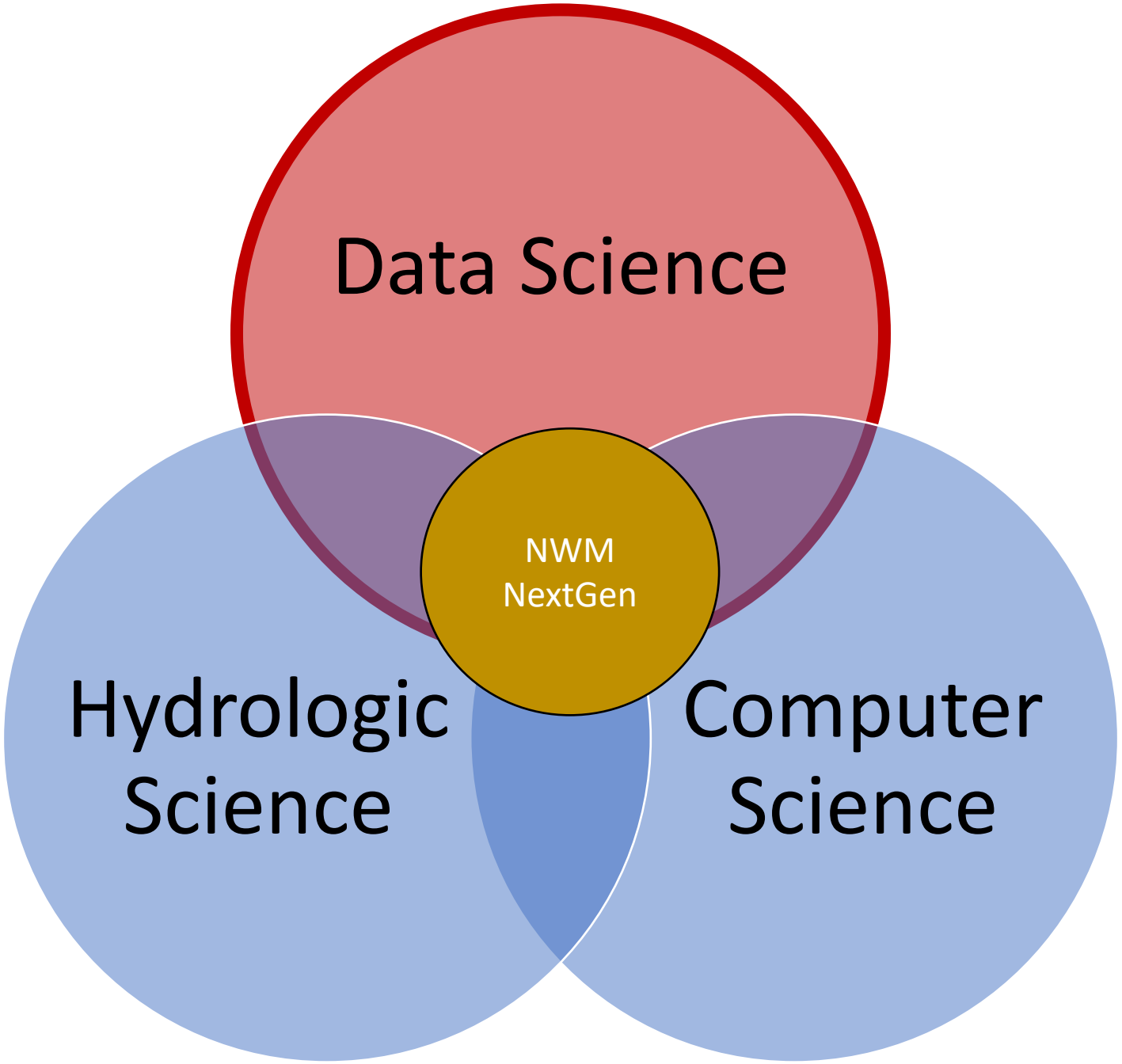
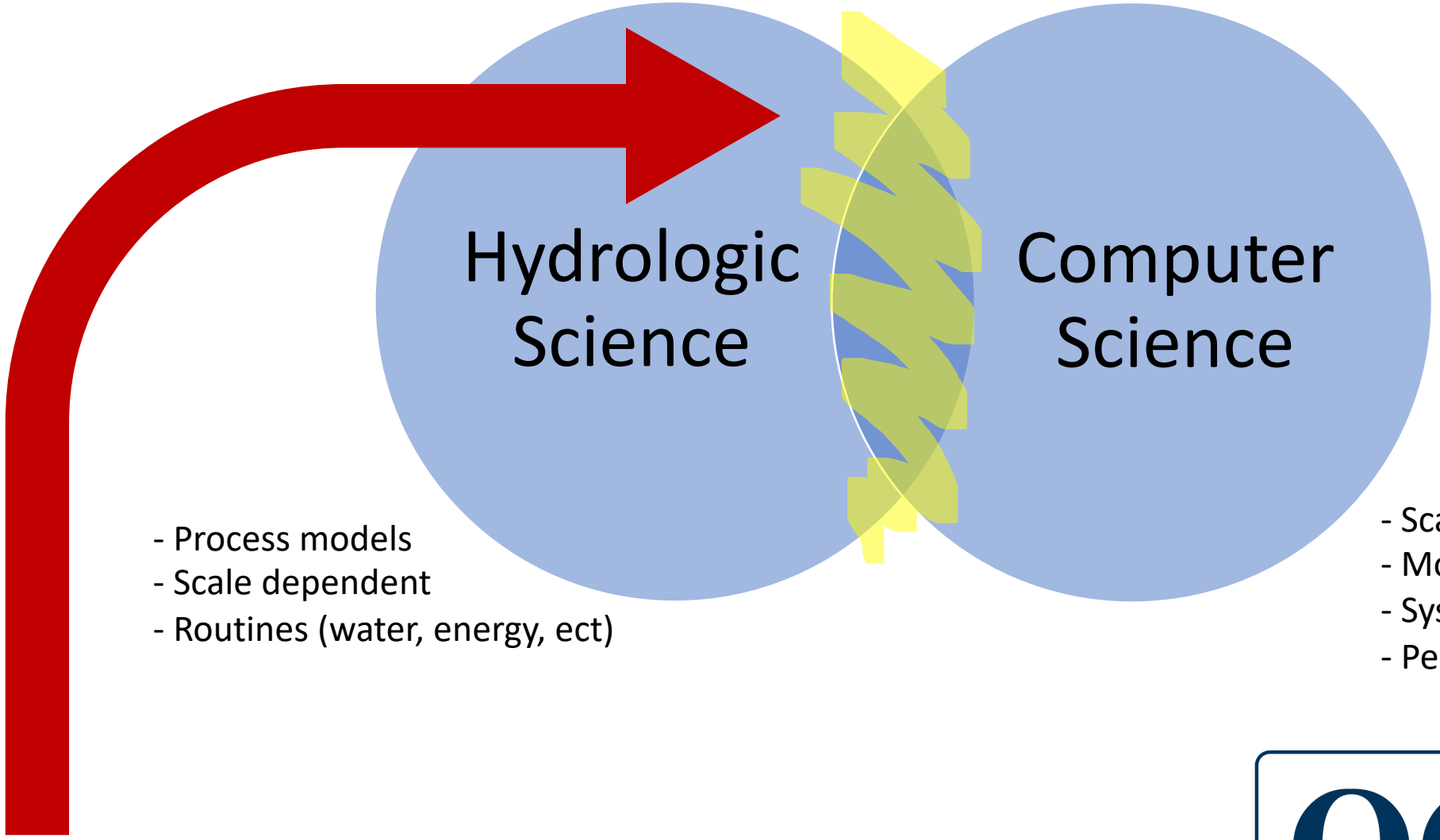
Hydrofabric Development for Next-Gen Framework Modelling

