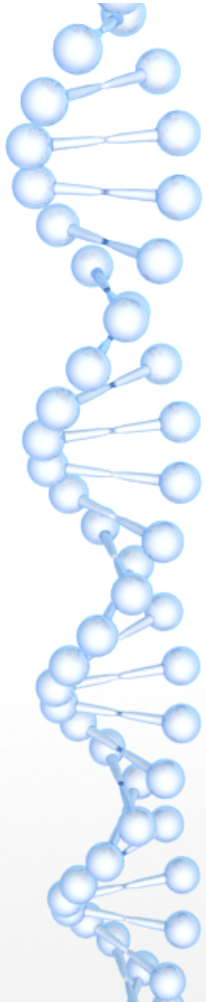


Pandemics

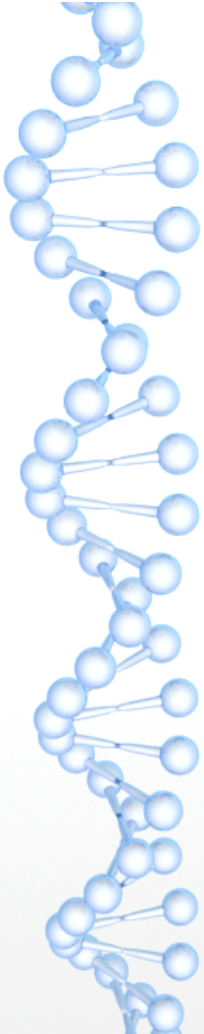
Ken Baclawski

Background

- Pandemics have different characteristics
  - Severity (e.g., cases and fatalities)
  - Period of time
  - Geographic extent
  - Data
- Ongoing major pandemics

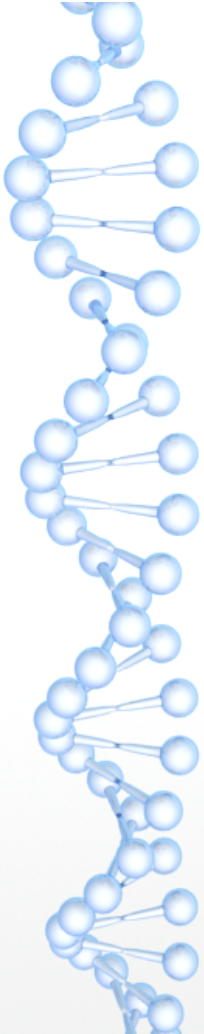
Pandemic	Fatalities	Period	Primary Extent
Tuberculosis	1.5M/year	Over 6000 years	Asia
HIV/AIDS	36.3M	40 years	East and Southern Africa
COVID-19	6.31M	2.5 years	North America

Pandemic Data is Big Data



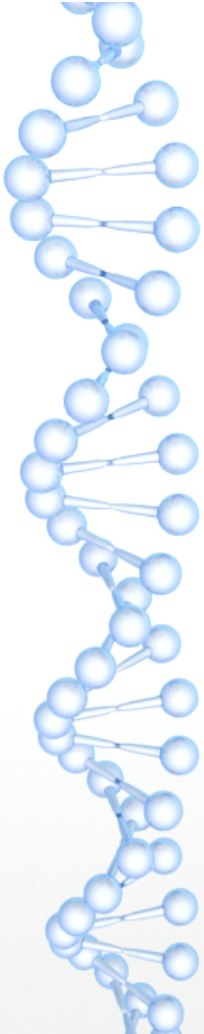
- Volume
  - HIV/AIDS 260K papers
  - COVID-19 700+K papers
- Variety
  - Lack of interoperability (silos)
  - Hasty publication
    - Ad hoc formats
    - Unspecified semantics
    - Inconsistencies
- Velocity
  - COVID-19 literature is rapidly increasing
  - Others are slower
- Veracity
  - Mostly accurate
  - Negative correlation with social media sharing

Systems for Pandemic Research (1)



- **Clinical Trials**: Tools to search and analyze papers and data on Covid-19 clinical trials
- **Data Analysis**: Papers that utilized semantic technology to integrate data from various data sources and to provide additional understanding of the data.
- **Drug Repurposing**: The process of taking a medication initially used to treat one disease and utilize it to treat a different disease.
- **Harmonization**: Semantic techology for integrating models for the medical domain. Whereas some industries suffer from a lack of standards, healthcare has the opposite problem: too many.

Systems for Pandemic Research (2)



