Data Science Training Webinars
Spatiotemporal Simulation

AN OVERVIEW OF WORKFLOW-DRIVEN SPATIOTEMPORAL SIMULATION

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Wuhan University

China Data Institute

Future Data Lab

Data Science Training Webinars
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AN OVERVIEW OF WORKFLOW-DRIVEN SPATIOTEMPORAL SIMULATION

WHY Workflow-Driven Spatiotemporal Simulation

HOW Workflow-Driven Platform of K-GCI is Different

WHAT The Features of K-GCI

EXAMPLE Telehealth Accessibility by 2SVCA

FUTURE WORK

WHY

Workflow-Driven Spatiotemporal Simulation

WHY Spatiotemporal Simulation

Uncertain Spatiotemporal Context

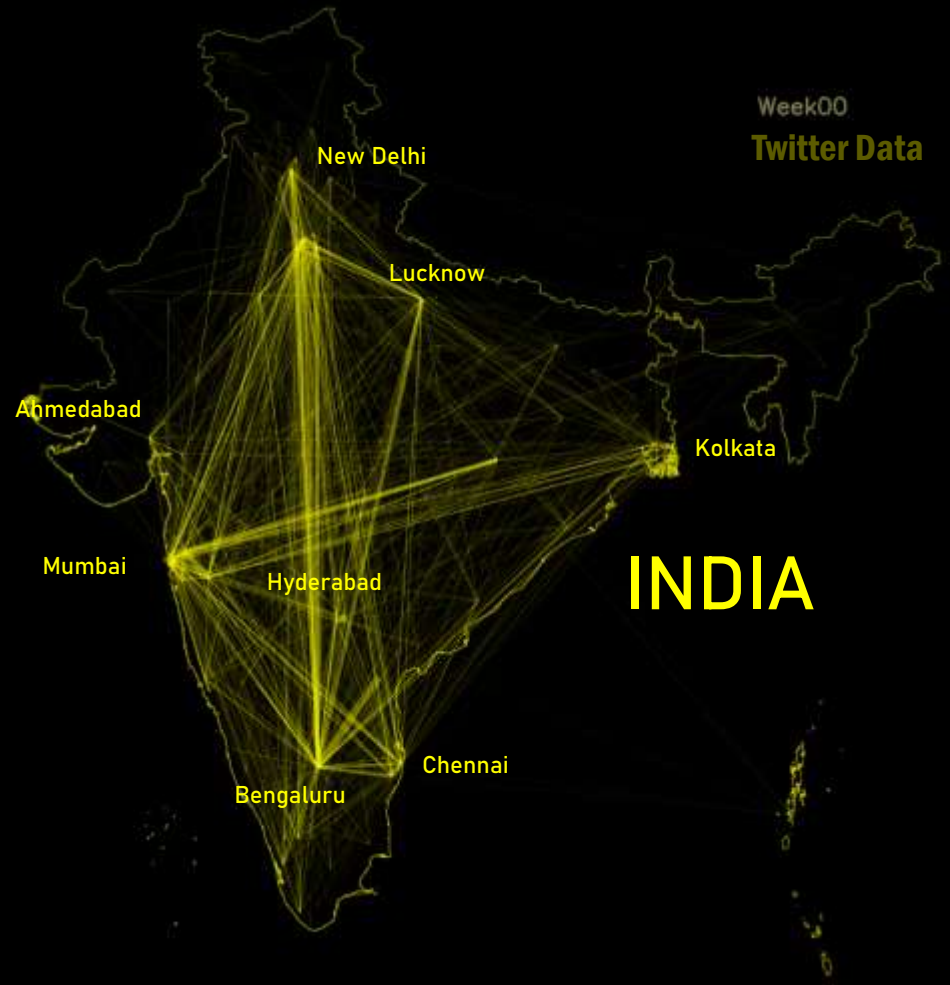
Unneglectable Temporal Trend

Multiple Scenario Prediction

Spatiotemporal Computing & Thinking

Increasing Complexity in Spatiotemporal Modelling

Spatiotemporal Evolution of City network Based on Social Media Data

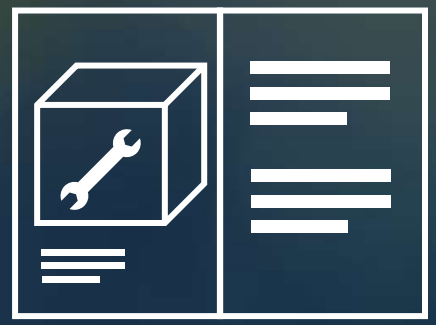


Liu, L., R. Wang, W. W. Guan, S. Bao, H. Yu, X. Fu and H. Liu (2022). "Assessing Reliability of Chinese Geotagged Social Media Data for Spatiotemporal Representation of Human Mobility." ISPRS International Journal of Geo-Information **11**(2).

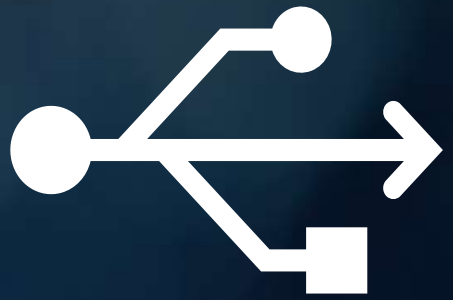
Data Source: https://dataverse.harvard.edu/dataverse/weibomobilityindex

WHY Workflow-Driven Platform

Spatiotemporal
Analysis Software



Executive
Paper



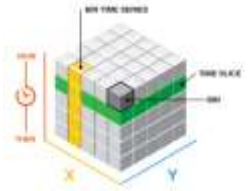
Workflow
Driven

Scalable **Structural** **Expandable** **Interoperable**

WHY Workflow-Driven Platform

Spatiotemporal Analysis Software

ArcGIS Pro



Visualize Space Time Cube

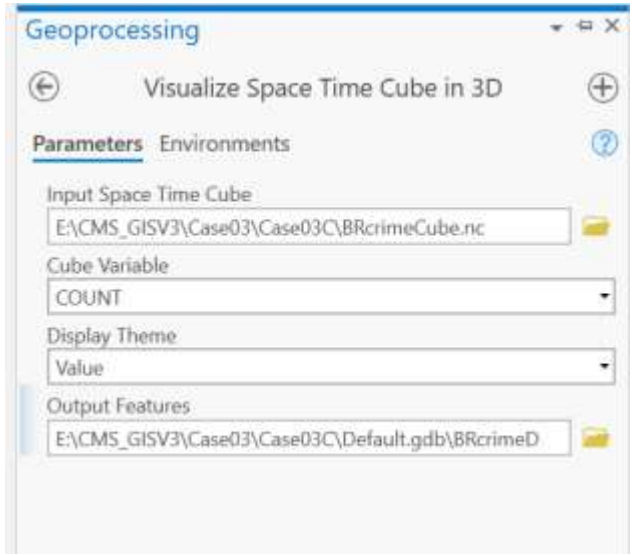


Image Source

Computational Methods and GIS Applications in Social Sciences, Third Edition , Fahui Wang, Lingbo Liu,CRC,Working Book, https://pro.arcgis.com/en/pro-app/2.8/tool-reference/space-time-pattern-mining/create-space-time-cube.htm

Executable Paper based on Jupyter

Cyber GISX

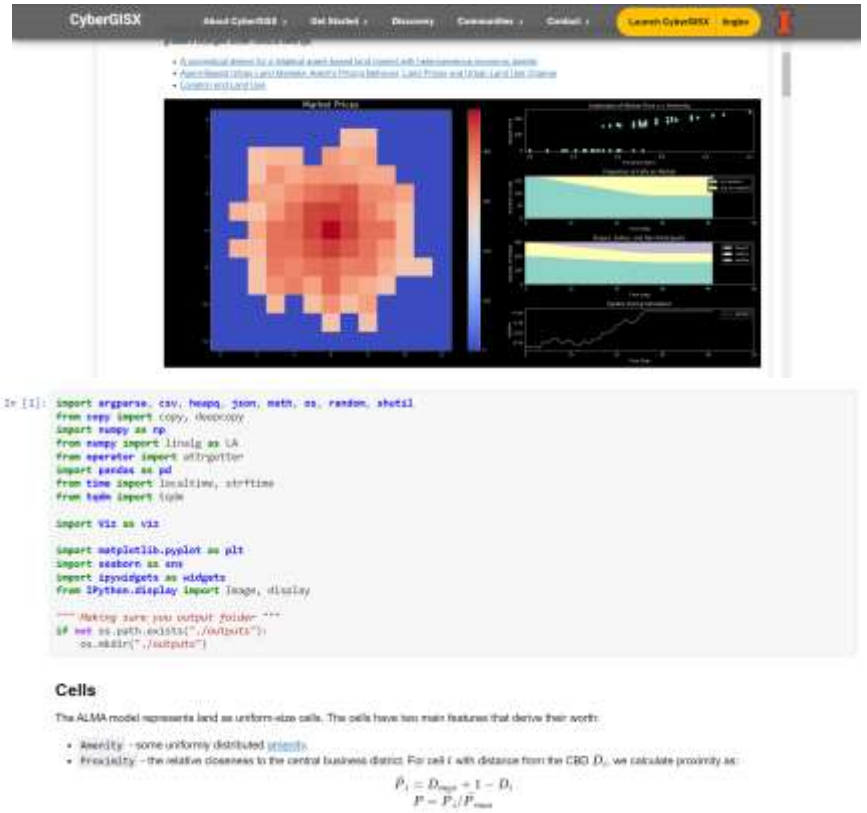
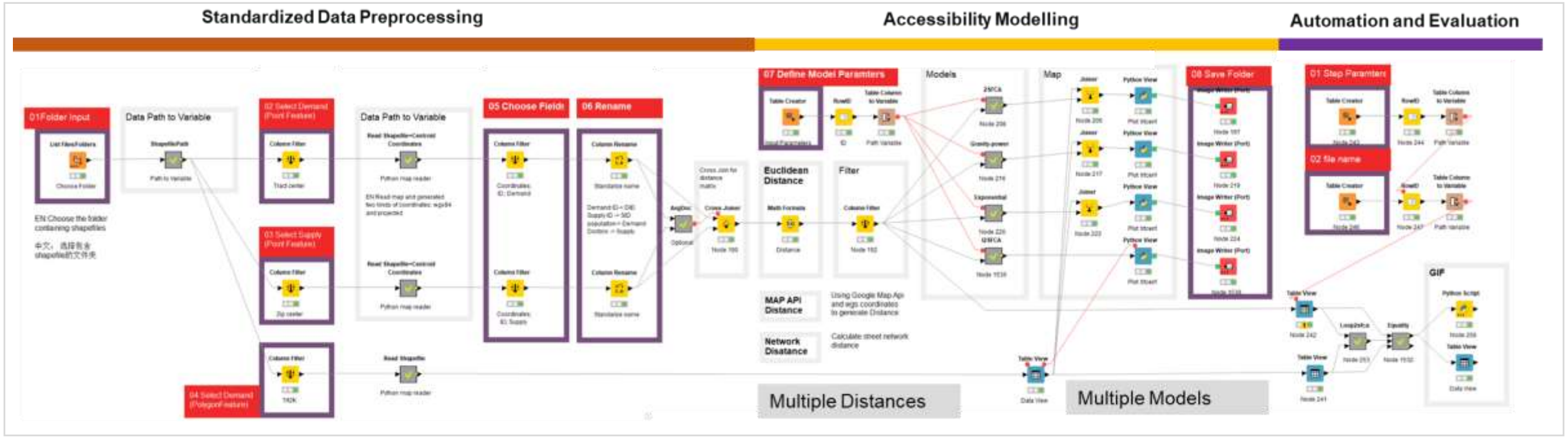


