



Conceptual Framework for an Exposure History

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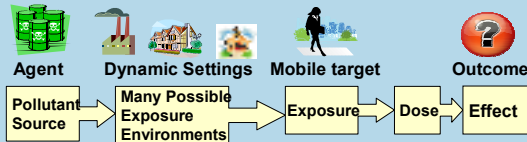
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Exposure Over Space and Time

What disease causing toxins have you been exposed to over your lifetime?

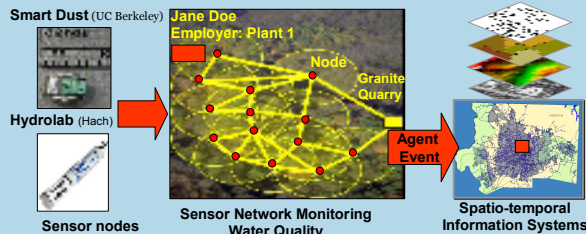
Problem: Health researchers need to understand a patient's **exposure history** to better diagnose, treat and prevent disease. For some diseases that develop over a period of years (e.g., cancer), investigating relationships between cases is complicated because of changing factors in the population and the environment. Individuals typically move many times over the course of their lives, breaking possible connections to locations of disease clusters or previous exposures.



Solution: Development of conceptual framework for spatio-temporal information system that can clearly represent and analyze the complex concept of an individual's **exposure history**.

Environmental Health Monitoring

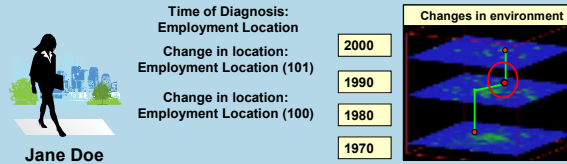
Expansion of wireless sensor networks will allow for the detection of fine scale changes or **events** in the environment and provide health researchers with better datasets to investigate connections between disease and the environment.



An **environmental event** is defined as a significant change in an environmental variable of interest as measured by one or more sensor networks. When the measured value of the exposure agent exceeds a threshold it becomes a **noteworthy environmental event**.¹

Modeling Human Mobility

A **geospatial lifeline**² in this model of human mobility is represented as a set of location events (intervals). Starting with an individual's location at time of diagnosis, one can move back in space and time documenting changes in their environment(s).



Components of Exposure History

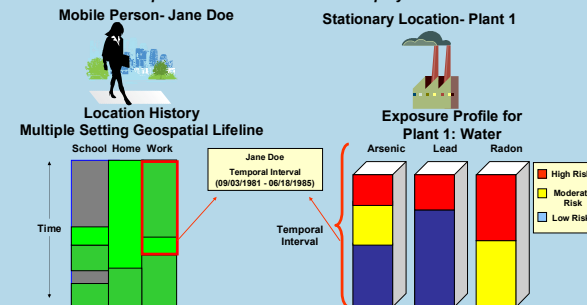
An **exposure event** occurs if and only if a person's geospatial lifeline **intersects** with a noteworthy environmental event in space and time.



A series of exposure events for a single person represents an **exposure history** that may feature a single agent or overlapping events from multiple agents. An exposure history model would allow querying exposure risks taking into account a person's multiple environments and environmental exposures from multiple domains (air, water, soil).

Exposure History Example

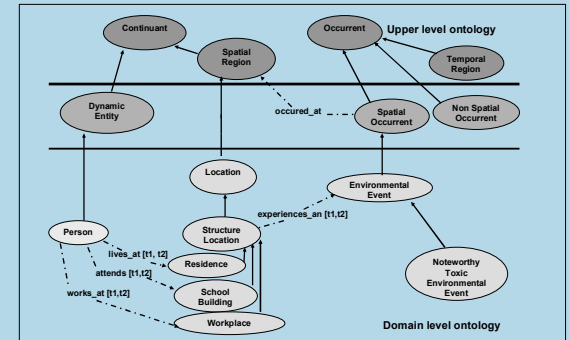
What was Jane's exposure risk to arsenic at her employment from 1978 to 2009?



Conceptual Framework

Web Ontology Language (OWL)³ is used to formally represent these exposure concepts and relationships. The upper level ontology is a modified version of the Basic Formal Ontology^{4,5} that has two types of entities:

Continuants: entities persisting over time, and **Occurrents:** entities representing temporary events



Resource Description Framework (RDF) statements model classes and relationships in the form:(subject, predicate, object). Temporal RDF statements associate a temporal interval with a relationship.⁶

Example:

Jane Doe is employed by Plant 1 from 09/3/1981 until 06/14/1985.

Plant 1 noteworthy environmental event (ID 101) 10/4/1984 until 05/28/1986.

Temporal RDF format: (s, p, o) : [t₁, t₂]

(s1, enrolled_in, P1) : [09:03:1981, 06:14:1985], (s2, experiences_an, NEE101) : [10:4:1984, 05:28:1986]



Conclusions and Future Work

This model will provide health researchers with an:

- improved understanding of dynamic spatial and temporal factors in health outcomes
- new model for evaluating lifetime exposure risks

Future work includes testing inference and query performance by populating the model with simulated individual movement and wireless sensor network data.

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