Reflections on Modeling in Health & Health Care

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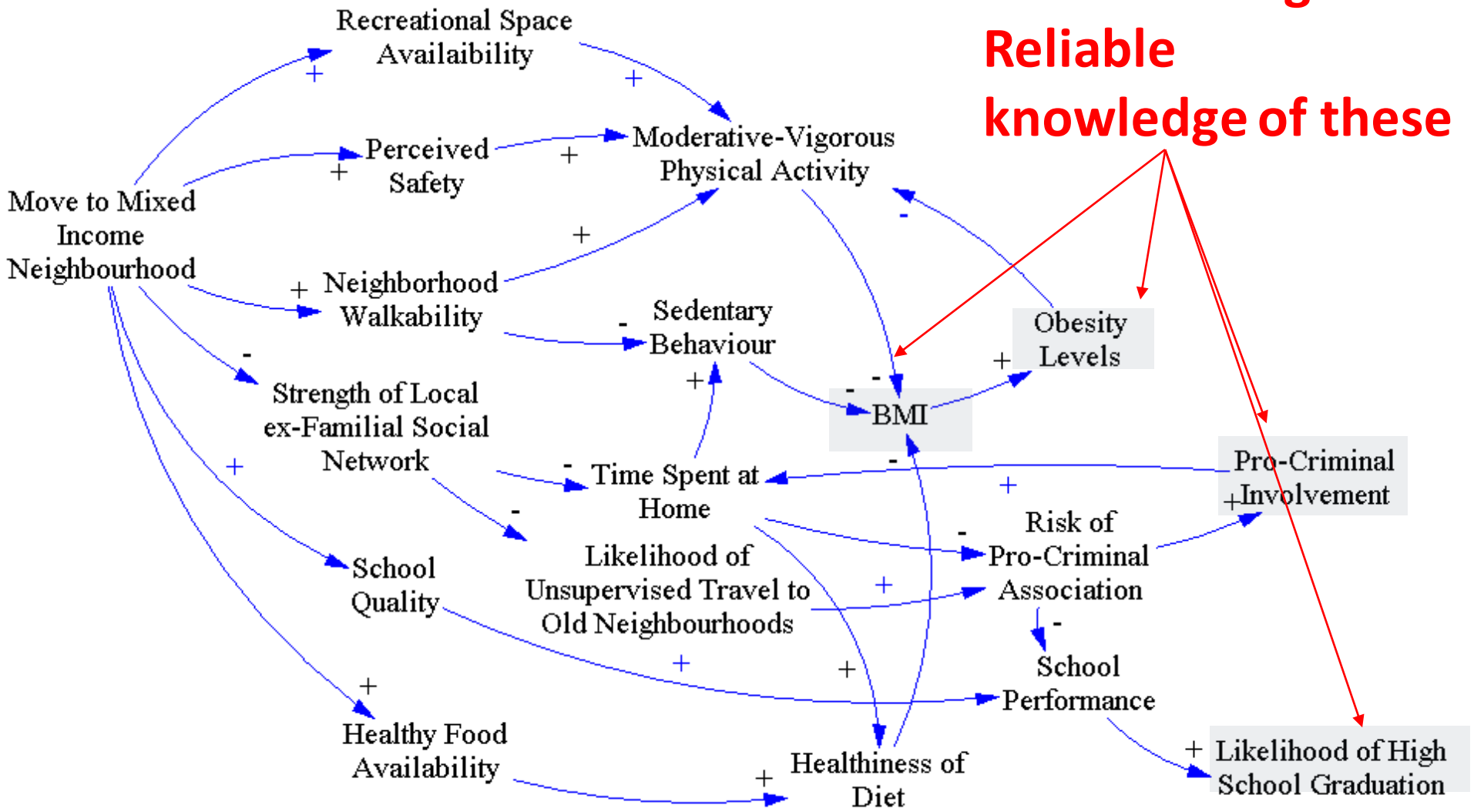
Strengths