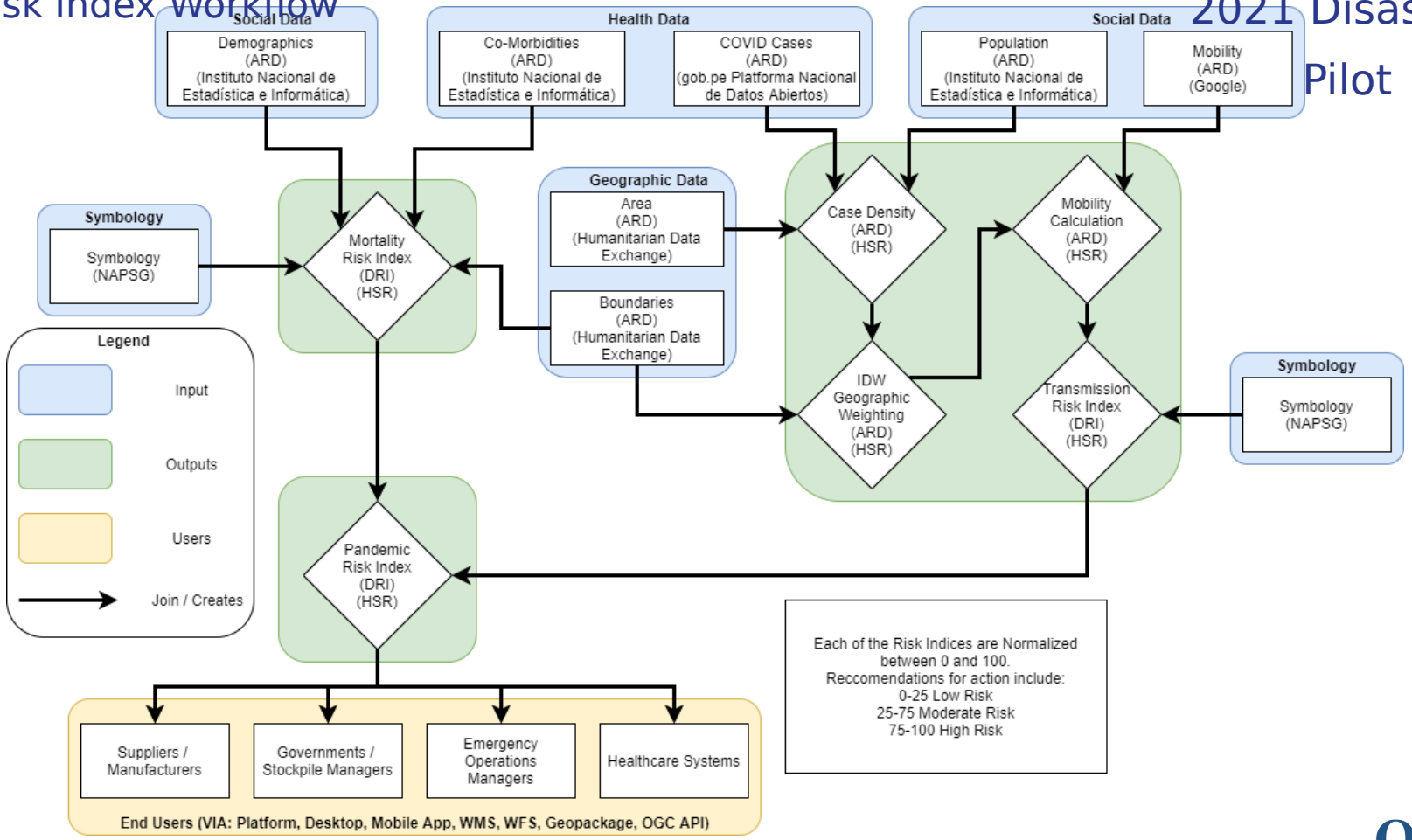
- **Semantic Search**: Search for documents using ontologies rather than keywords. This was one of the first and most common knowledge graph applications in industry.
- **Statistics**: Systems that take data and represent it graphically
- **Surveillance**: Systems that aid in monitoring patients. One keynote and a focus session of CogSIMA 2022 were devoted to these systems.
- **Vocabularies**: Ontologies designed to model specific domains such as the Covid-19 virus (e.g., CIDO) in order to be reused by other researchers.
- Source: Michael DeBellis and Biswanath Dutta, *Semantic Technology and the COVID-19 Pandemic.* See: Session https://bit.ly/3v7VJkn Slides https://bit.ly/3w5ZQ0X Video https://bit.ly/3w3icQ8

Open Geospatial Consortium Pilot

- Opportunity to test end-to-end information flow related to all phases of disaster management
- The following slides show the OGC workflows for:
  - Pandemic Risk Index
  - Medical Supply Needs Index
- Source: Josh Lieberman and Paul Churchyard, *Overview of the OGC Disaster Pilot.* See: Session https://bit.ly/3trSWlg Slides https://bit.ly/3G8FUvK Video https://bit.ly/3AA5SH3