J Michael Johnson[1,2]

(1) Lynker Technologies (2) NOAA, National Water


Data Science
NWM
NextGen
Hydrologic
Science
Computer
Science



Hydrofabric: Spatially derived product that compiles with an open data *standard (HY_Features)* to let ***domain science*** become *machine interpertable*

https://docs.opengeospatial.org/is/14-111r6/14-111r6.html

OGC®
Making location count.

4.3. catchment

A physiographic unit where hydrologic processes take place. This class denotes a physiographic unit, which is defined by a hydrologically determined outlet to which all waters flow. While a catchment exists, it may or may not be clearly identified for repeated study.

4.21. flowpath (also flow path)

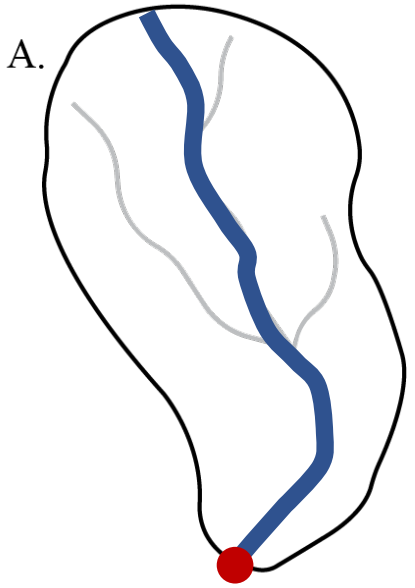
One-dimensional (linear) feature that is a hydrology-specific realization of the holistic catchment. Topologically, flowpath can be understood to be an edge bounded by inflow and outflow nodes, and associated with left-bank and right-bank sub-catchment faces. The concept of an edge bounded by nodes is described in detail in the ISO topology model [ISO19107]. The flowpath is usually represented as a geometric curve.

A catchment network can be represented as:

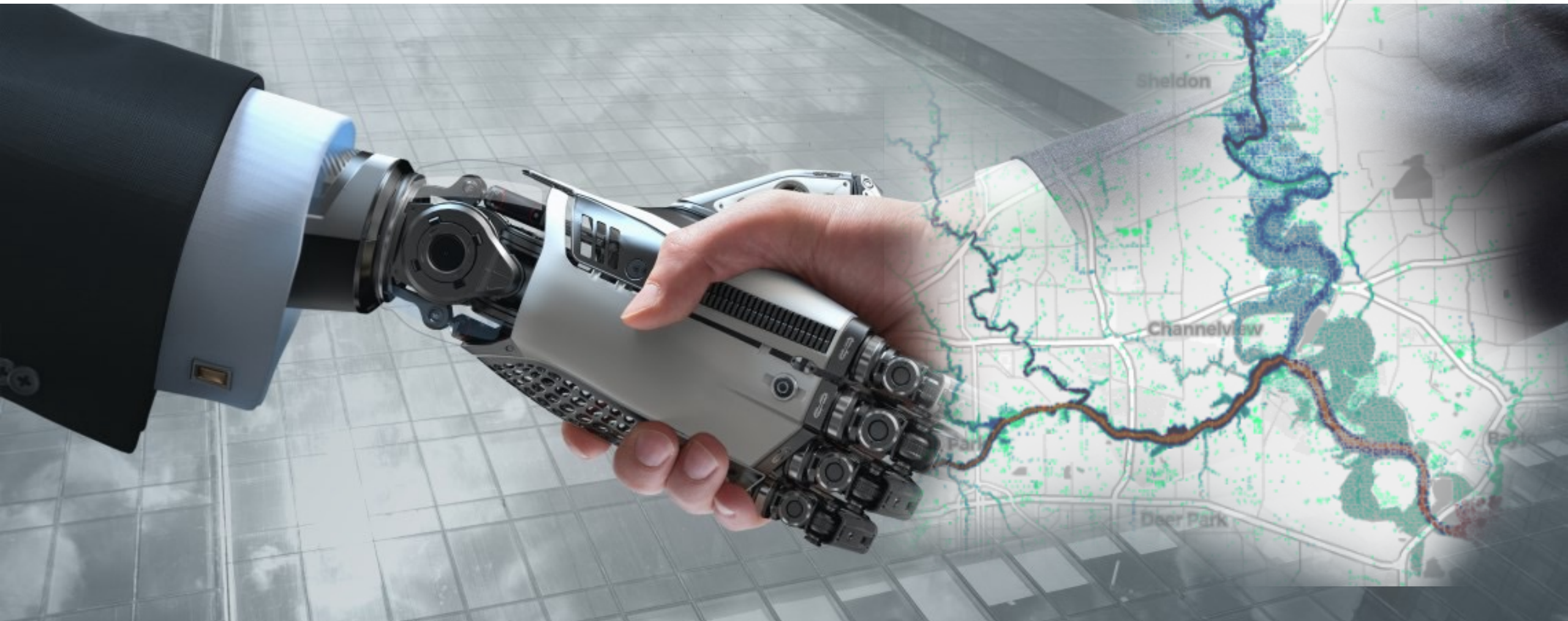
1. Spatial features
2. A graph of nodes and edges

But:

One catchment = One flowpath = One outlet (nexus)



Computer Scientists to engage with domain scientists

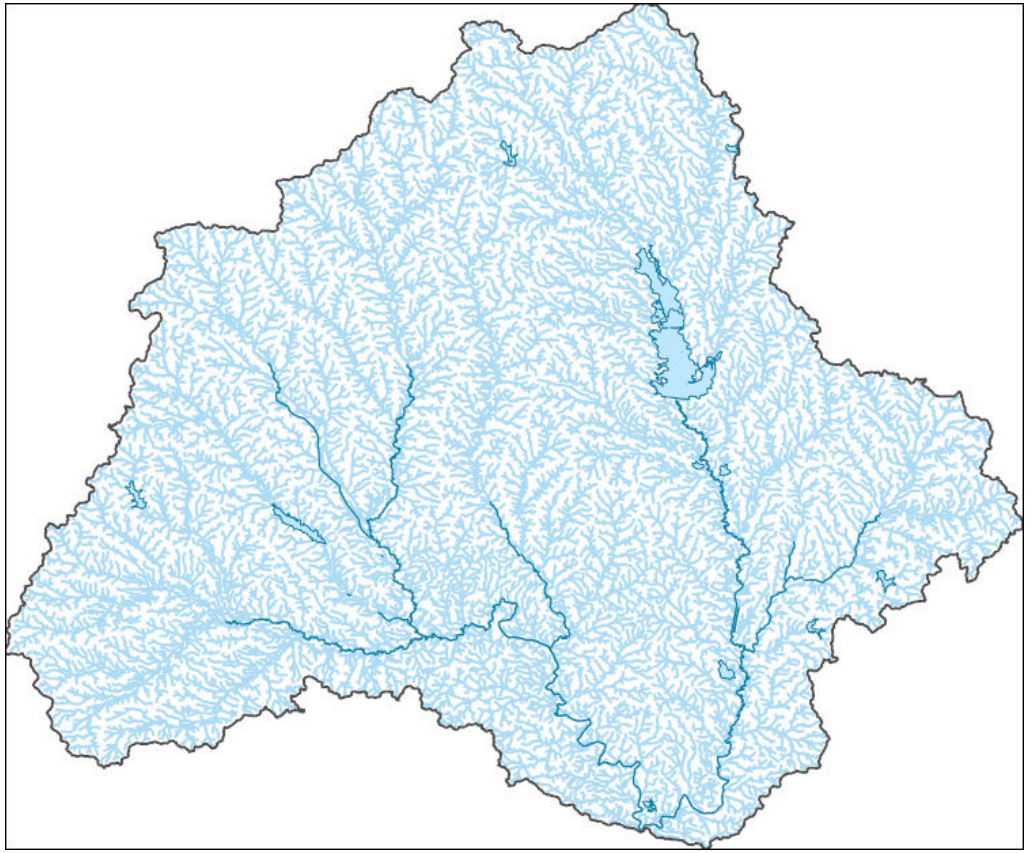


What is a Hydrofabric?