Image Source

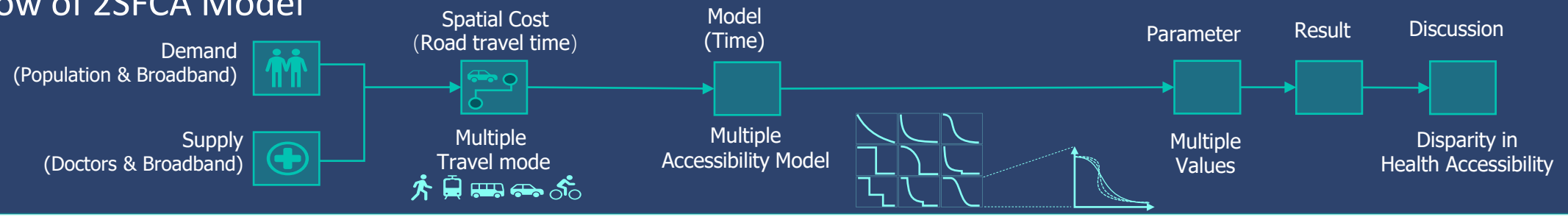
https://cybergisxhub.cigi.illinois.edu/notebook/agent-based-land-market/

WHY Workflow-Driven Platform

Workflow-Based Spatiotemporal Analysis Platform



Workflow of 2SFCA Model



HOW

Workflow-Driven Platform in Spatial Data Lab is Different

KNIME-based Geospatial Cyberinfrastructure Open K-GCI

Lingbo Liu , Fahui Wang, Weihe Wendy Guan*, Shuming Bao, Chaowei Yang, Hanchen Yu, Xiaokang Fu, KNIME-based Geospatial Cyberinfrastructure for Open Source GIS Education 3.0 , 2022, under Peer View

HOW Open K-GCI is Different

Workflow Platform with Mono-Coding Language Support

Python

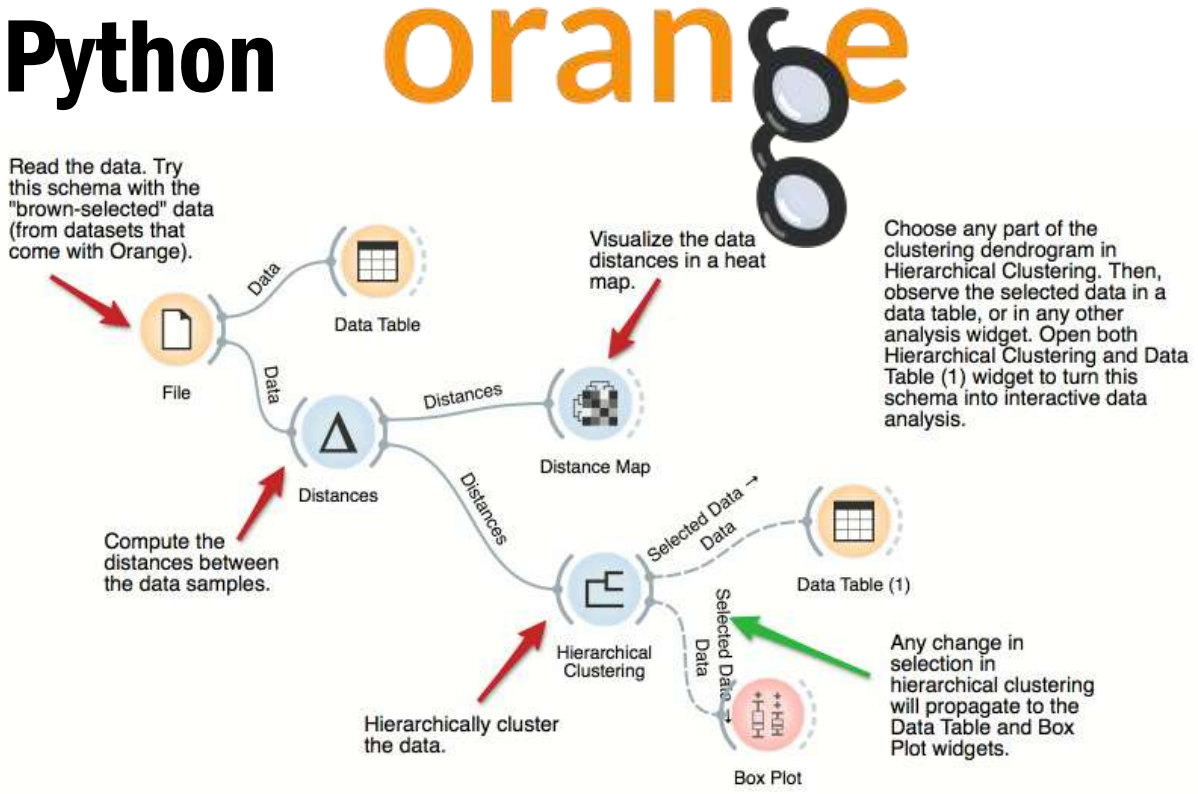


Image Source
https://orangedatamining.com/workflows/

R

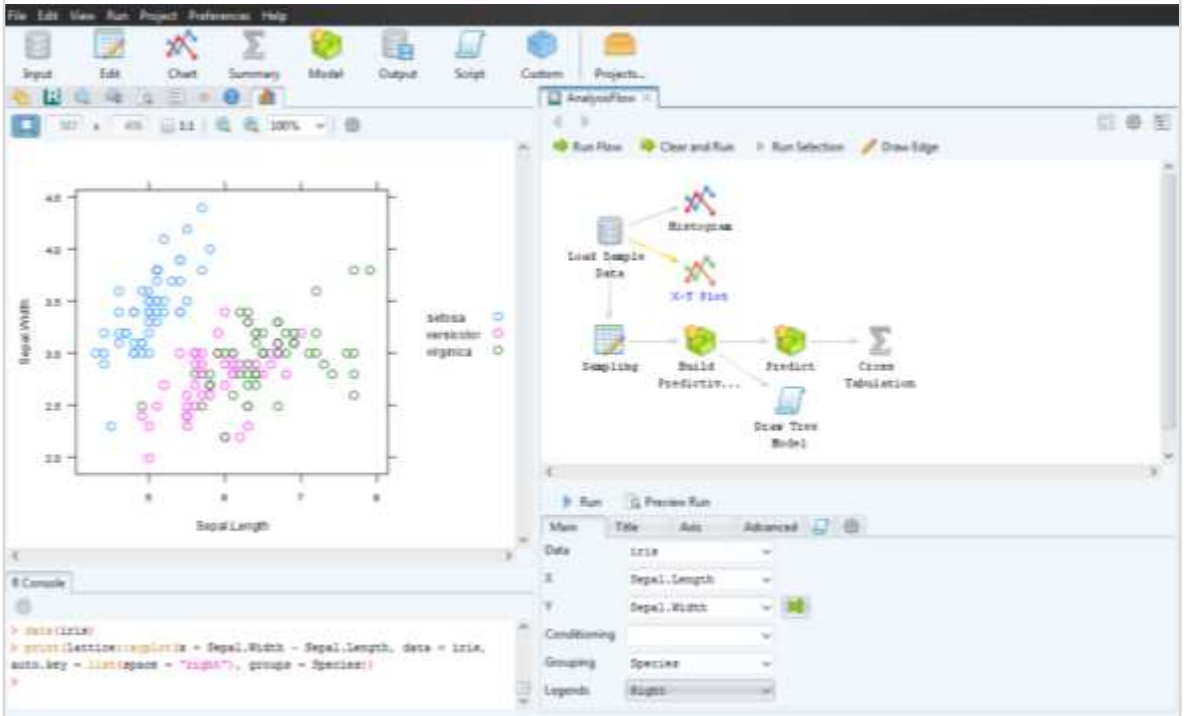
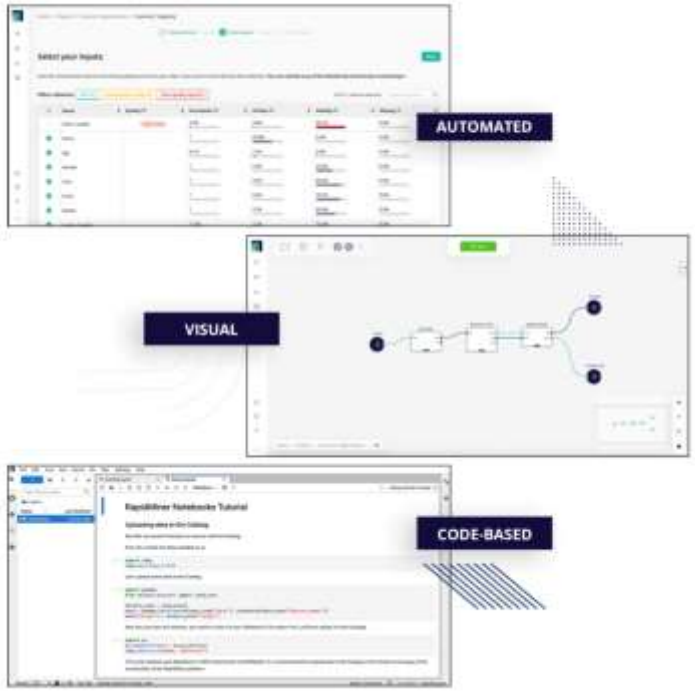