Pandemic Risk Index Workflow

2021 Disasters Pilot



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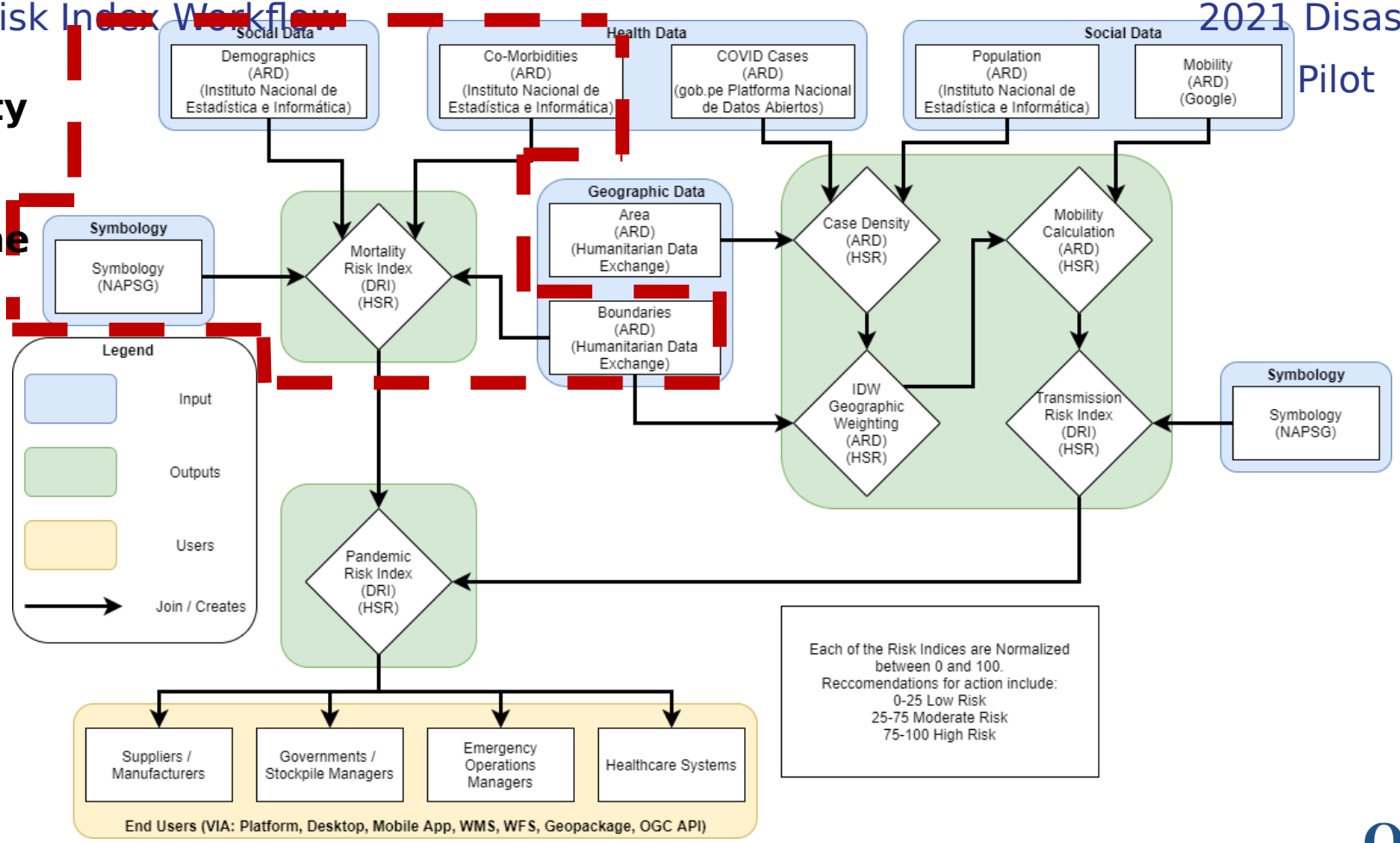
Pandemic Risk Index Workflow

2021 Disasters Pilot

Mortality Risk Index Components



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Pandemic Risk Index Workflow

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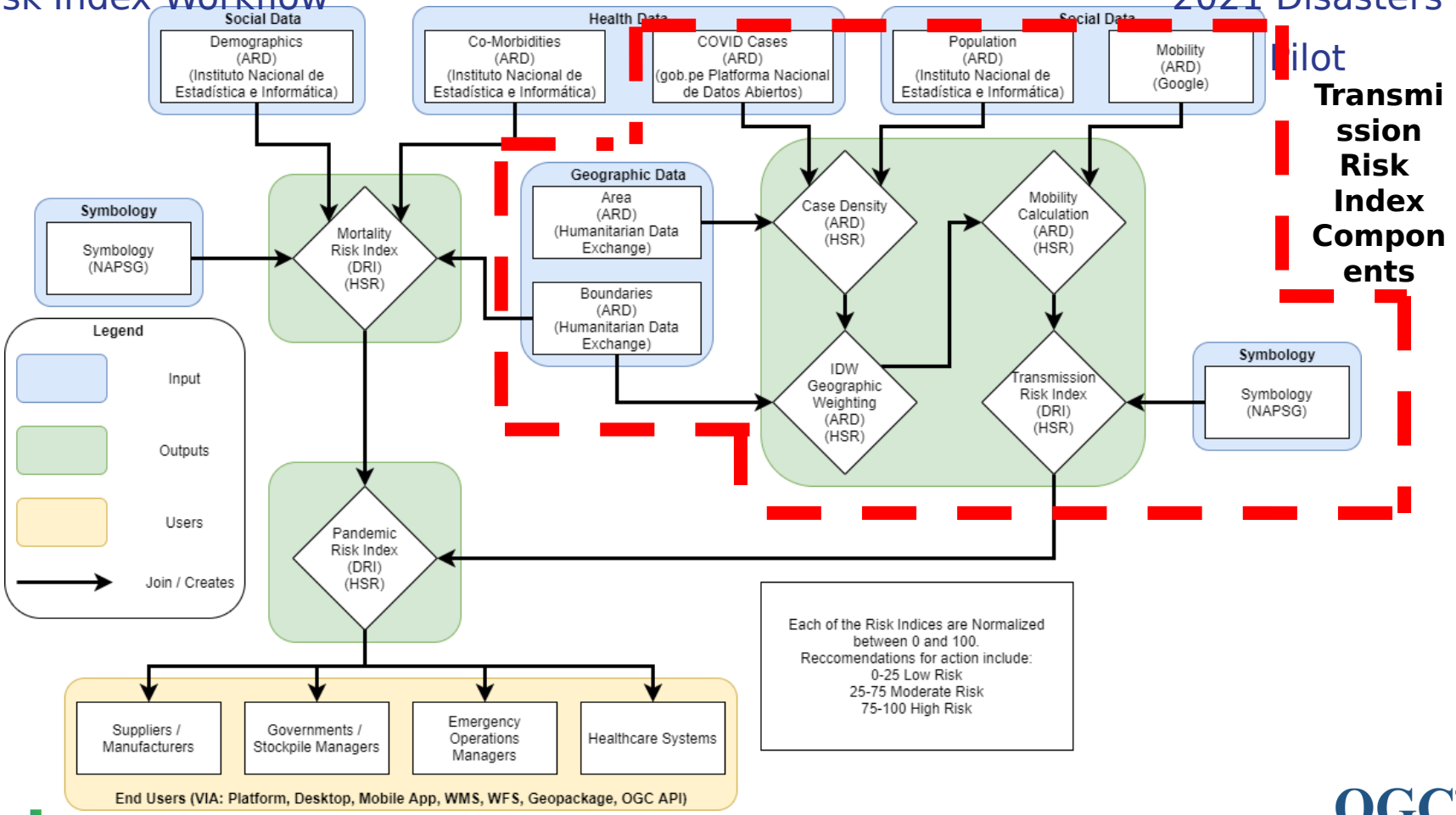