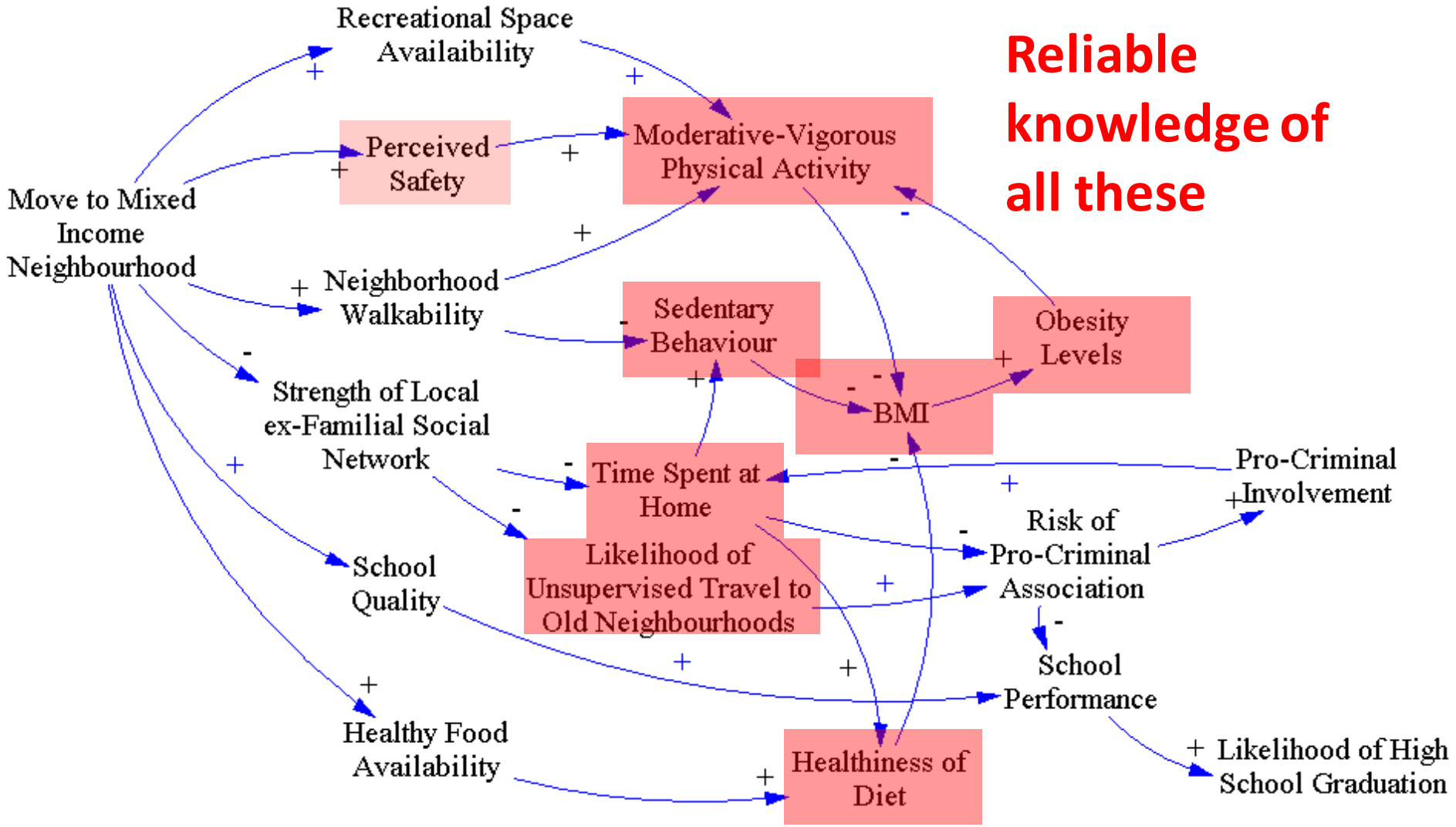
- Pronounced interest in computational (and particularly) systems science methods
- Greater awareness of need for addressing cross-sectoral challenges
- Large variety of readily available big data
- Growing accessibility of big data collection to health scientists
- Rising capacity of big data to understand effects along particular causal pathways
- Emergence of (at least minimally) accessible model characterization
- Reduced tribalism
- Recognition of the importance of team science
- Broad availability of basic background materials online