Image Source
https://r.analyticflow.com/en/

HOW Open K-GCI is Different

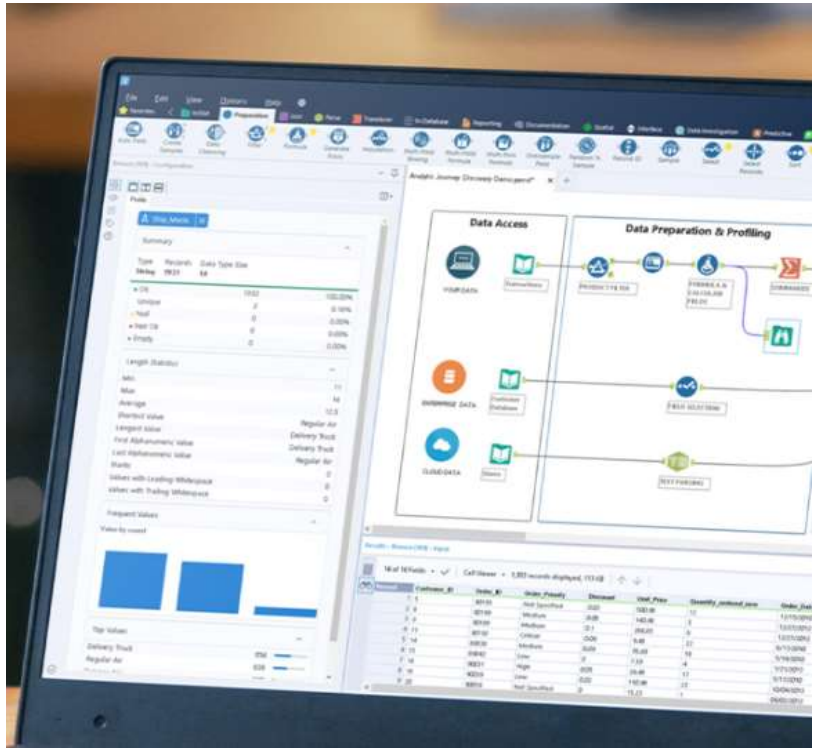
Workflow Platform with Multi-Coding Language Support

RAPIDMINER



https://rapidminer.com

alteryx

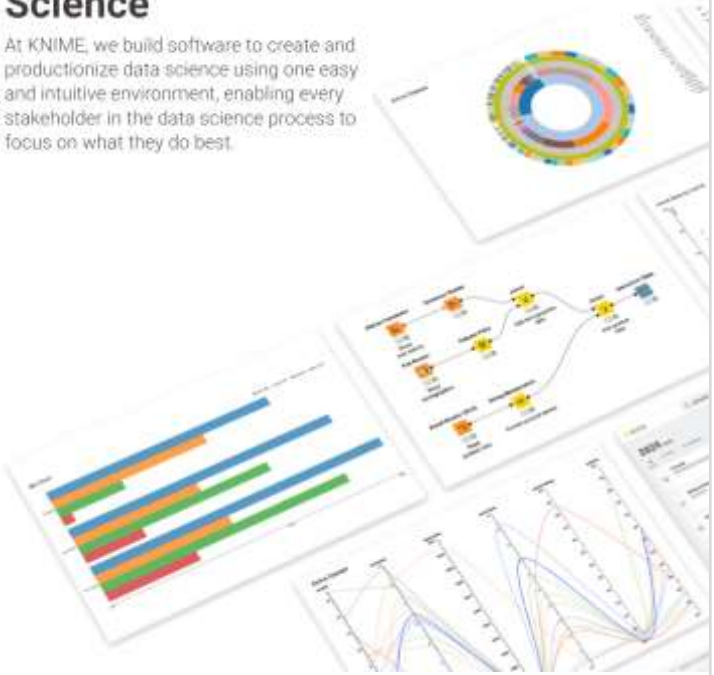


https://www.alteryx.com

Open for Innovation
KNIME

End to End Data Science

At KNIME, we build software to create and productionize data science using one easy and intuitive environment, enabling every stakeholder in the data science process to focus on what they do best.



https://www.knime.com/

HOW Open K-GCI is Different

Workflow Platform Comparison

SoftWare	Language Support	Open Source	Cost	Built-in Geospatial Function	Data Limit	Server
Orange	Python	Yes	Free	x	No	x
R AnalyticFlow	R	Yes	Free	x	No	x
Alteryx	Python, R, JavaScript	Yes	Education license	Yes	No limit	Yes
RapidMiner	Python, R, Java	x	Education license	x	10,000 rows	Yes
KNIME	Python, R, JavaScript	x	Free(KNIME analytic platform) Education license(KNIME Sever-Small)	x	No limit	Yes

HOW Open K-GCI is Different

Codeless Visual Programming

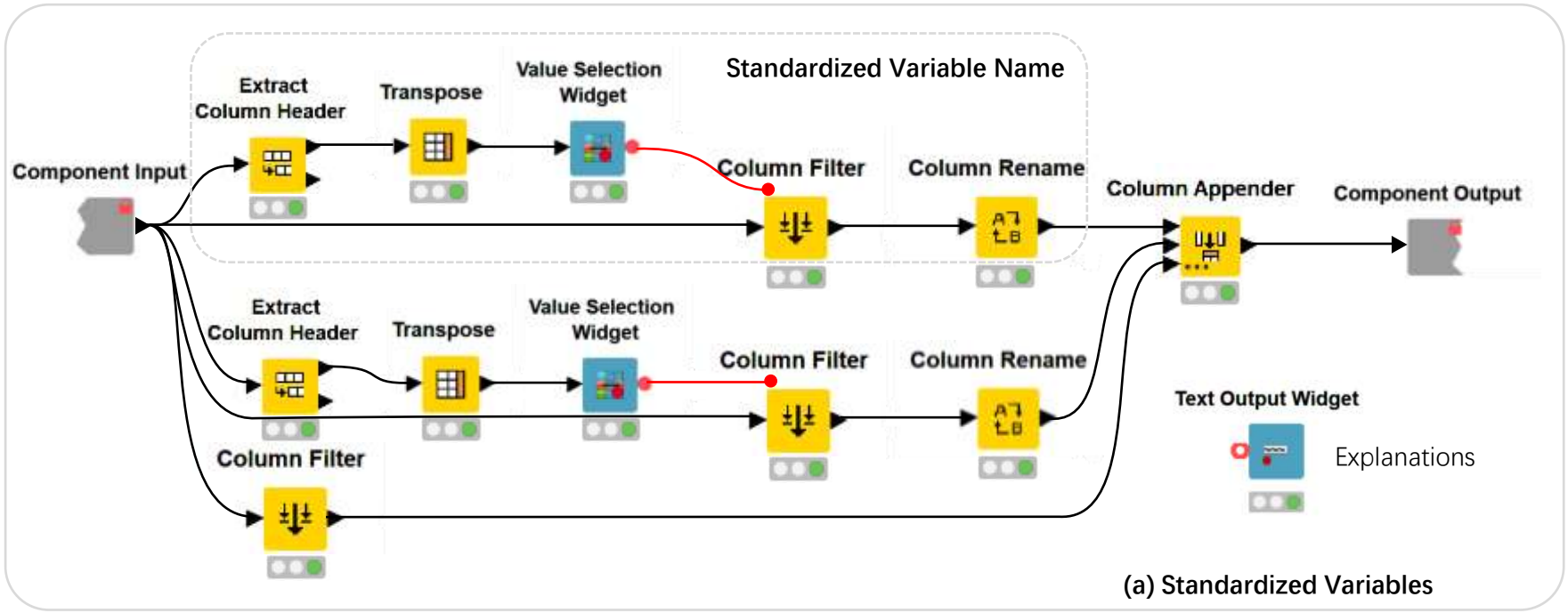
Open K-GCI

Scalable Structural Replicable Expandable Interoperable

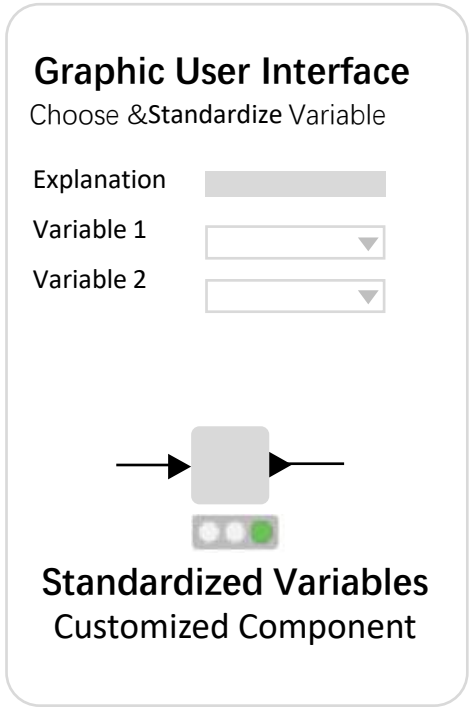
Standard Nodes + WebPortal-based Executable Paper