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Pandemic Risk Index Workflow

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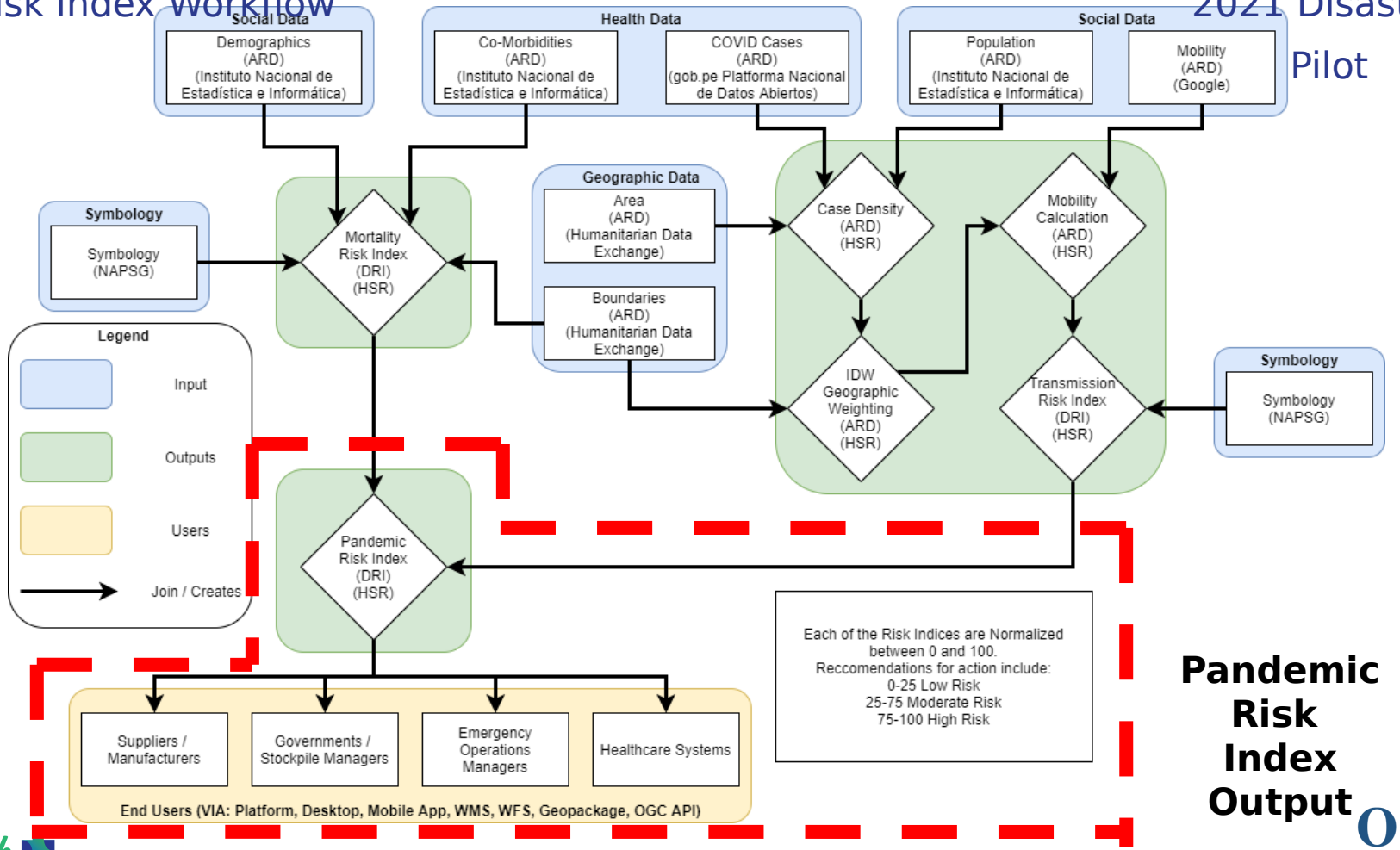