1. Collection of ***files/features/catchment realizations*** that describe the ***connectivity*** of surface water

   - Using a **discretization** suitable to a given rainfall/runoff/routing formulations

2. Derive the **parameters** that influence processes computed with formulations

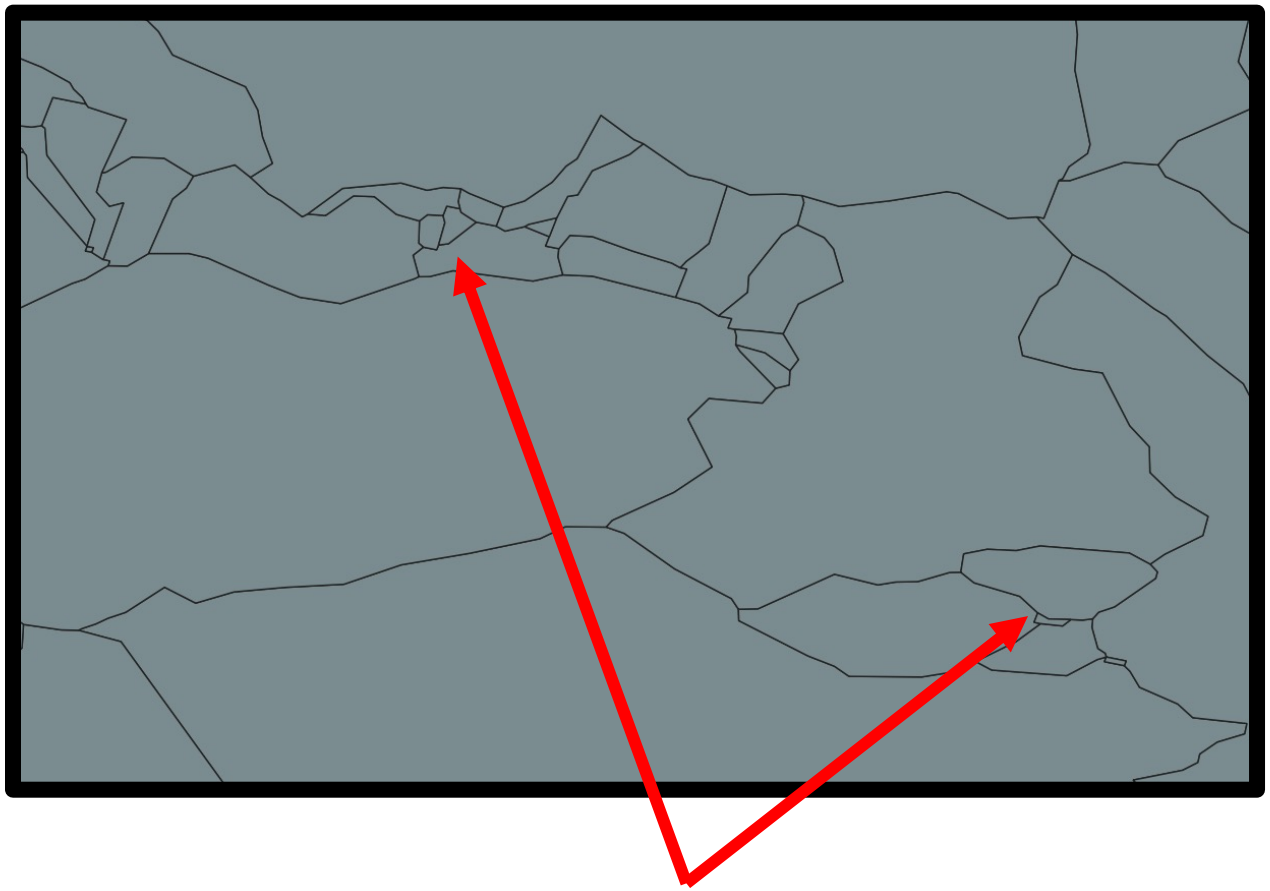


National Hydrography Dataset

- Principle “hydrofabric” for the US:
  - Flowpaths are derived from a 1:100,000 topographic maps
  - Catchments are generated from a 30m Digital Elevation Models (DEM)

- *Provides a seriously good start but…*

- *Not* flexible
- Has *severe* scale mismatch between process and application
- Errors in topology and geometry
- No parameter generation capabilities



Goal: To create hydrofabric ***workflows*** that are:

- Open Source and community driven
- Flexible
  - The right network representation can be defined for region and for process
- Consistent
  - Topology, geometry, and identification are consistent across representations
- Can derive needed parameters sets for any known model formulations

1. Reference Fabric

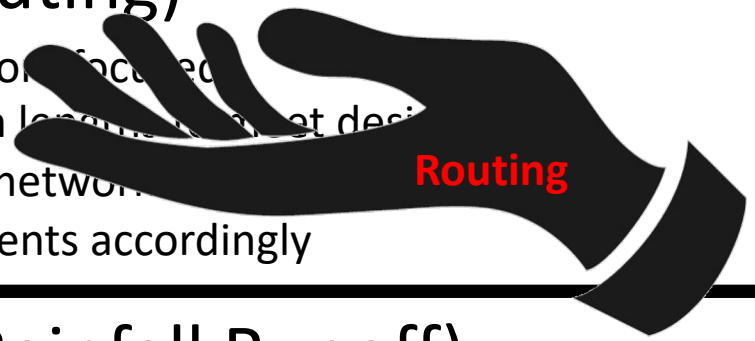
NHD, USGS GFv2.0, NGEN

2. Refactor (Routing)

- Flowpath Netwo[illegible]
- Adjust flowpath l[illegible]et desi
- Does NOT lose networ[illegible]
- Modify Catchments accordingly