Understanding with Traditional Instruments

Traditional instruments give Reliable knowledge of these

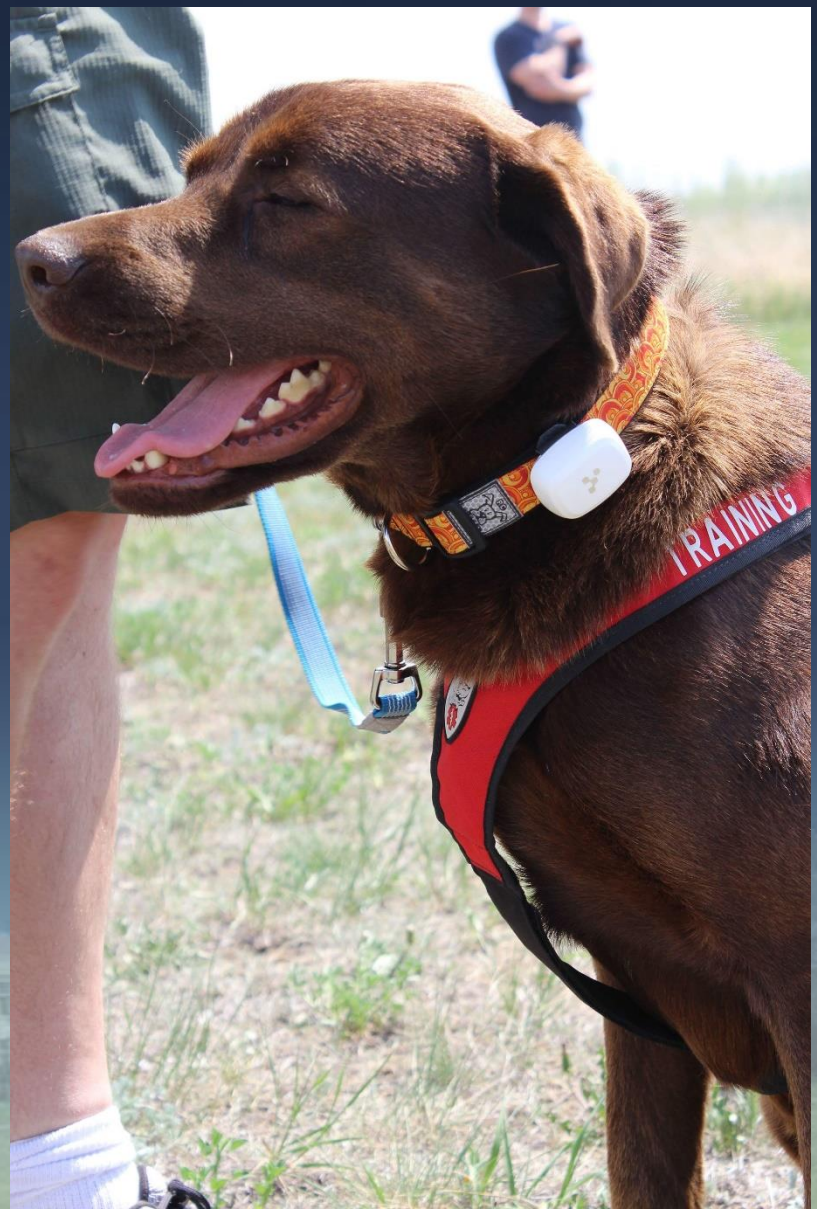


Understanding With "Big Data" (e.g., Smartphone & wearable based data)