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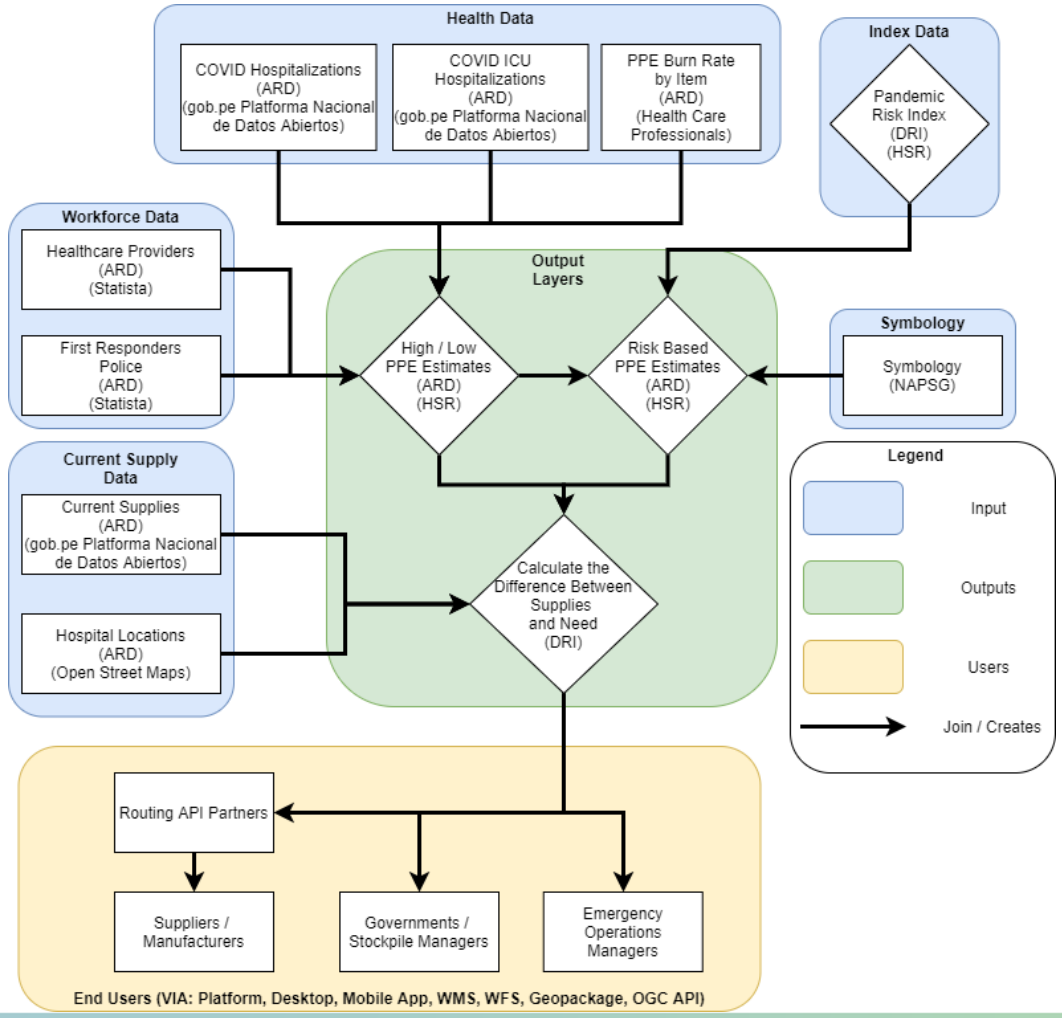
Medical Supply Needs Index Workflow

2021 Disasters Pilot



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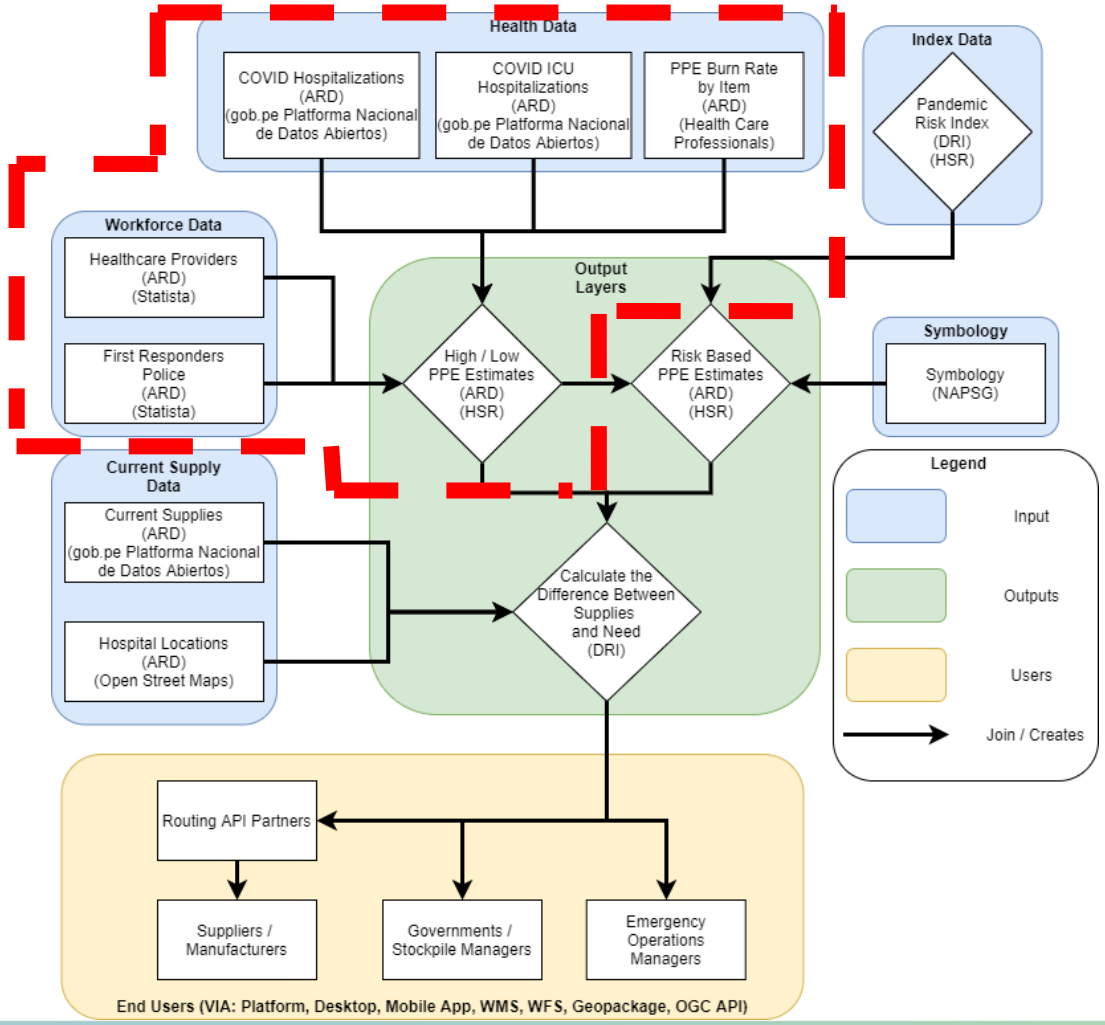
Medical Supply Needs Index Workflow