HOW Open K-GCI is Different

Enable Crowdsourcing Customized Tools— Standardize Variables

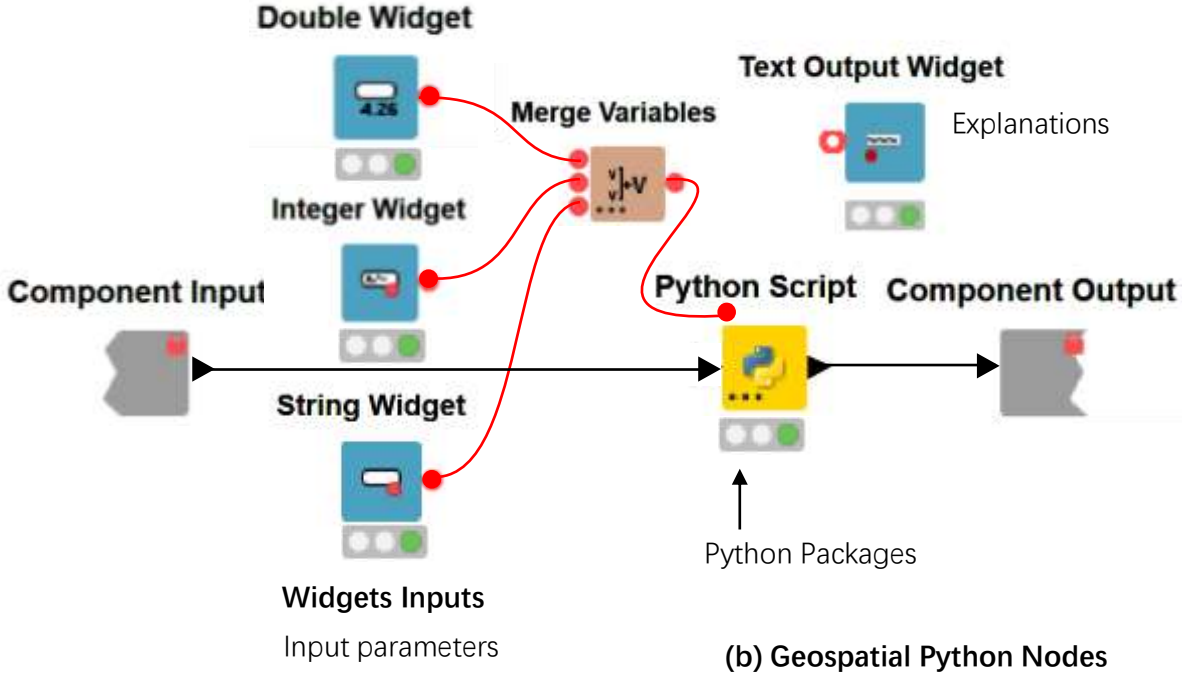


(a) Standardized Variables

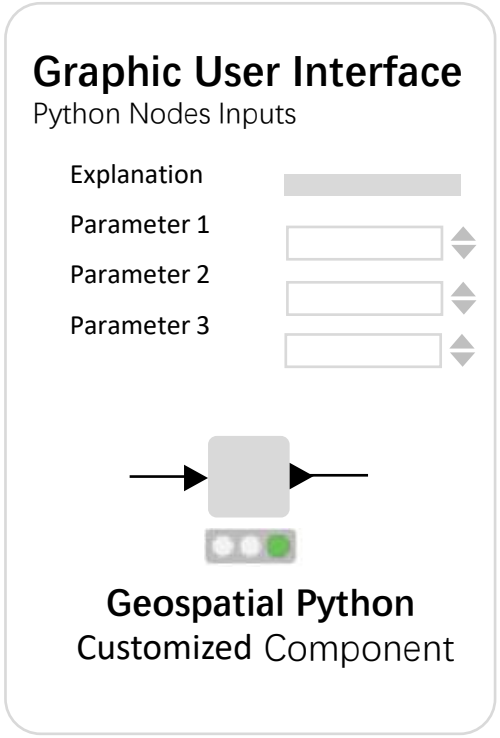


HOW Open K-GCI is Different

Enable Crowdsourcing Customized Tools— Standardize Geospatial Python Nodes



(b) Geospatial Python Nodes



HOW Open K-GCI is Different

Geospatial Nodes List

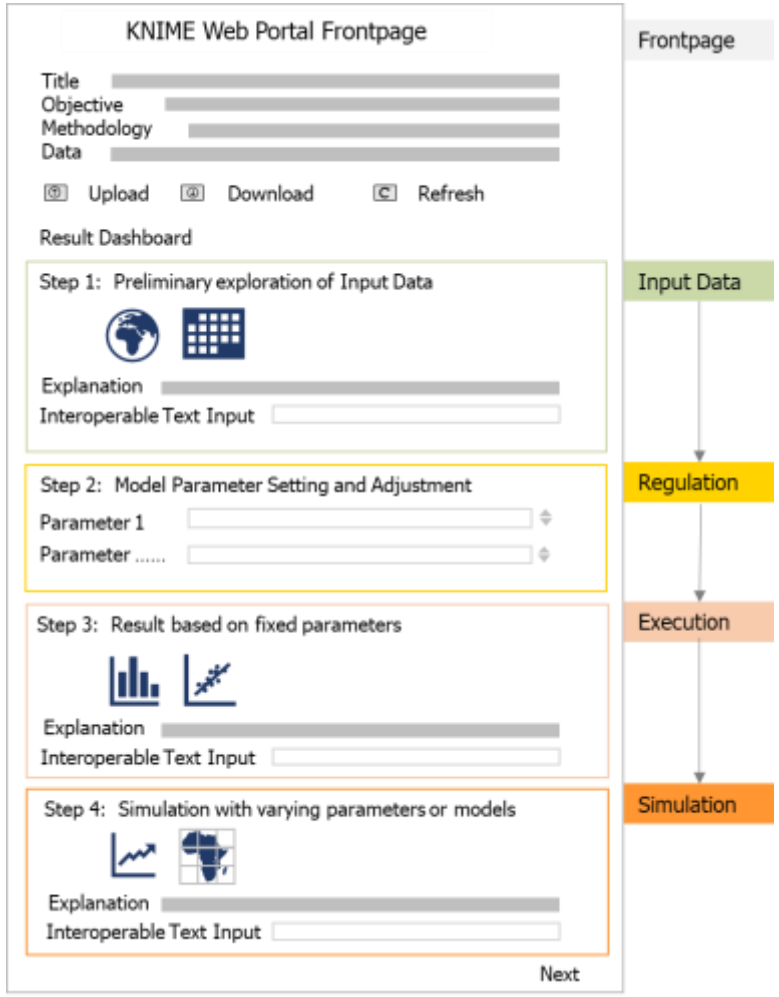
Basic Category	NO.	Name
Input	GeoB01	GeoReader_Single
	GeoB02	GeoReader_Layer
	GeoB03	GeoReaderXY
Output	GeoB04	GeoSaver_Single
	GeoB05	GeoPackageSaver
Project and Transformation	GeoB06	CRS-Transformer
Geometric Manipulation	GeoB07	Area
	GeoB08	Length
	GeoB09	PointXY
	GeoB10	FeatureToPoint
	GeoB11	Convex_hull
	GeoB12	Envelope
	GeoB13	Buffer
	GeoB14	TotalBound
Spatial Overlay	GeoB15	DistanceMatrix
	GeoB16	SpatialJoin
	GeoB17	MultiRingBuffer
	GeoB18	Dissolve
	GeoB19	Overlay
	GeoB20	Clip
Geocoder	GeoB21	Geocoder
	GeoB22	Reverse geocoder

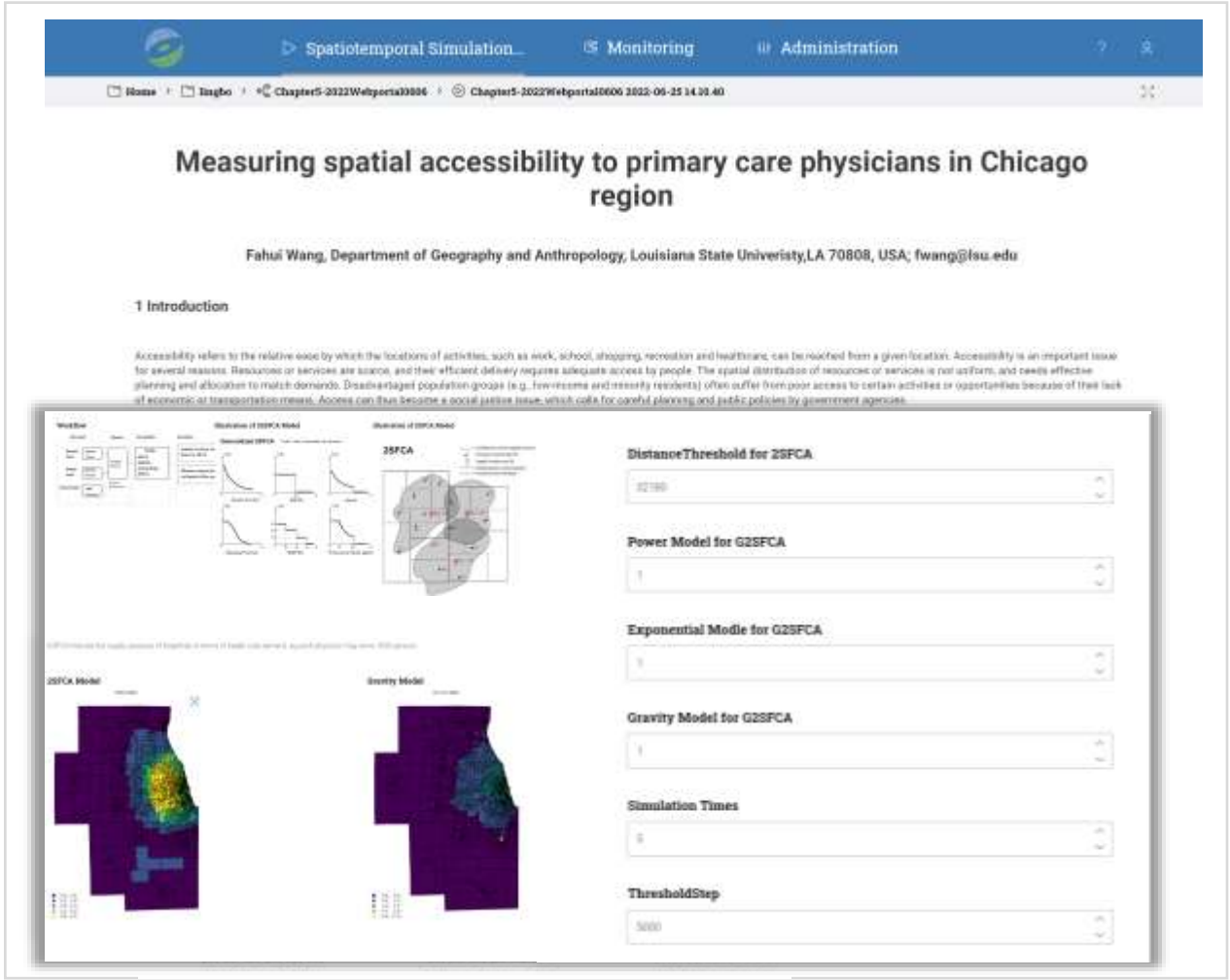
Advanced Category	NO.
Spatial Weights	GeoA01
Two Stage Least Squares (2SLS)	GeoA02
Spatial Lag Model_Spatial Two Stage Least Squares (S2SLS)	GeoA03
Geometric Manipulation	GeoA04
Spatial Lag Model_Maximum Likelihood	GeoA05
Spatial Error Model_General Method of Moments	GeoA06
Spatial Error Model_Maximum Likelihood	GeoA07
Model with Lag and Error_Generalized S2SLS	GeoA08
Spatial Regimes_Non-Spatial Models	GeoA09
Spatial Regimes_Spatial Models	GeoA10
Moran's I	GeoA11
LISA	GeoA12
GWR	GeoA13
MGWR	GeoA14