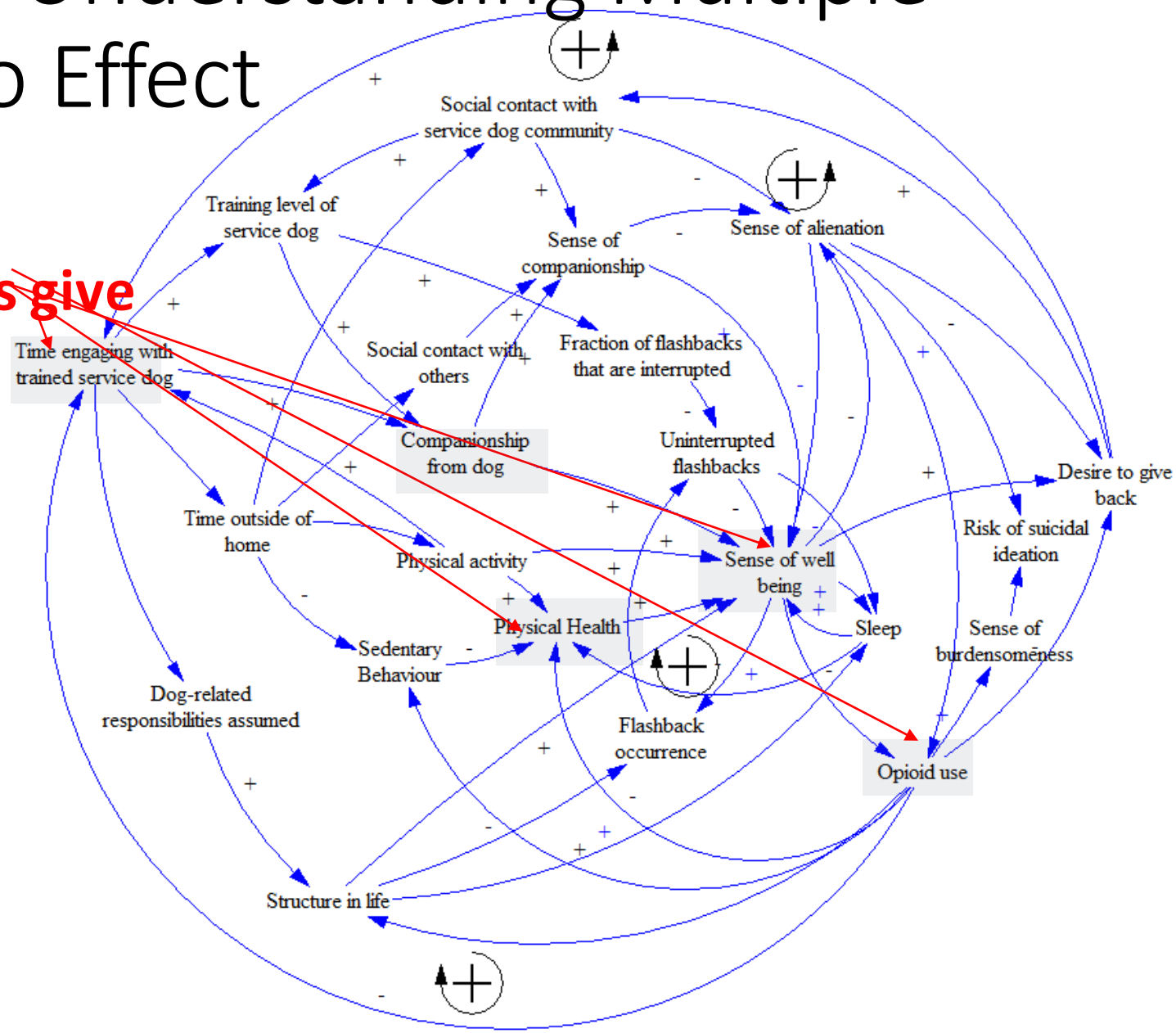
Elements of Ethica Study

- **Interviews (veteran, family, trainer)**
- **Smartphone**
  - *Microsurveys (Ecological momentary assessments), including photo & audio submission*
  - *Sensors*
    - Physical activity & sedentary behaviour
    - Social contacts (via other beacons)
    - Location
    - Distance to beacon for paired dog
  - *Conduit for fitbit data*
- **Fitbit** (heart rate, sleep)
- **Classic survey instruments**
- **On Dogs**: Bluetooth beacon on collar
- **Prescribing history** during study