High / Low Medical Supply Needs Index Components



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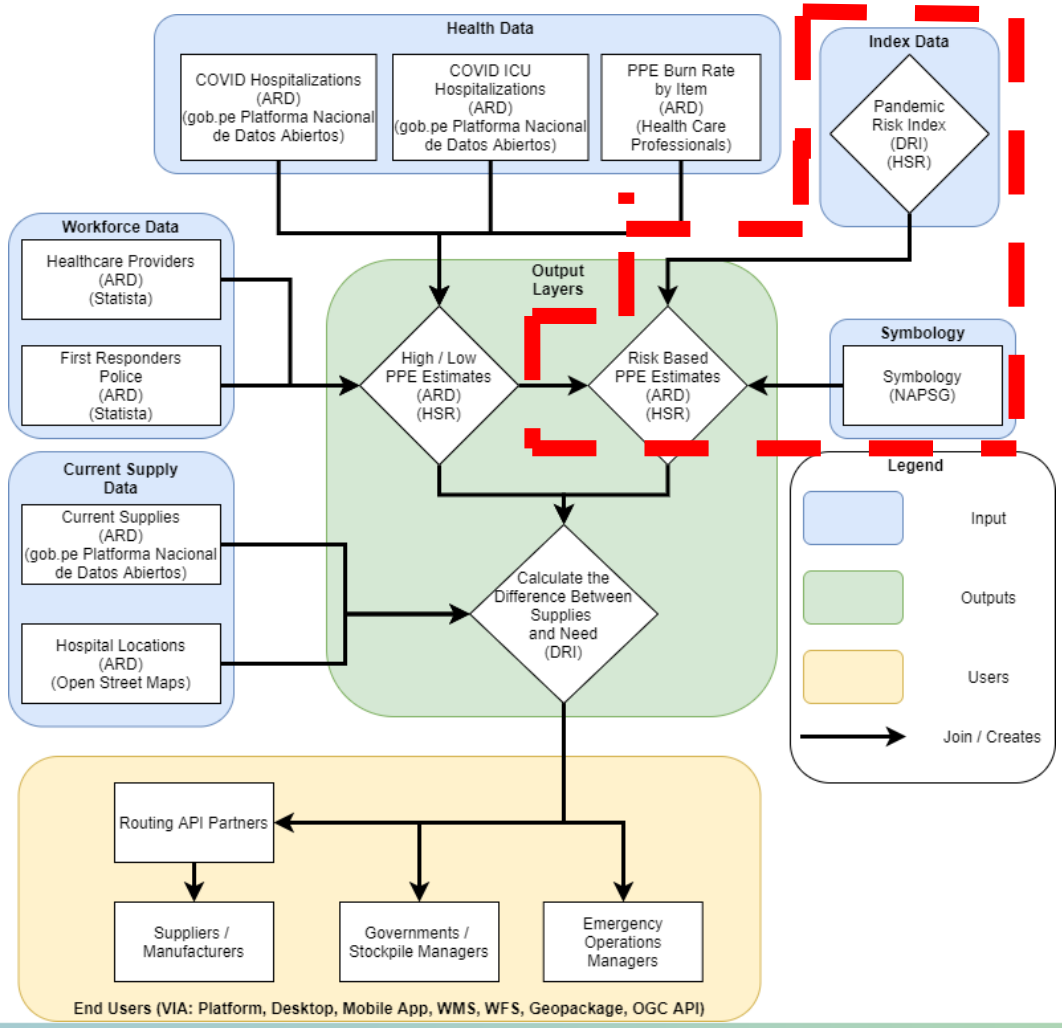
Medical Supply Needs Index Workflow