Extensive Category	NO	Name
TravelCost	GeoF01	ShapefileDist
	GeoF02	OsmTime
	GeoF03	TransitionTime
Interpolation&Smoothing	GeoF04	kriging
	GeoF05	Kernal density
	GeoF06	Stkernal
ServiceAreaModel	GeoF07	Huffmodle
	GeoF08	Proximal Model
	GeoF09	Network Community
AccessibilityModel	GeoF10	2SFCA|I2SFCA
	GeoF11	2SVCA|I2SFCA
SpatialStatisticModel	GeoF12	Co-Location
Regionalization	GeoF13	REDCAP
	GeoF14	MLR
	GeoF15	MaxP
System of Linear Equations	GeoF16	LawryModel
Linear Programming	GeoF17	WasteCommute
	GeoF18	Location-Allocation
Traffic modelling	GeoF19	TrafficSimulaiton

HOW Open K-GCI is Different

KNIME WebPortal for Interoperable and Executable Paper —FIRES





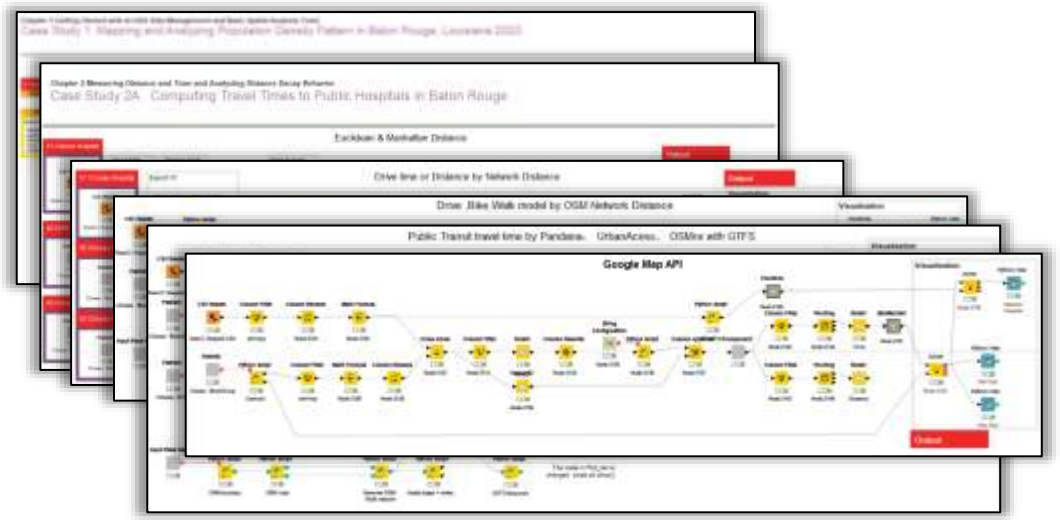
HOW Open K-GCI is Different

Progress in KNIME-CI for Spatiotemporal Simulation

Workbook for

Quantitative Methods and Socio-Economic Applications in GIS

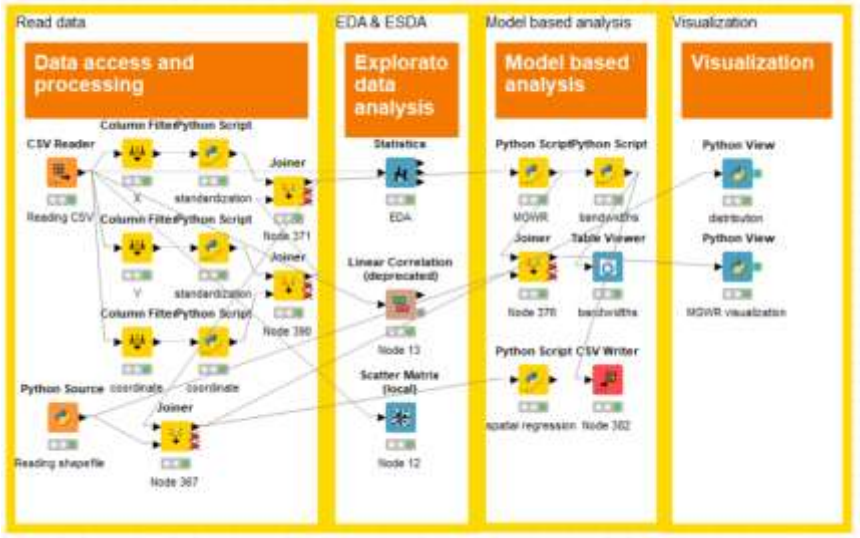
Fahui Wang, Louisiana State University



Workbook for

Workbench for Spatial Data Analysis

Based on the work of Luc Anselin and Stewart Fotheringham



WHAT

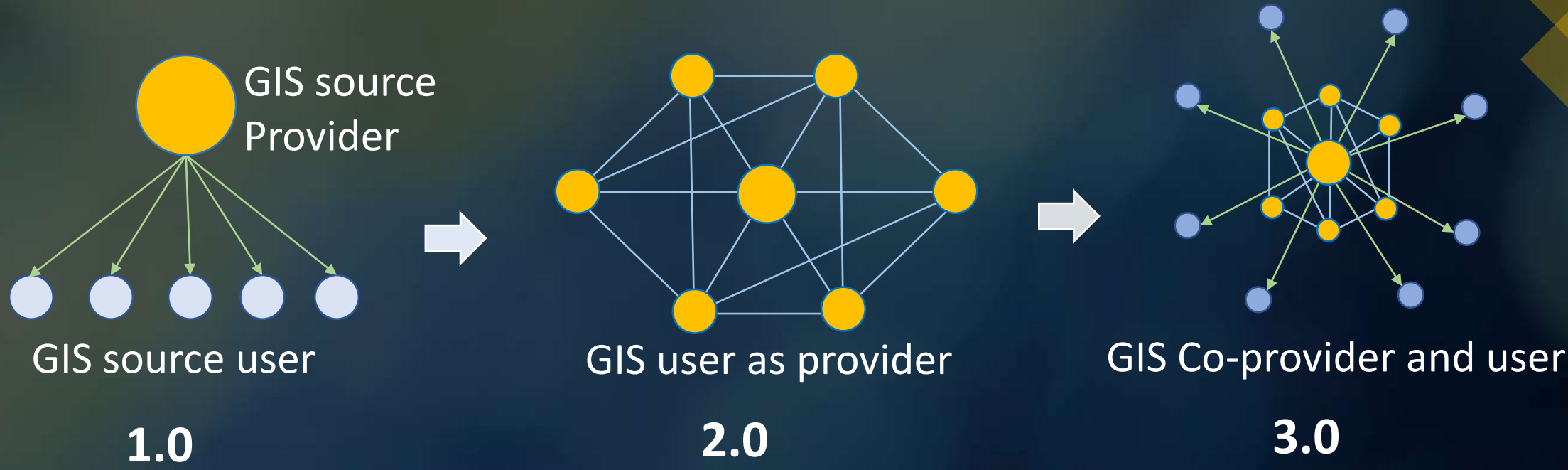
The Features

KNIME-based Cyberinfrastructure Open K-GCI

Lingbo Liu , Fahui Wang, Weihe Wendy Guan*, Shuming Bao, Chaowei Yang, Hanchen Yu, Xiaokang Fu, KNIME-based Geospatial Cyberinfrastructure for Open Source GIS Education 3.0 , 2022, under Peer View

WHAT The feature of Open KNIME-CI is

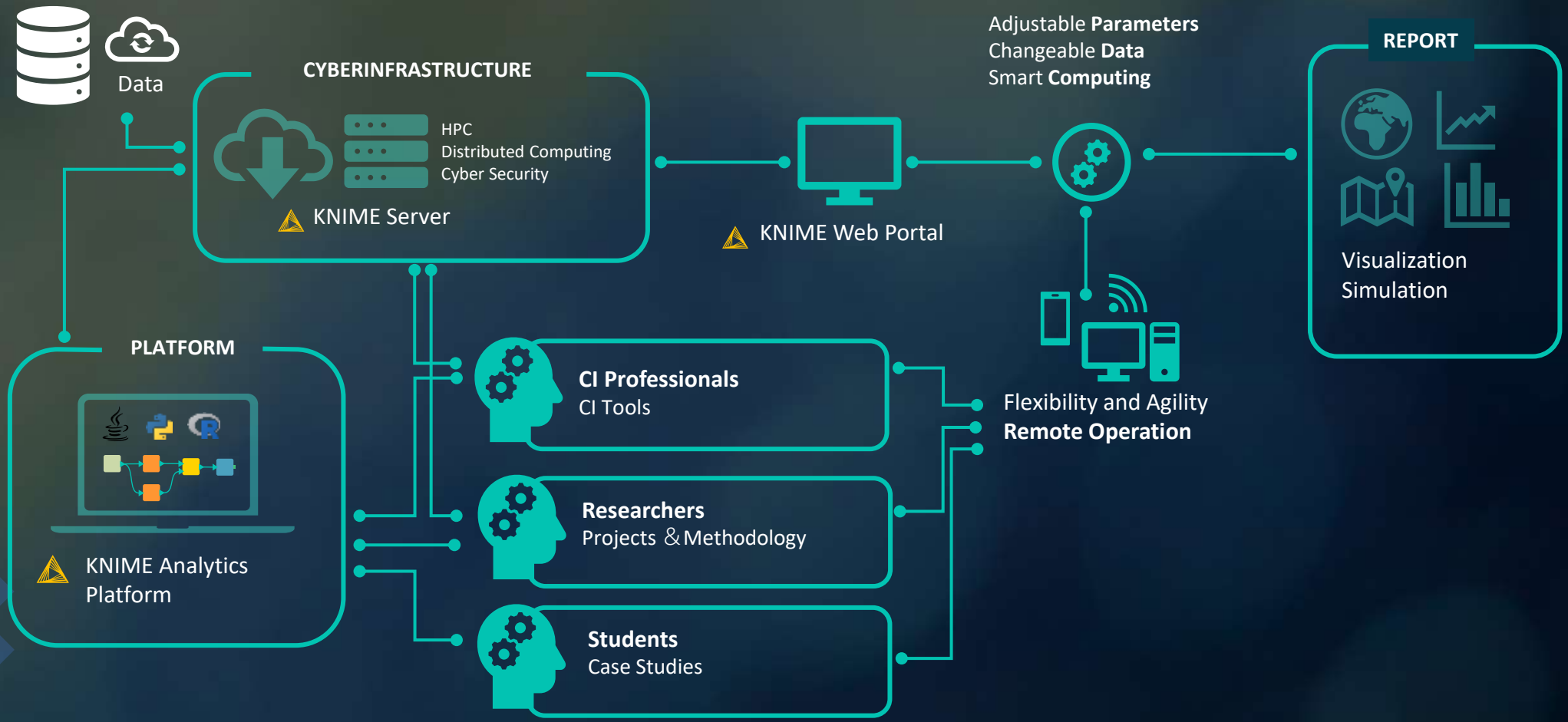
Open-Source GIS Education 3.0



Lingbo Liu , Fahui Wang, Weihe Wendy Guan*, Shuming Bao, Chaowei Yang, Hanchen Yu, Xiaokang Fu, KNIME-based Geospatial Cyberinfrastructure for Open Source GIS Education 3.0 , 2022, under Peer View