R packages:

USGS-R/*hyRefactor*



3. Aggregate (Rainfall Runoff)

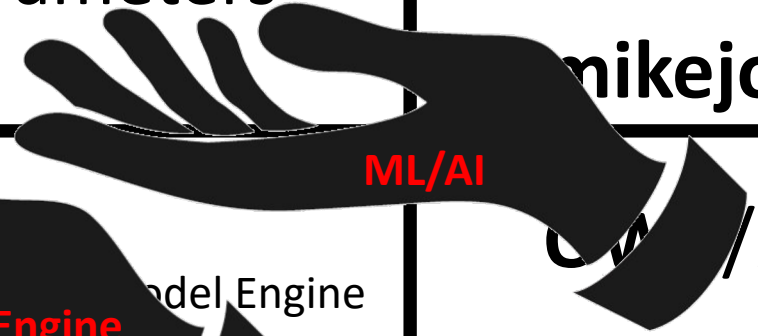
- Catchment Network focus[illegible]
- Adjust catchments to me[illegible]
- DOES lose network resolution
- Modify flow paths accordingly

OWP/*hyAggregate*

4. Catchment/Flowpath Parameters

Summarize catchment properties

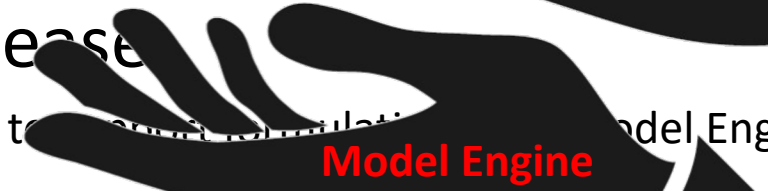
mikejohnson51/*zonal*



5. NGEN Releas[illegible]

Generate files t[illegible]odel Engine

[illegible]/*hyRelease*



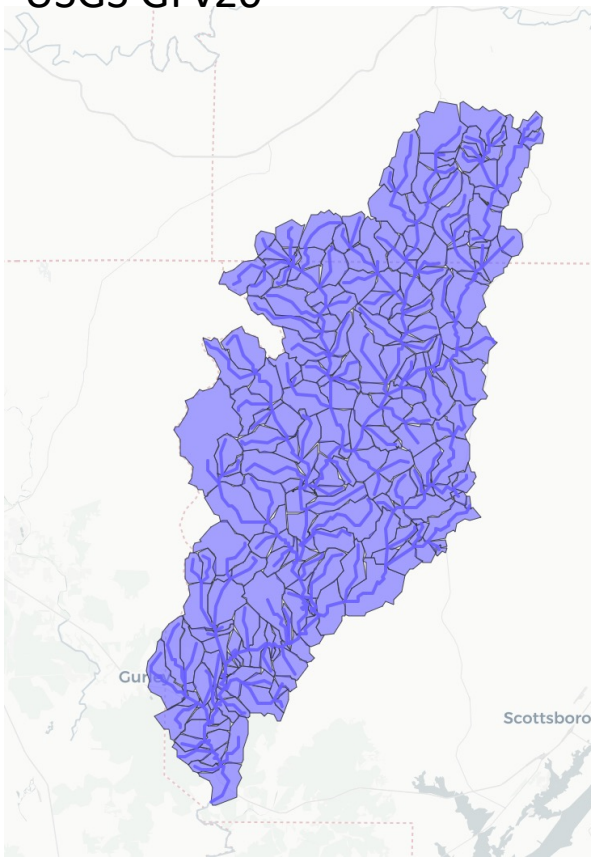
Example Application:

*We want a hydrofabric with an ideal catchment area of **10 sqkm** - but no smaller then **3 sqkm** – and no flowpath lengths shorter then **1 km**….*

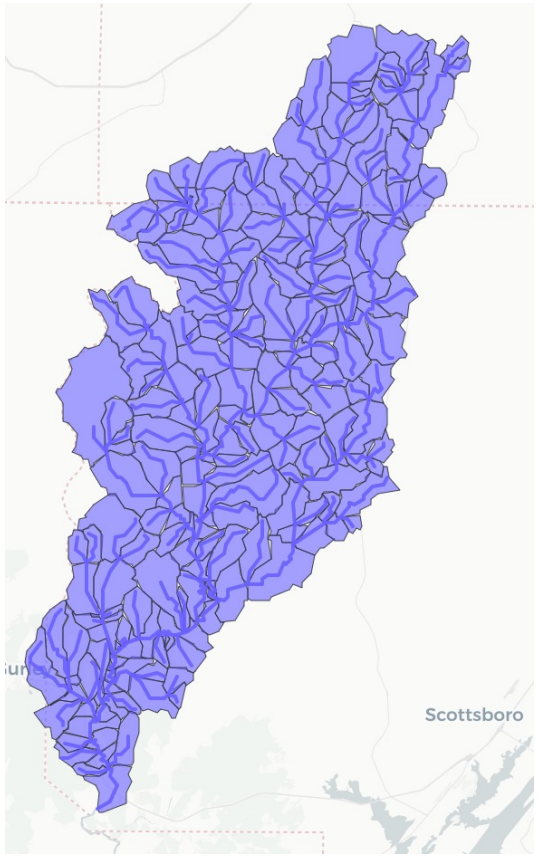
https://github.com/mikejohnson51/hyAggregate/blob/master/vignettes/complete_workflow.Rmd