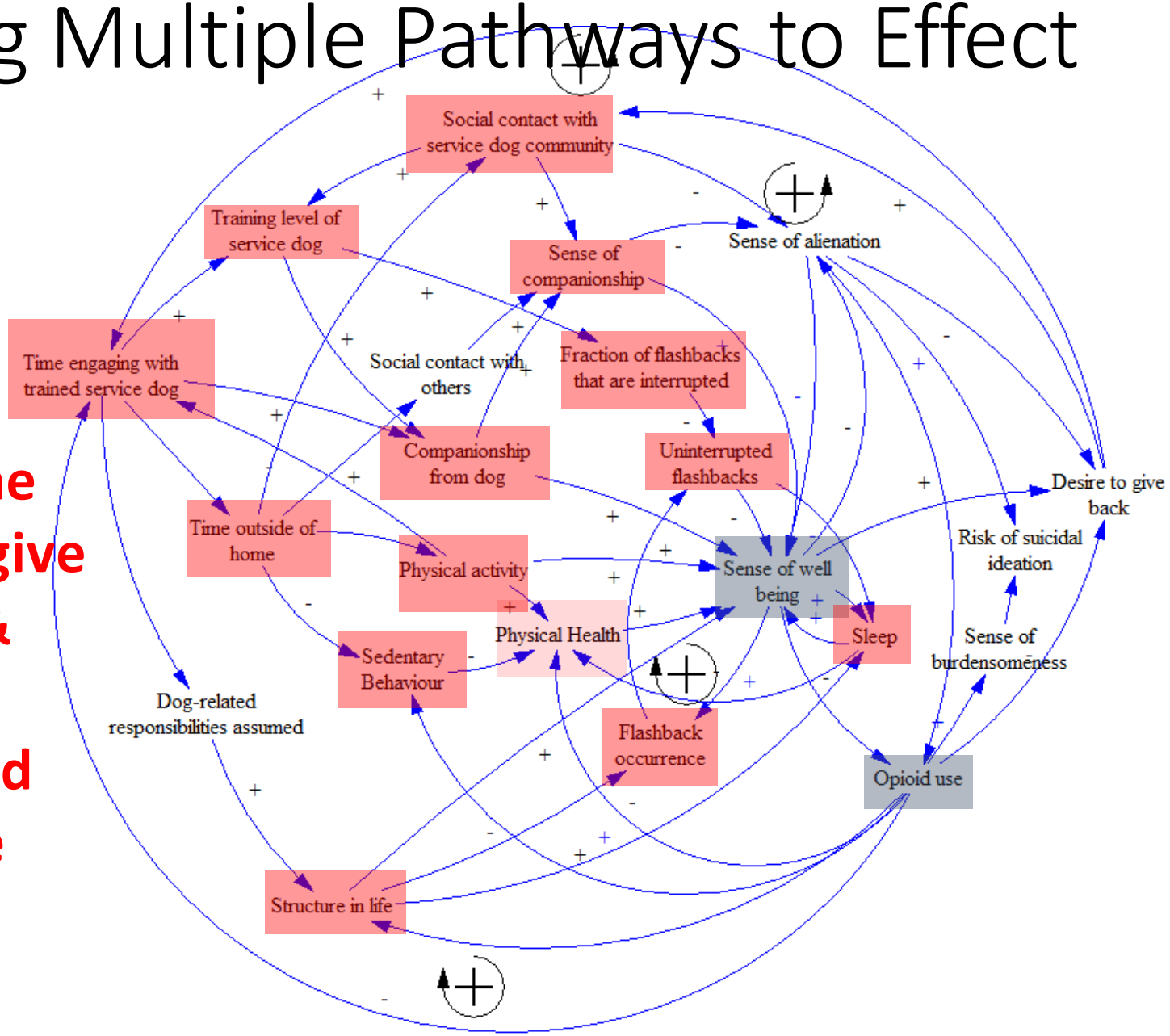
Traditional: Understanding Multiple Pathways to Effect

Traditional instruments give limited& coarse knowledge of these



With Ethica-enabled Mobile Devices: Understanding Multiple Pathways to Effect

Smartphone measures give far larger & temporally fine-grained knowledge of these



Traditional ABM Logic Specification

Z:\LinuxHome\Usask\Research\NICH_THIMModel\thim-master\repast\sarah\src\THIM\Person.java - Notepad++ [Administrator]