2021 Disasters Pilot



Index Based Medical Supply Needs Index Components

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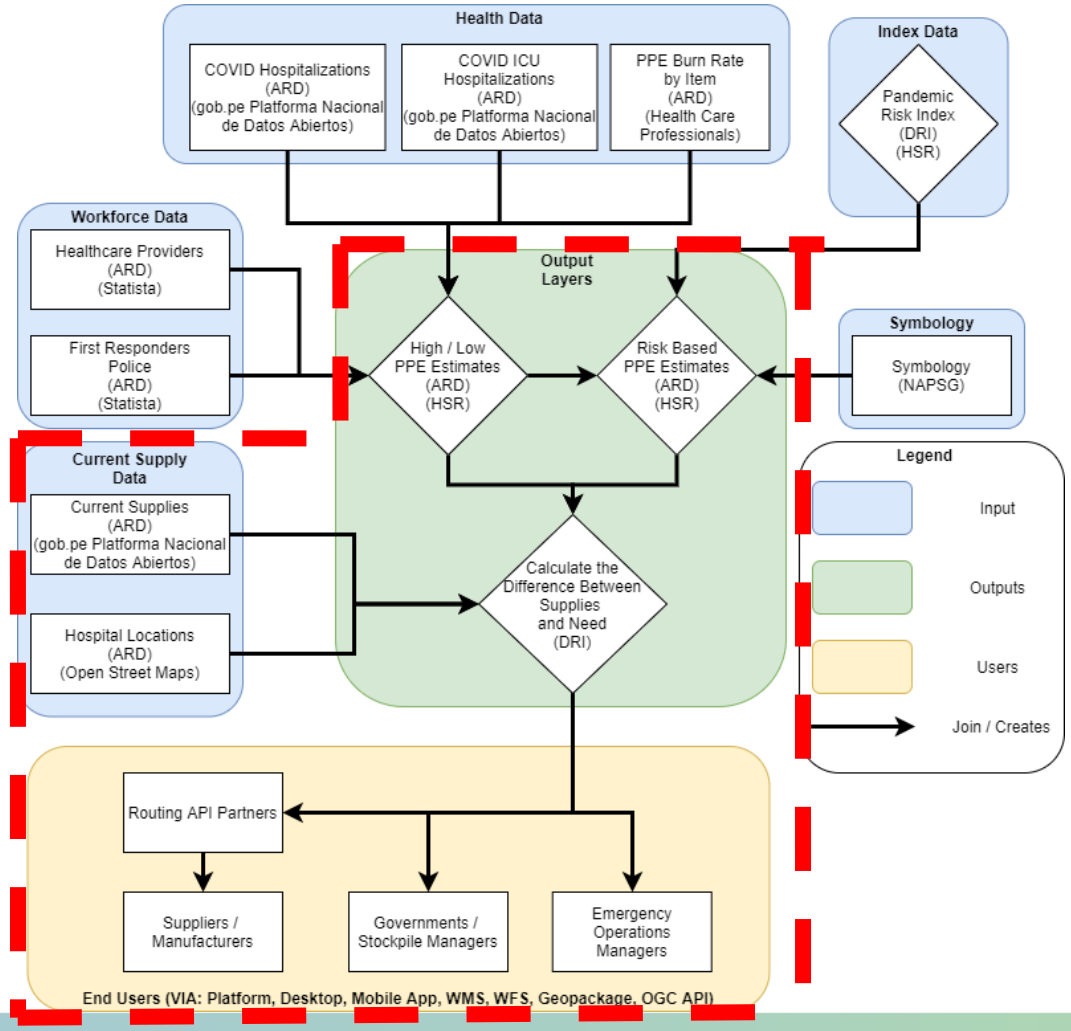
Medical Supply Needs Index Workflow

2021 Disasters Pilot

Medical Supply Needs Index Output



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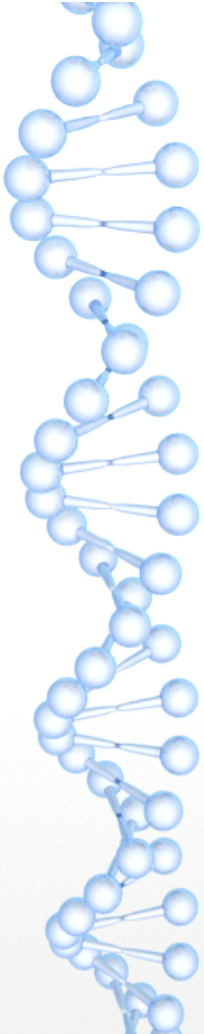
Modeling Interventions



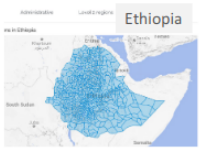
- Interventions represent decision making on a regional or national level
- Necessary for mitigating risks and managing disasters
- Interoperability occurs on many levels
  - Data for situation awareness and decision making
  - Communication among government agencies, companies, communities
- Modeling is essential but can be time-consuming and expensive
- Yolanda Gil has been developing tools for rapid modeling.

AI in MINT: From Modeling to Decisions

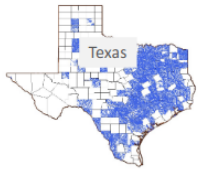
AI for Integrated Modeling

- Reduce effort from years to weeks
  - Automated reasoning
  - Machine learning
  - Intervention-driven user guidance

food insecurity



flooding



droughts

Expert Modeler	Gather Data	• Locate, catalogue, and curate potentially relevant data • Generate new data when possible (eg from remote sensing data, improve data quality, automated data transformations for interoperability, etc.)
	Define Regions	• Define useful regions for different modeling domains
	Prepare Models	• Create configurations of models for different modeling situations • Create model set ups to customize model to specific areas or limited scope • Run models to determine sensitivity to parameters and inputs
Modeler	Identify Objectives	• Decompose problems based on responses of interest and modeling regions • Coordinate model and data choices for integrated modeling • Identify ranges of drivers, adjustable parameters, and interventions
	Transform data	• Find appropriate data for the region given the modeling problems • Transform the data needed by the models
	Use models	• Find appropriate models to address modeling problems • Run model under different drivers and adjustable parameters to expose patterns of system behavior
Analyst	Explore results	• Generate report for decision maker • Run model under different assumptions to characterize uncertainty
Decision Maker	Drill down on analytic products	• Inspect details of quantitative analyses to understand patterns of behavior, causal relations, impact of interventions, etc.