Reference → refactor → aggregate

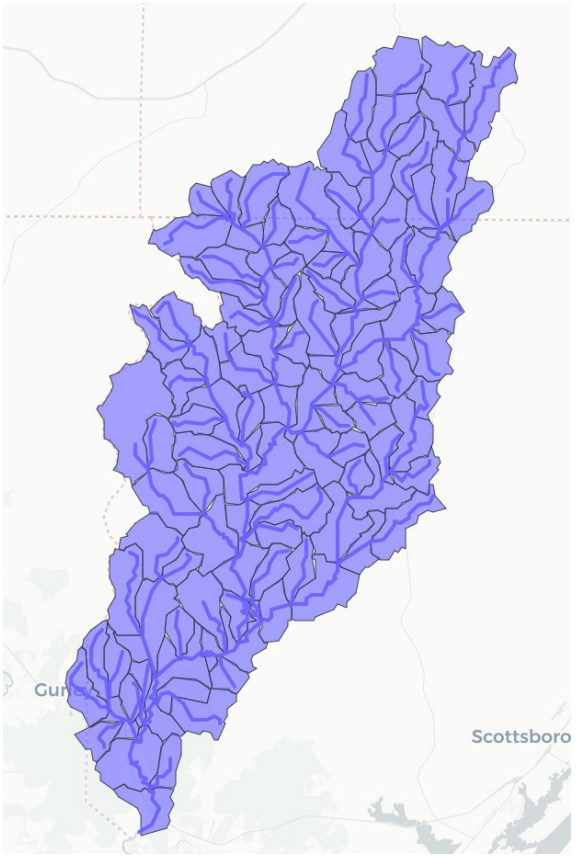
USGS GFv20



Units: 281
Average Area: 2.903 sqkm
Average Length: 2.055 km
Total River Length: .581 KM
Catchments < 3sqkm: 177 (62%)
Flowpaths < 1 KM: 83 (29%)



Units: 223
Average Area: 3.658 sqkm
Average Length: 2.723 km
Total River Length: .581 KM
Catchments < 3sqkm: 113 (51%)
Flowpaths < 1 KM: 19



Units: 104
Average Area: 7.844 sqkm
Average Length: 4.566 km
Total River Length: .489 km (84%)
Catchments < 3sqkm: 0
Flowpaths < 1 KM: 0

SAVE!!

More users, formulations, realizations = more needed inputs

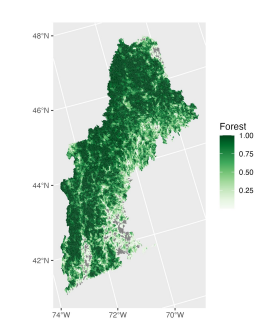
Needs to be an automated way to generate variable for formations in a consistent automated way.

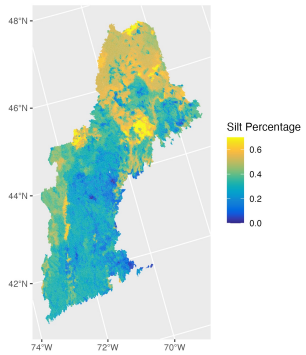
- MODIS
- Gridmet
- NED
- NLCD
- POLARIS
- SSURGO
- …

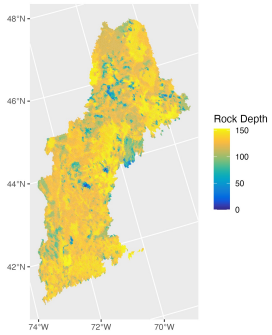

```
aggregate_lstm_params = function(gpkg,
                                 catchment_name,
                                 geo_dir,
                                 years = 3,
                                 precision = 9,
                                 out_file = NULL)
```

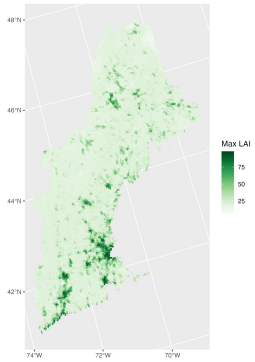
```
aggregate_nwm_params_reduce = function(gpkg,
                                       nwm_dir,
                                       catchment_name,
                                       flowline_name,
                                       single_layer = FALSE,
                                       precision = 9,
                                       out_file = NULL){
```