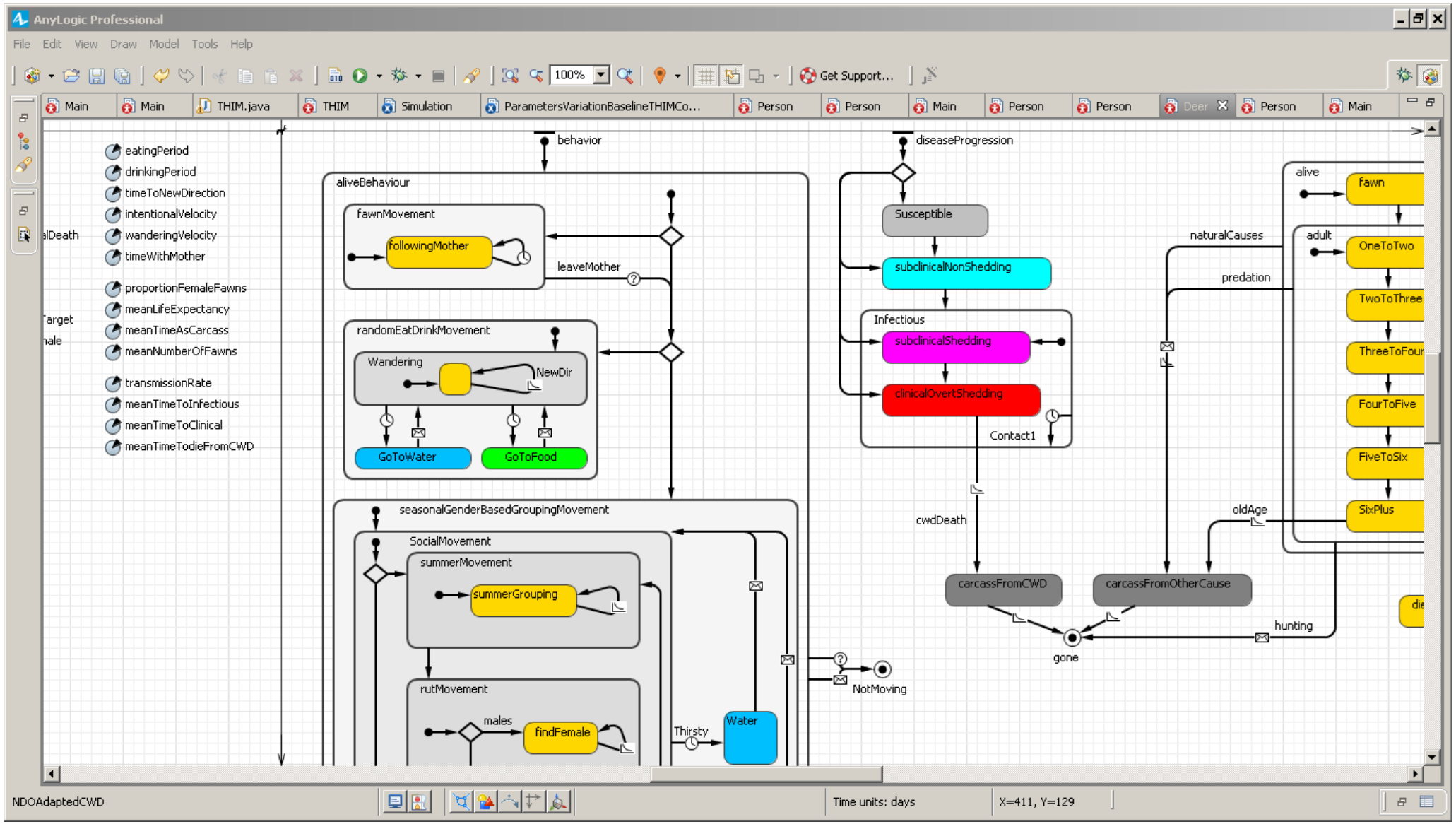
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ?

Movement.mpp | Abstract v1 | scala-output-100000 | new 1 | Person.java

```
316         }
317         if (willMove)
318         {
319             double dBestPropIncDiff = 1.0;
320             Context<?> mainContext = ContextUtils.getParentContext(this.myNeighborhood);
321             Neighborhood nBestNeighborhood = null;
322             for(Context<?> hoodContext : mainContext.getSubContexts())
323             {
324                 Neighborhood hood = (Neighborhood) hoodContext;
325                 if (hood.getAvgIncome() > 0 )
326                 {
327                     dPropIncDiff = Math.abs( this.income - hood.getAvgIncome()) / hood.getAvgIncome();
328                     if ( dPropIncDiff < dBestPropIncDiff)
329                     {
330                         nBestNeighborhood = hood;
331                         dBestPropIncDiff = dPropIncDiff;
332                     }
333                 }
334             }
335             if ( nBestNeighborhood != null && dBestPropIncDiff < stayPropIncDiff )
336             {
337                 this.setMyNeighborhood(nBestNeighborhood);
338             }
339         }
340     }
341
342     public void changeNeighborhood(Neighborhood bestNeighborhood)
343     {
344         if (this.home)
345             {this.home = false;}
346         for (Person child : this.myChildren)
347         {
348             child.myNeighborhood = bestNeighborhood;
349         }
350         this.myNeighborhood = bestNeighborhood;
351     }
```

Java source file | length : 13884 lines : 431 | Ln : 349 Col : 10 Sel : 0 | 0 | Dos\Windows | UTF-8 w/o BOM | INS