From Yolanda Gil, *AI for Understanding Complex Systems: Modeling Interventions*

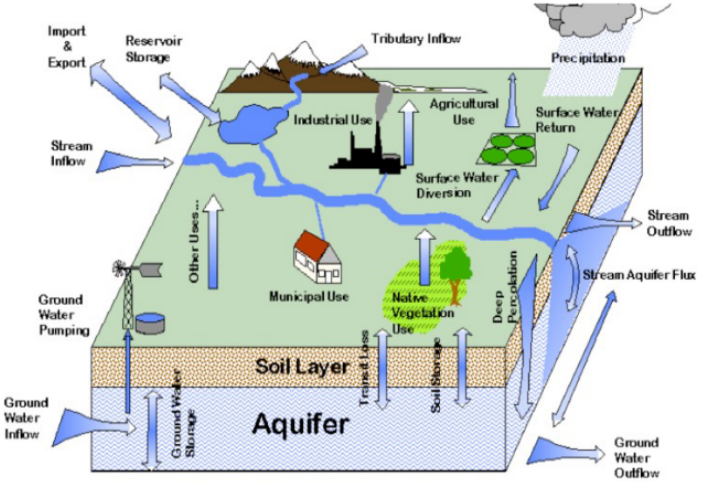
Modeling and Realizations (I)

- A simulation ***model*** (or integrated model) is used to emulate processes in a dynamic system under different initial conditions in order to understand its behavior
- A ***realization*** is a single run of an integrated model, where given a fixed input situation and parameter settings (i.e., given input datasets and parameters), the integrated model generates a prediction (i.e., output datasets)
  - A realization is a workflow execution
  - Non-deterministic models can lead to several realizations, each corresponding to a different seed
- A ***realization specification*** consists of an input situation (input data and input parameter settings) together with the model(s) form which can then be submitted for execution in order to create a realization. A realization specification is an execution-ready workflow
- An ***incongruent realization*** is a realization with a complete execution that is considered erroneous because the predictions are not consistent with observations, physical laws, or known system behaviors

From Yolanda Gil, *AI for Understanding Complex Systems: Modeling Interventions*

Interventions (I)

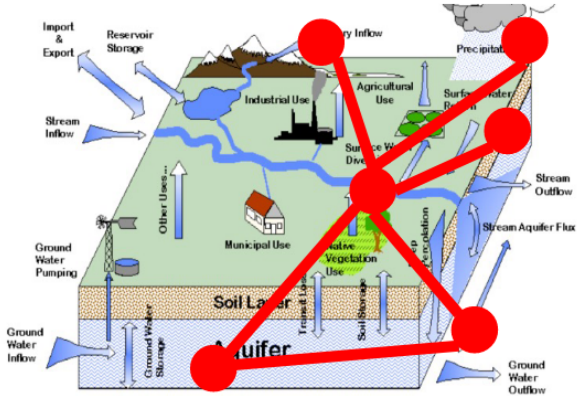
- An **intervention** is a possible action that could change the behavior of a system, typically carried out by humans to change an existing situation with the goal of eliminating/mitigating future undesirable outcomes
  - e.g., increasing the amount of fertilizer subsidies with the intention to increase crop production
  - e.g. carry out controlled fires in region R to burn 80% of the vegetation every two years



From Yolanda Gil, *AI for Understanding Complex Systems: Modeling Interventions*

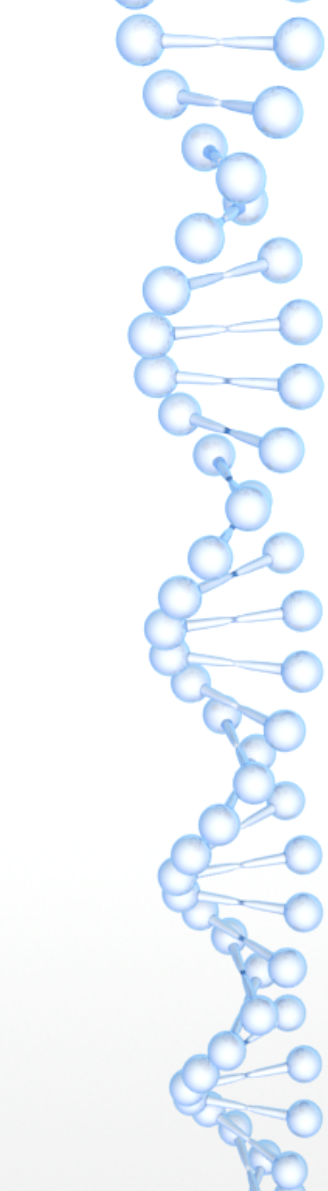
Interventions (II)

- An intervention itself is an action(s) that affects the system, but it is often not part of the model and may be represented in terms of the system variable(s) that the intervention can affect
  - e.g., reducing fertizer prices to increase the use of fertilizers in agriculture



From Yolanda Gil,
AI for Understanding Complex Systems: Modeling Interventions

Session: https://bit.ly/3ubnvM0
Slides: https://bit.ly/3M1CJcO
Video: https://bit.ly/3L4BCbc
YouTube: https://youtu.be/Umjtt2RxG64



Discussion