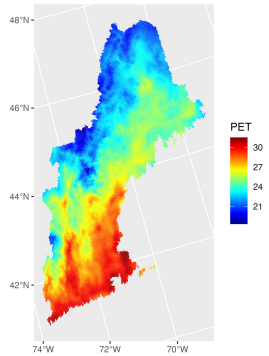
Replicate CAMELS variables for LSTM…

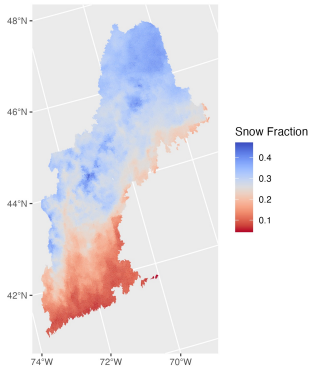


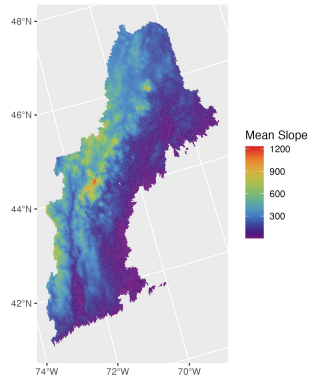


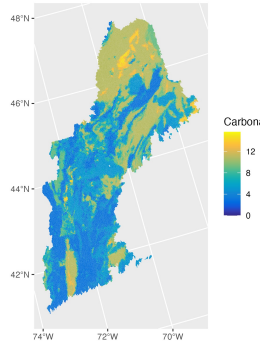


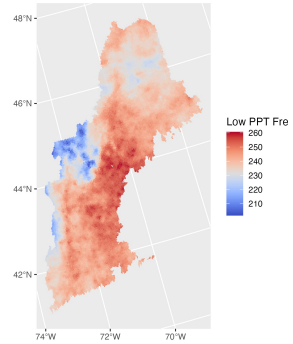


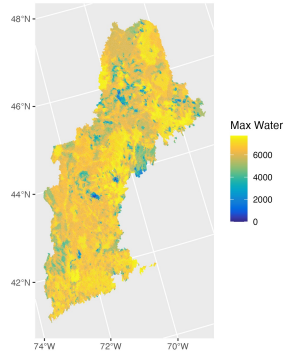


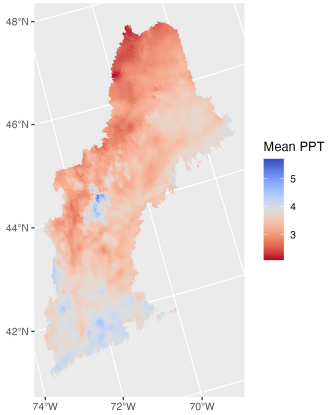


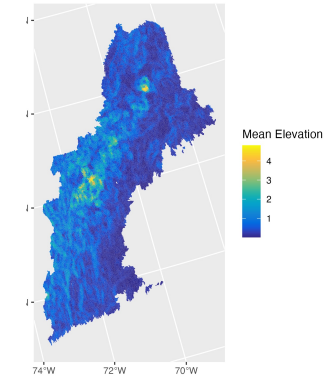


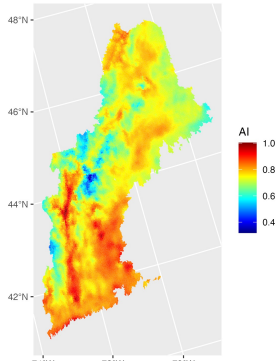


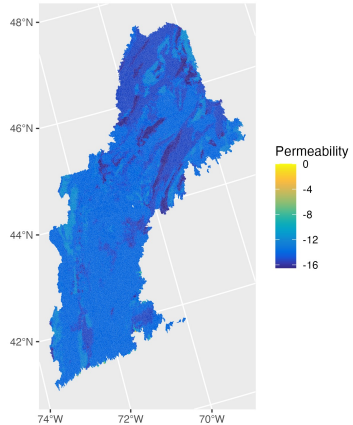


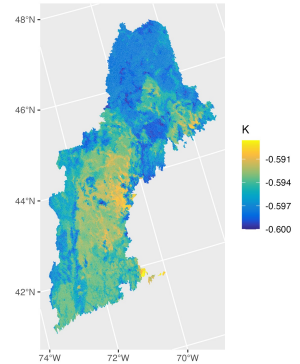












SAVE!!