With (Limited) Declarative Languages



Weaknesses

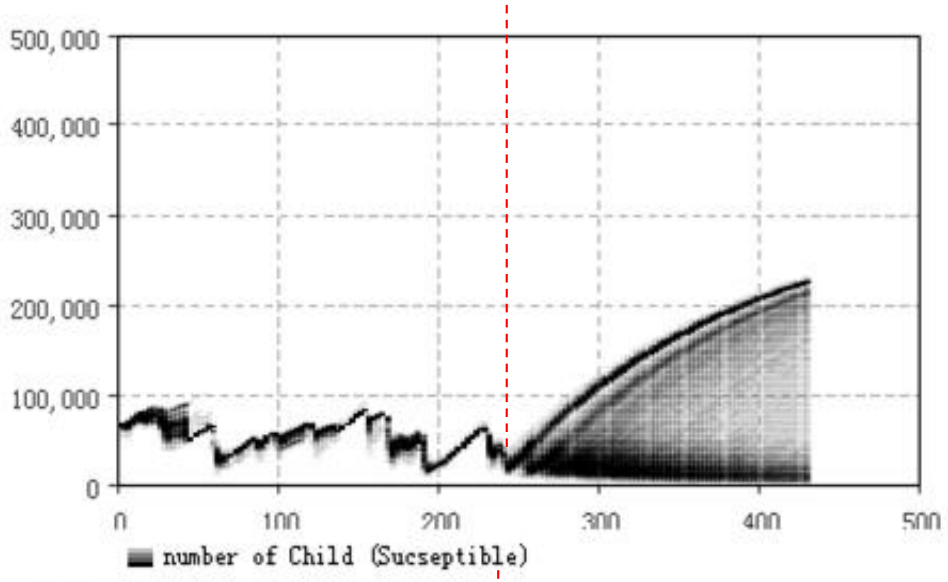
- Limitations of existing platforms
  - Impoverished modeling languages & abstractions: Unnecessary intrusion of implementation details into model specification
  - Poor scalability
- Rareness of computational researchers truly immersing themselves in health & health care concepts & language
- Weakness of analytic and computational foundations in public health & epidemiological education
- Limited education opportunities in cross-method modeling
- Shallow application of “systems science” label
- Lack of awareness of/adherence to software engineering best practices
- Siloed & parochial character of some tenure and promotion systems
  - Incomplete consideration of cross-disciplinary work
  - View of application work as conceptually weaker