WHAT The feature of Open KNIME-CI is

Hybrid KNIME-CI



EXAMPLE

Telehealth Accessibility by 2SVCA

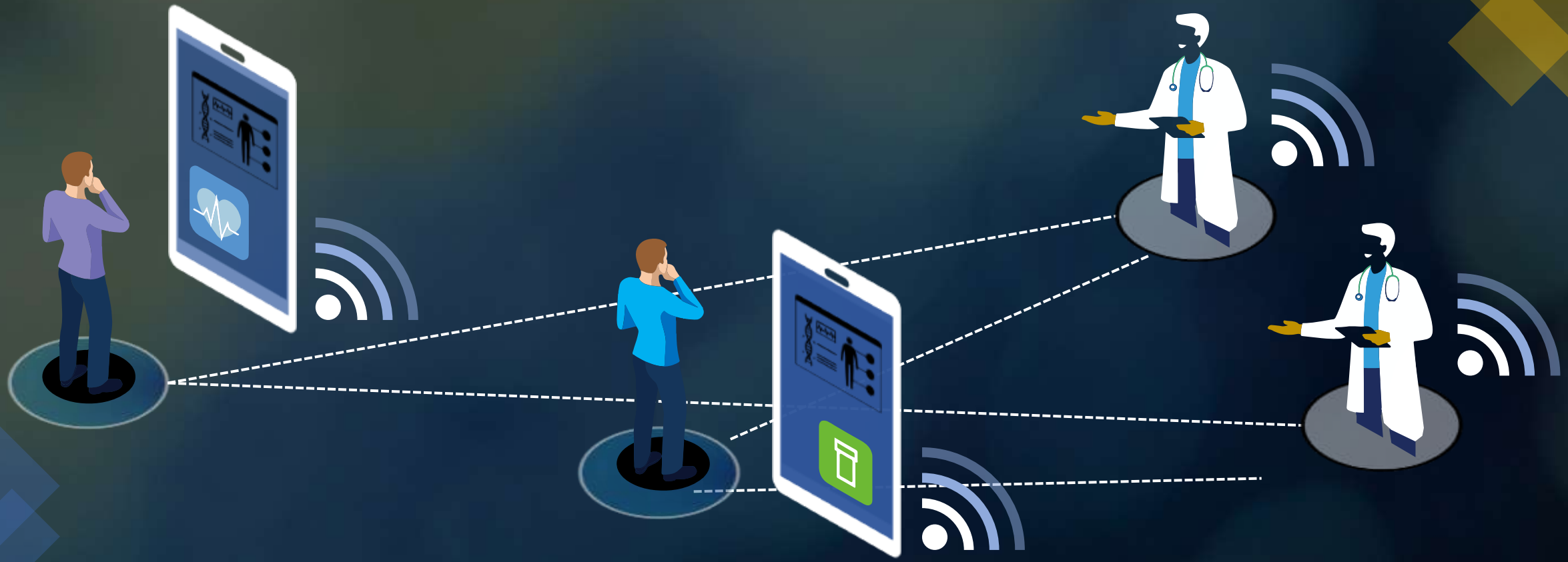
Lingbo Liu , Fahui Wang, Weihe Wendy Guan*, Shuming Bao, Chaowei Yang, Hanchen Yu, Xiaokang Fu, KNIME-based Geospatial Cyberinfrastructure for Open Source GIS Education 3.0 , 2022, under Peer View

Lingbo Liu, Jennifer Alford-Teaster, Tracy Onega, Fahui Wang, Refining 2SVCA Method for Examining Disparities in Telehealth Accessibility of Primary Care Physicians in Baton Rouge, Louisiana , 2022, Working Paper

EXAMPLE Telehealth Accessibility by 2SVCA

Duality of distance dependence and digital divide

Integrating Physical accessibility and Virtual accessibility (From 2SFCA to 2SVCA)



EXAMPLE Telehealth Accessibility by 2SVCA

Case Study	Exploring the disparity of telehealth accessibility in Baton Rouge Metropolitan Statistic Area (BRMSA)
Methodology	2 Step Virtual Catchment Area (2SVCA) model
Data	Census Data at the block level: Population, Road network, Boundary Hospital Data : Location, Capacity(Number of doctors or hospital beds) Internet Access Data: Fixed broadband speed

Location of BRMSA

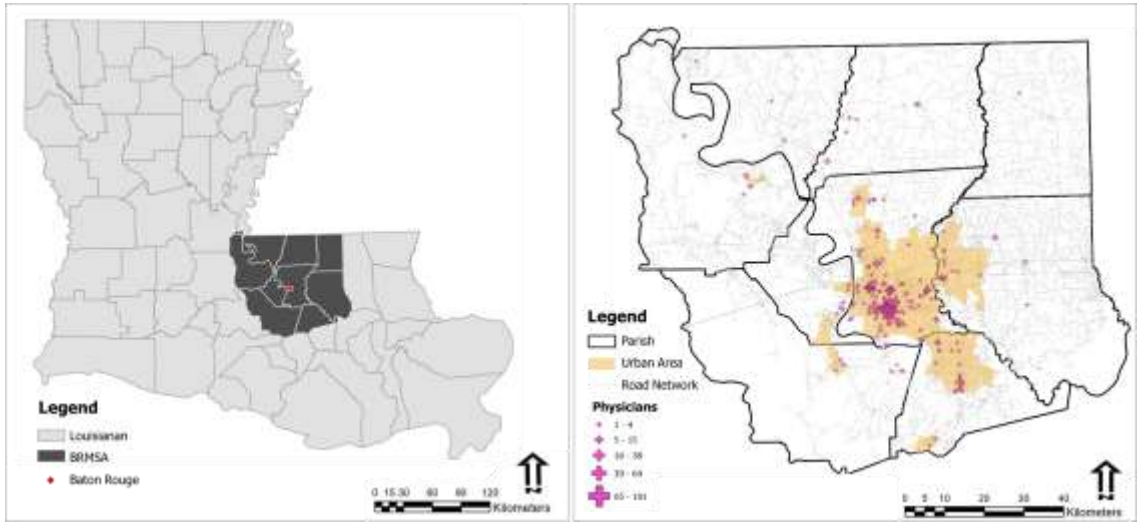
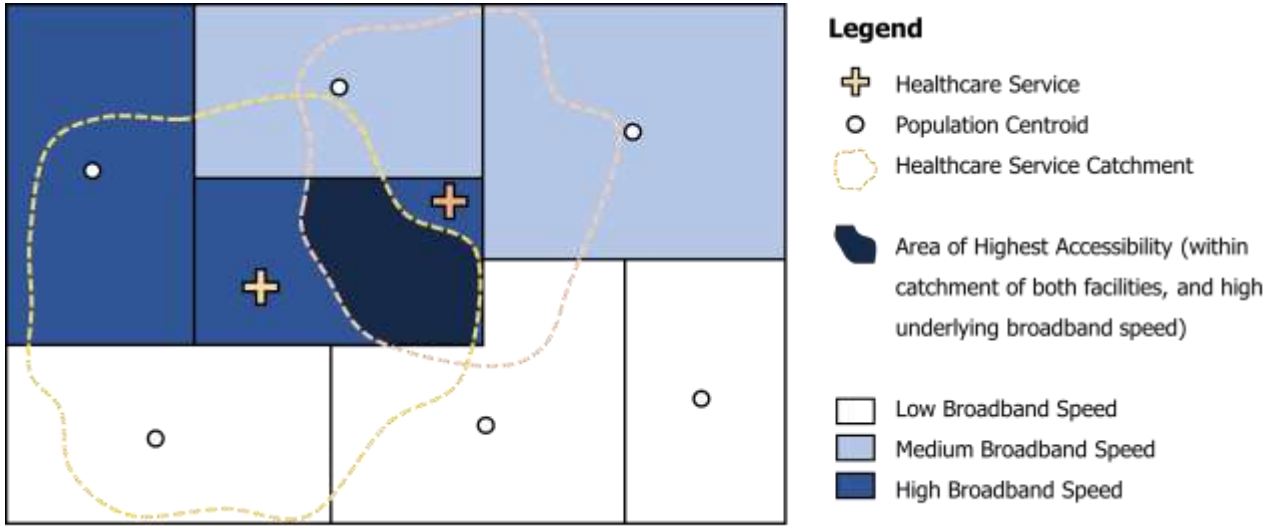
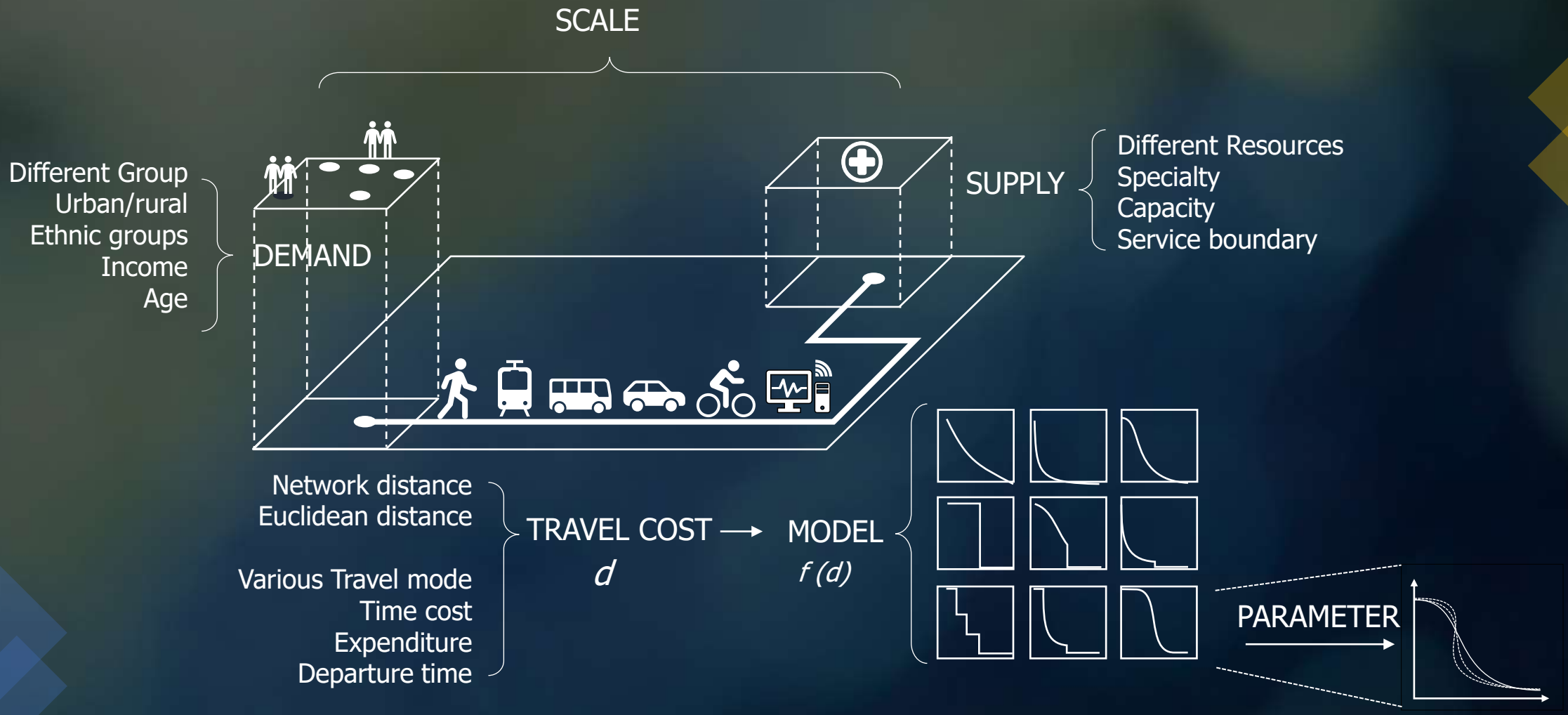