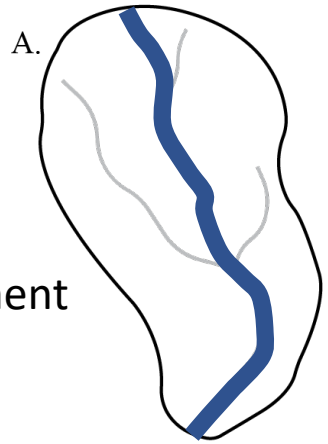
A hydrofabric collection

Spatial

- Catchment POLYGONS
- Flowpath LINESTRINGS
- Nexus POINTS

Graph

Edge-list topologies



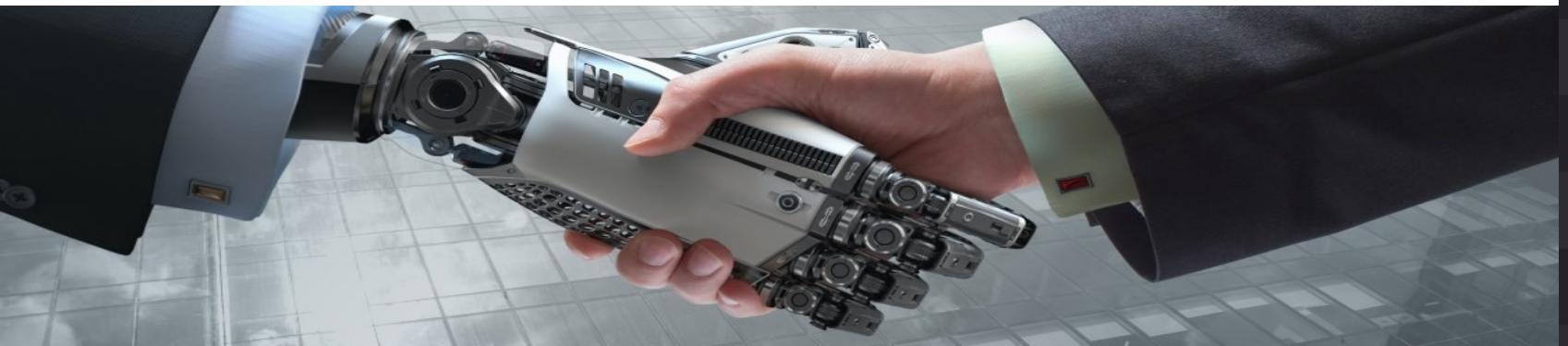
Parameters

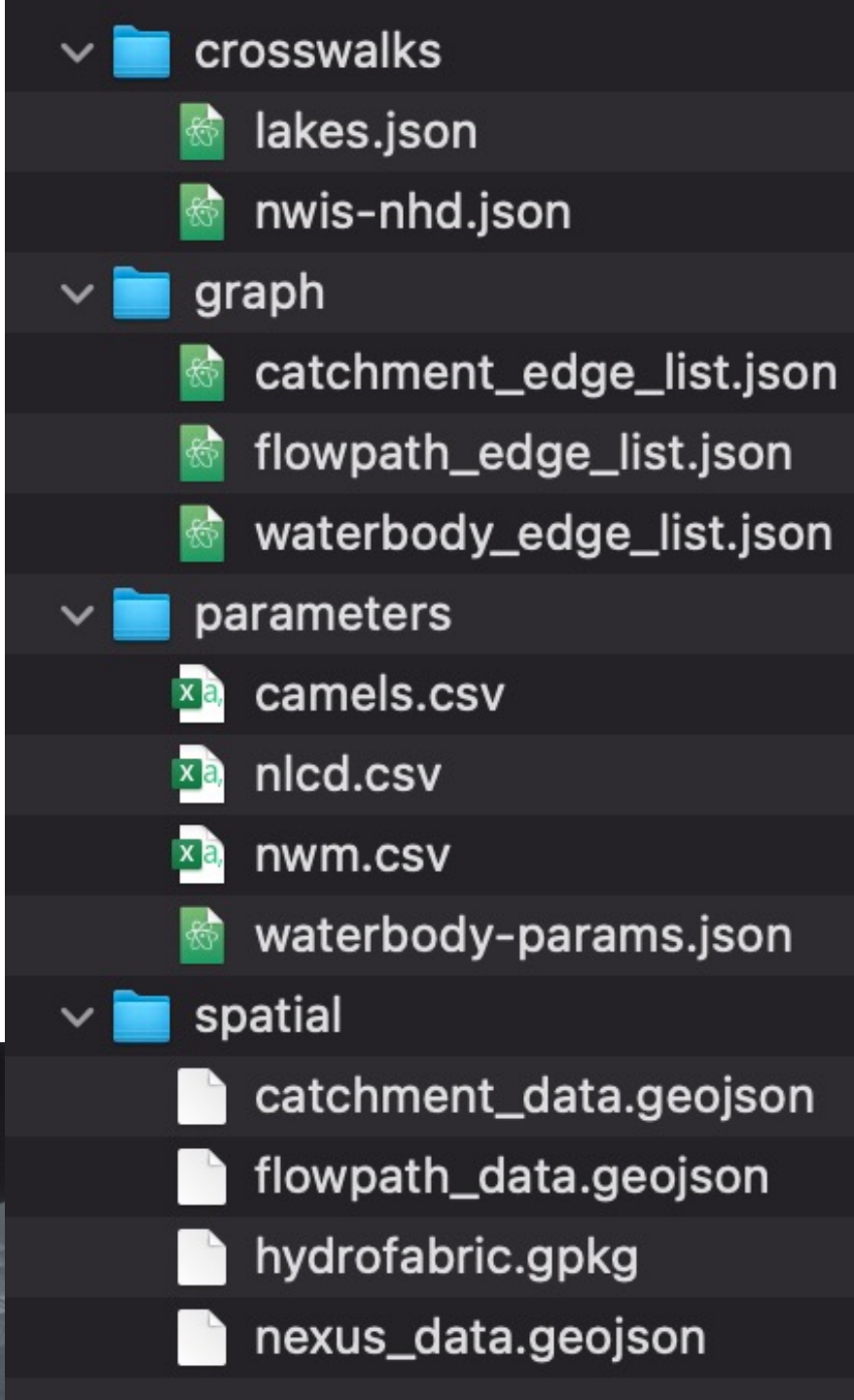
Things that happen in the catchment

1. Mean Rainfall
2. Average soil type,
3. Land cover coverage
4. Path length

Cross-walks

NWIS Gages IDs
NHD waterbodies
Dams





Special Thanks:

David Blodgett and Andy Bock (USGS)

Thank You!

Mike Johnson

mike.johnson@noaa.gov

https://water.noaa.gov

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