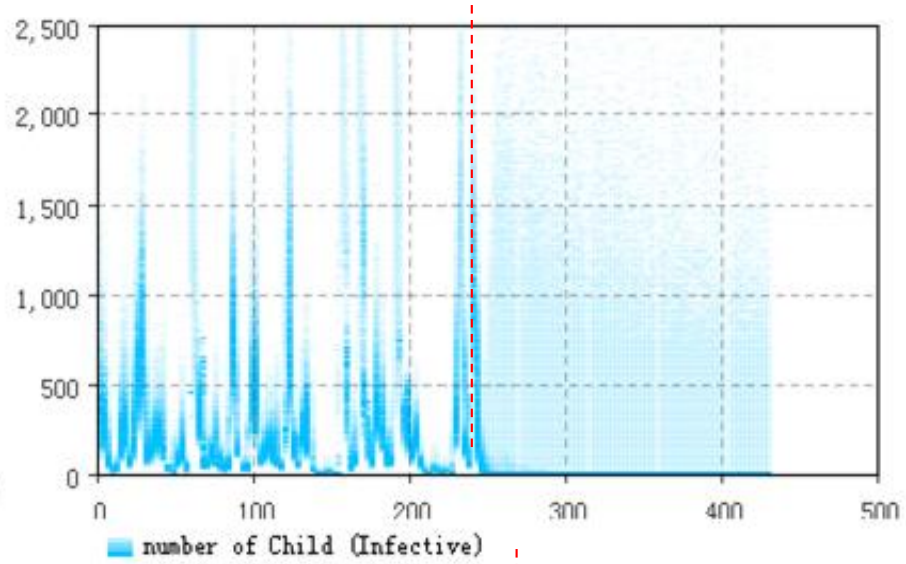
Opportunities

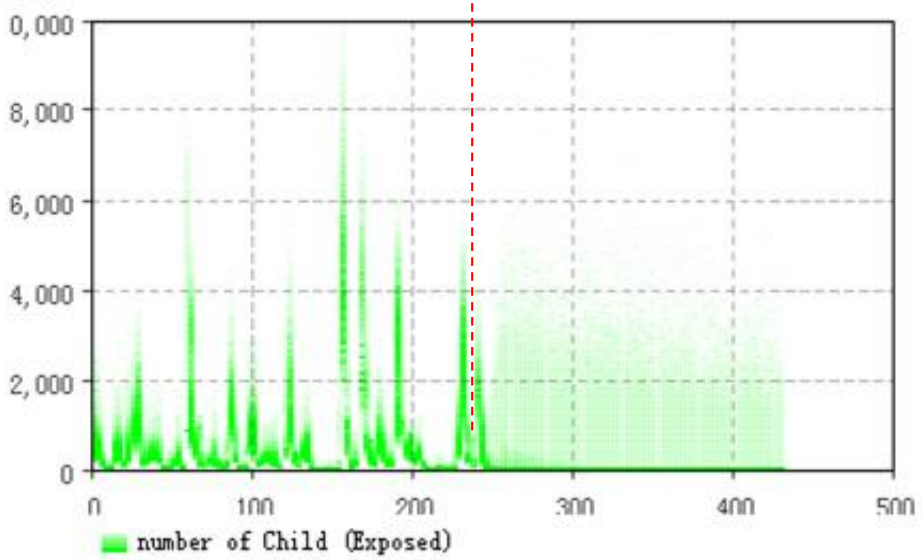
- Dynamic models and big data
  - Grounding models & big data via machine learning (recurrent updates&data streams)
  - Further growth of readily accessible and relevant big data
  - Capacity of big data to aid theory building at causal pathway level
  - Big data approaches to discovering causal relations (CCM, causal inference)
  - Clarity as to why see intervention effects
- Team based enablement (removing programmer from the learning loop)
  - Team based agile modeling for learning
  - Collaborative modeling enablement
- More structured, bite-sized, integrated educational material
- Novel modeling frameworks
  - Multi-scale & hybrid modeling formalisms
  - Declarative, health-focused model specification languages
  - Language enablement of performant, transparent, concise models
  - Data-science integrated frameworks enabling perpetually current models
  - Mathematical analysis tools
- Fully homomorphic encryption based cross-sectoral data linkages & analysis
- Enhanced model cognitive architectures
- Software engineering enriched modeling
- Rise of multi-inst. education networks
- Reduction in disciplinary disparities

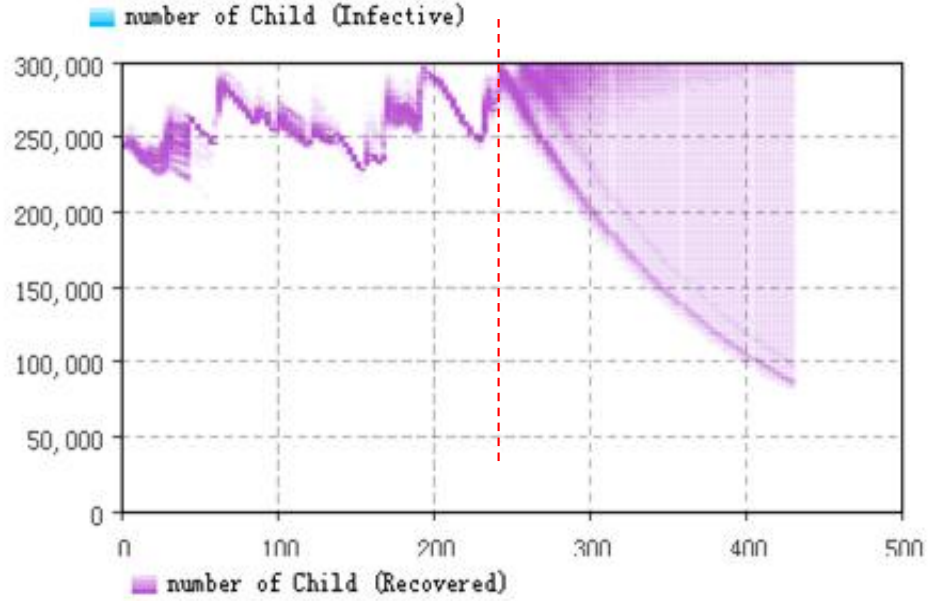
Population Tomography

Latent Variables









Recurrent Regrounding of Models: Moving Beyond Blind Models

Threats

- Conception of dynamic models as crystal balls, rather than learning tools
- View of modeling projects as purely technical endevours
- Conceptualization of data science as inherently theory-free
- Cultural hesitancy towards data sharing data
- Thickening of national border restrictions
- Lack of awareness of career options on part of trainees
- Inadequate training networks
- Lack of methodological innovations to support health modeling

Dynamic Models

Not

vs.

But

Advice to the Younger Generation

- Go local!
- Where viable, mix pure application with methodological advances
- Persist where you see alignment of key needs & your interest & capacity
- Math, math, and more math
- Embrace cutting edge technologies, but judiciously
- Avoid disciplinary navel-gazing
- Concentrate on doing good work – quality will be recognized
- Invest in complementary relationships
- Don’t be afraid of turning down opportunities
- Consider mixing big grant applications with contract opportunities