Illustration of 2SVCA



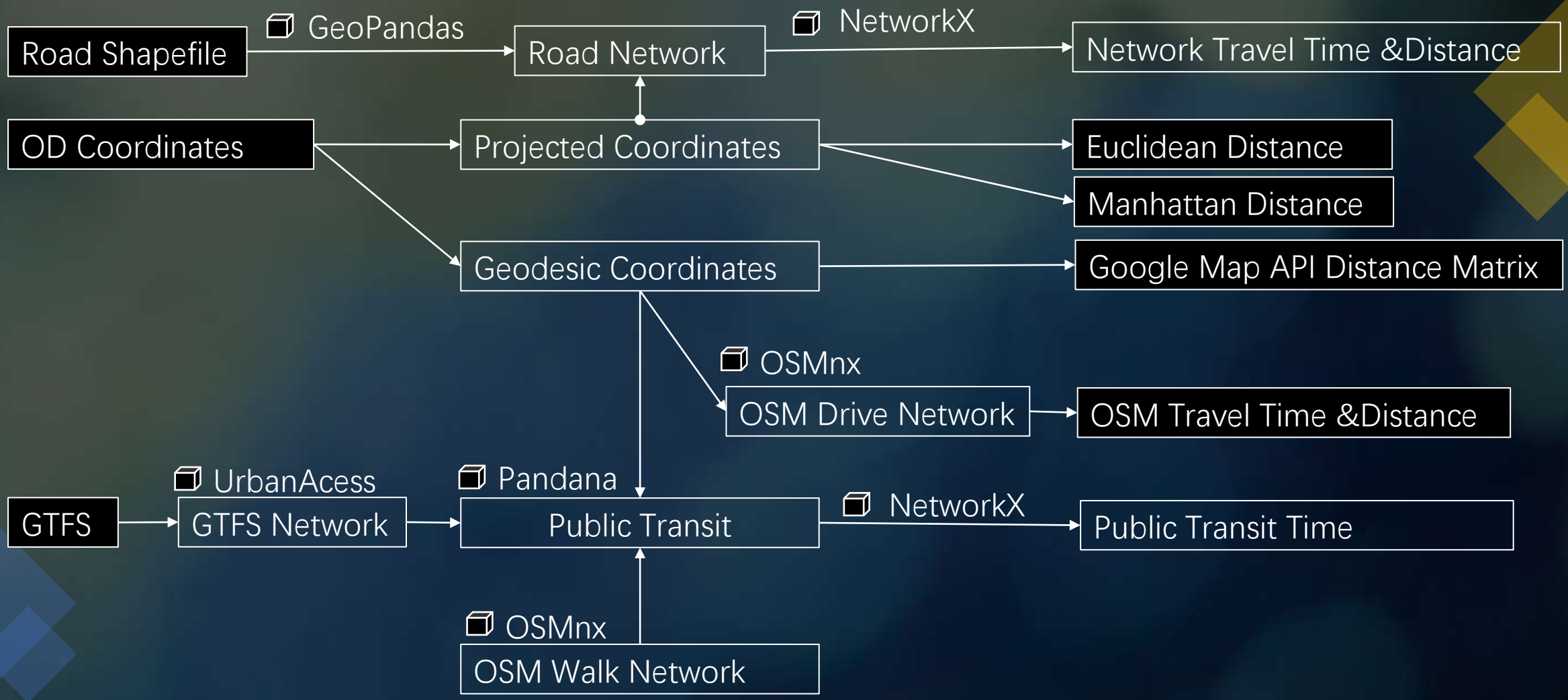
Alford-Teaster, J., F. Wang, A. N. A. Tosteson and T. Onega (2021). "Incorporating broadband durability in measuring geographic access to health care in the era of telehealth: A case example of the 2-step virtual catchment area (2SVCA) Method." J Am Med Inform Assoc **28**(11): 2526-2530.

EXAMPLE Telehealth Accessibility by 2SVCA



Uncertain Spatiotemporal Context in 2SFCA/2SVCA

EXAMPLE Telehealth Accessibility by 2SVCA



KNIME workflow framework for calculate multiple travel cost

EXAMPLE Telehealth Accessibility by 2SVCA

Cloud

Cloud Census Data — *R package* **censusapi** → QUERY → TIGER Line Geo-Data
Geography | Population | Road network

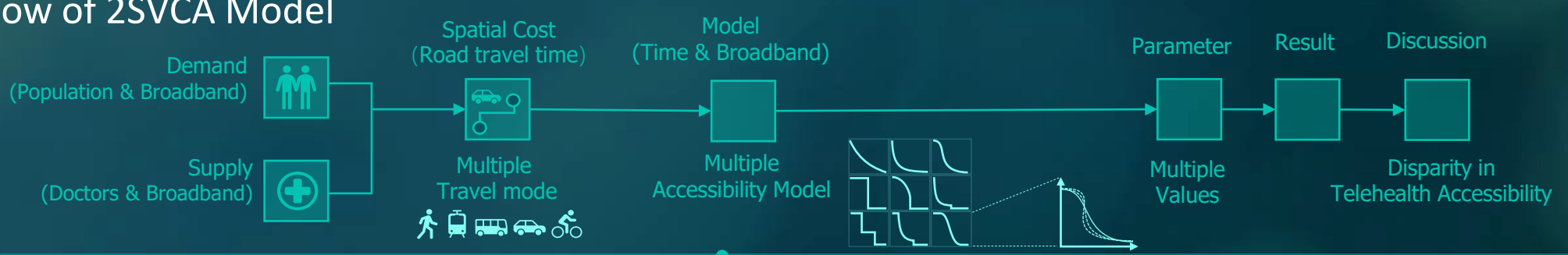
Federal Communication Commission — **Broadband Deployment Data** → QUERY → Fixed Broadband Data
at the Census Block Level

Socrata — Socrata Open Data API → QUERY → Hospital Capacity
COVID-19 Reported Patient Impact and Hospital Capacity by Facility

Server

Data Stored, Processed and Analyzed in KNIME Server or Analytics Platform(local version)

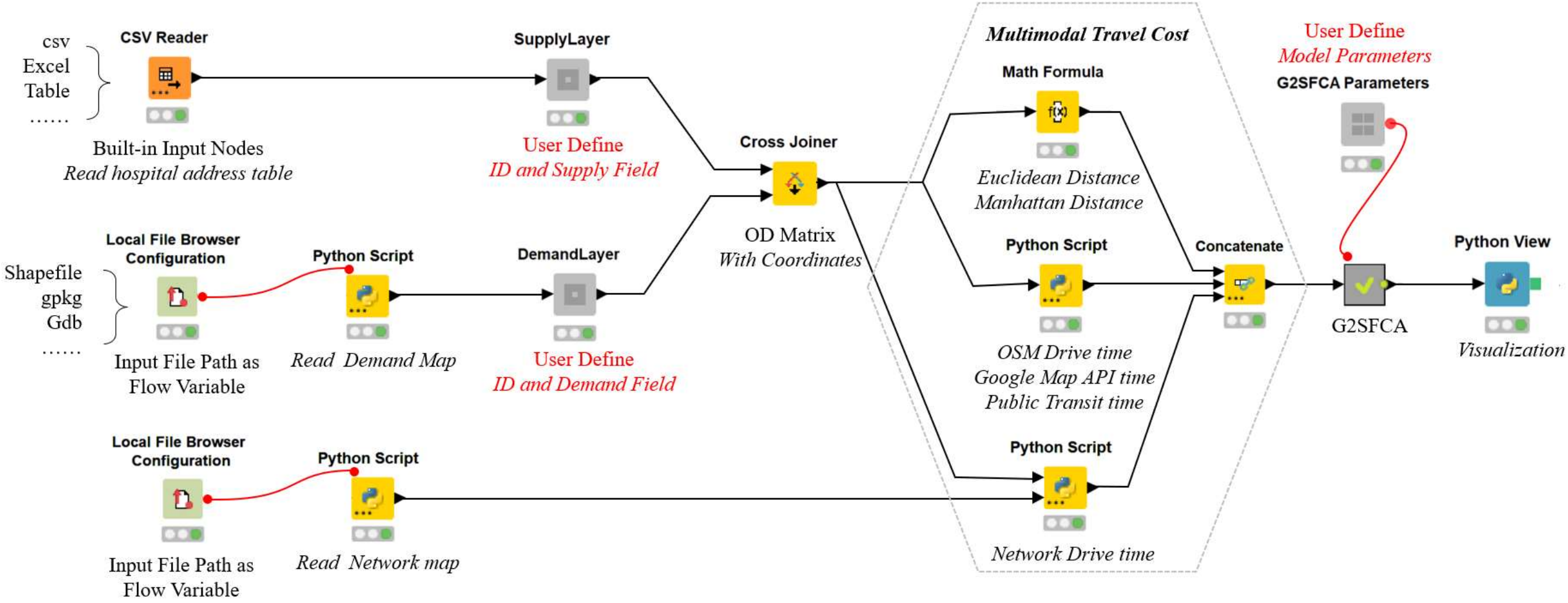
Workflow of 2SVCA Model



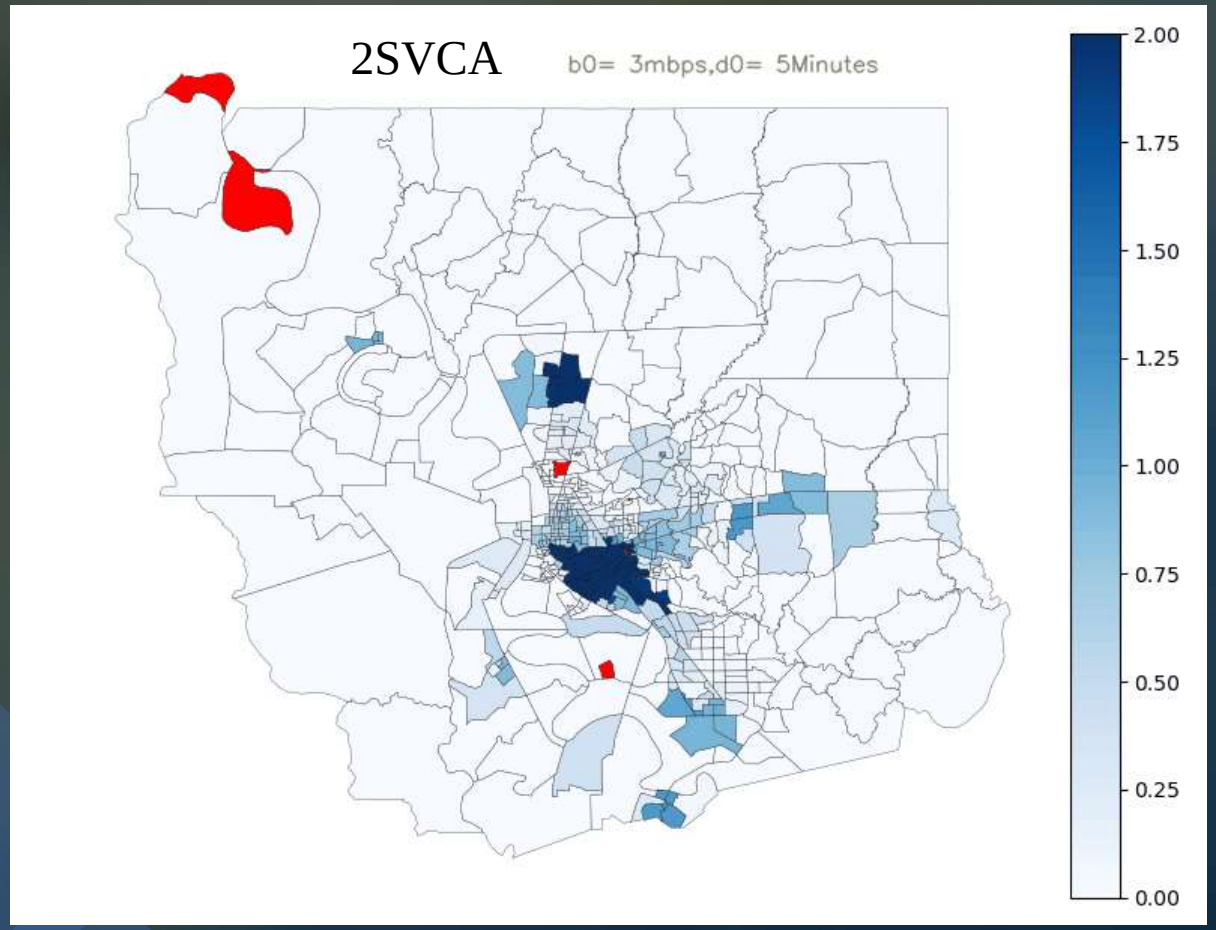
Web Portal

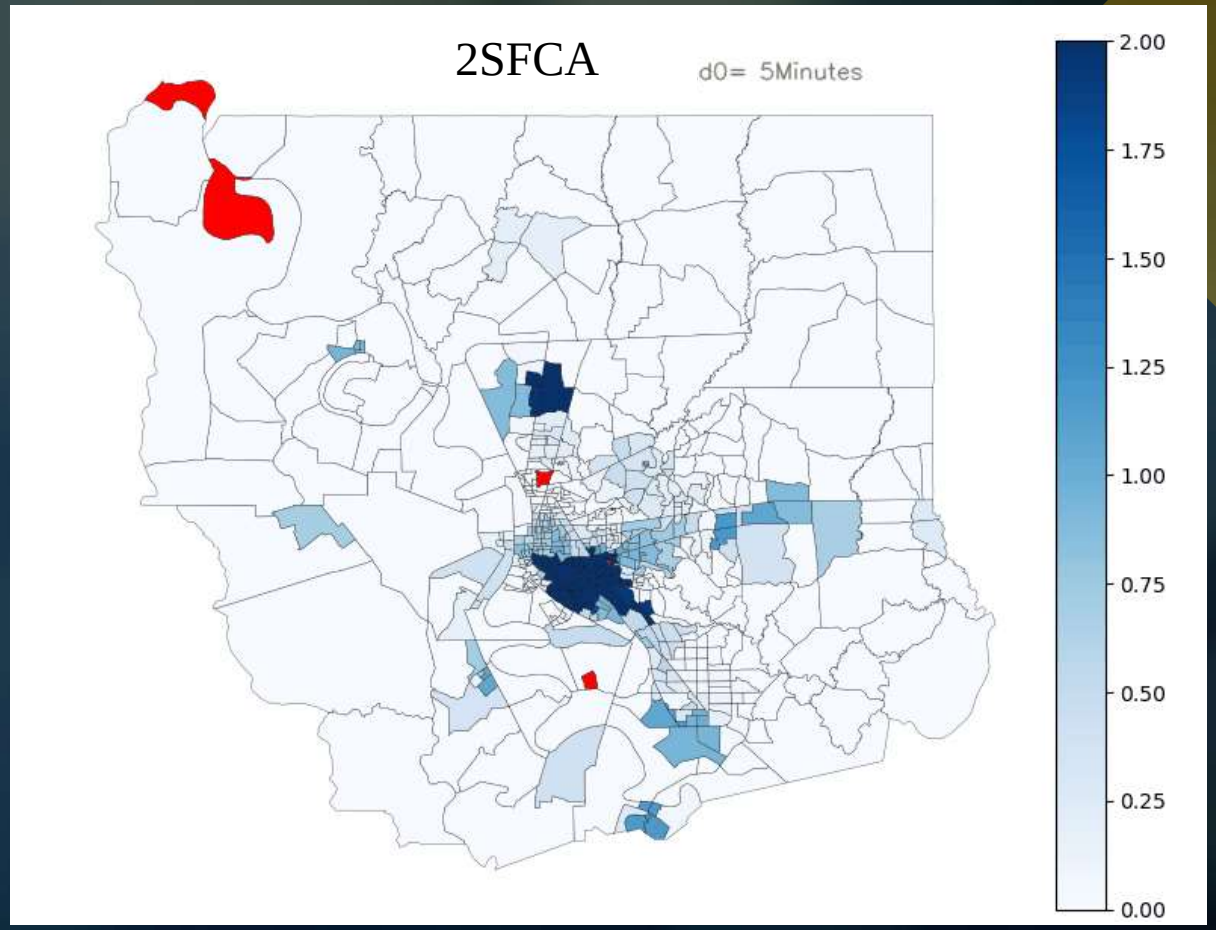
KNIME WebPortal or Analytics Platform (local version)

EXAMPLE Telehealth Accessibility by 2SVCA



EXAMPLE Telehealth Accessibility by 2SVCA



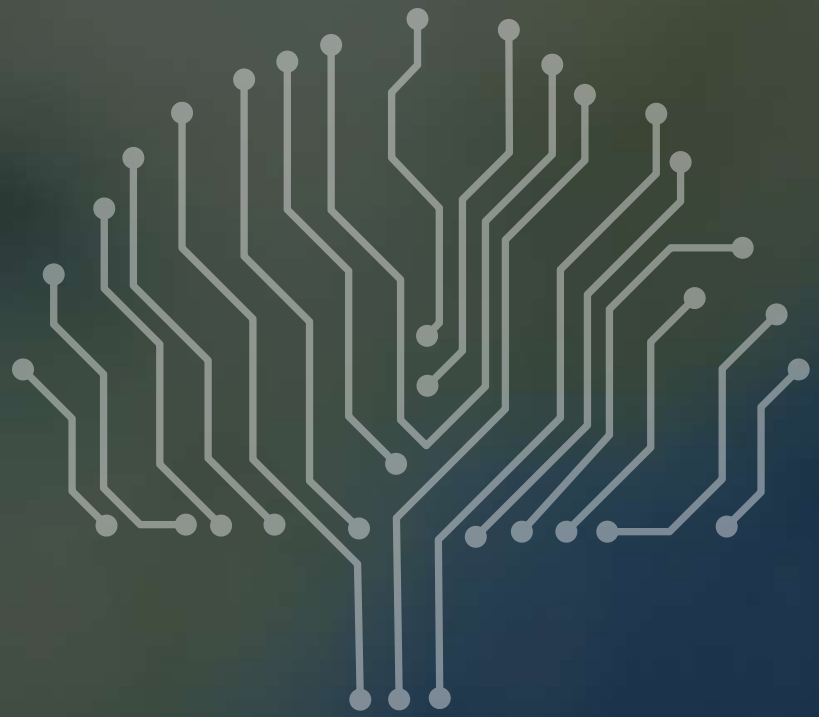


(a) Virtual accessibility by 2SVCA (d_0=5-30 minutes, b_0= 3Mbps) vs.(b) physical accessibility by 2SFCA (d_0=5-30 minutes)

FUTURE WORK

Knowledge Tree of Spatiotemporal Analysis

Open K-GCI Community



Spatial Data Lab

Knowledge Tree of Spatiotemporal Analysis

Theory-Model-Tools-Case Studies

A Data-driven, Workflow-based Cyberinfrastructure
to
Collect, share and update Data
Enable collaborative research on Spatiotemporal Analysis
Build knowledge tree of Spatiotemporal research
Offer training program based on workflows

NSF IUCRC
Spatiotemporal Innovation
Center(STC)

National Science
Foundation

Center for
Geographic Analysis
Harvard University

Spatial Data Lab

Open for Innovation
KNIME

THANKS

Spatial Data Lab http://spatialdatalab.org

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lingboliu@fas.Harvard.edu

Center for Geographic Analysis

Harvard University

Geo-computation Center for Social Sciences

Wuhan University

China Data Institute

Future Data Lab