Social System Design Lab

GEORGE WARREN BROWN
SCHOOL OF SOCIAL WORK

TREC
Transdisciplinary Research on Energetics and Cancer Centers

# MULTI-BIRTH COHORTS:
## A METHOD FOR MODELING AGING POPULATIONS

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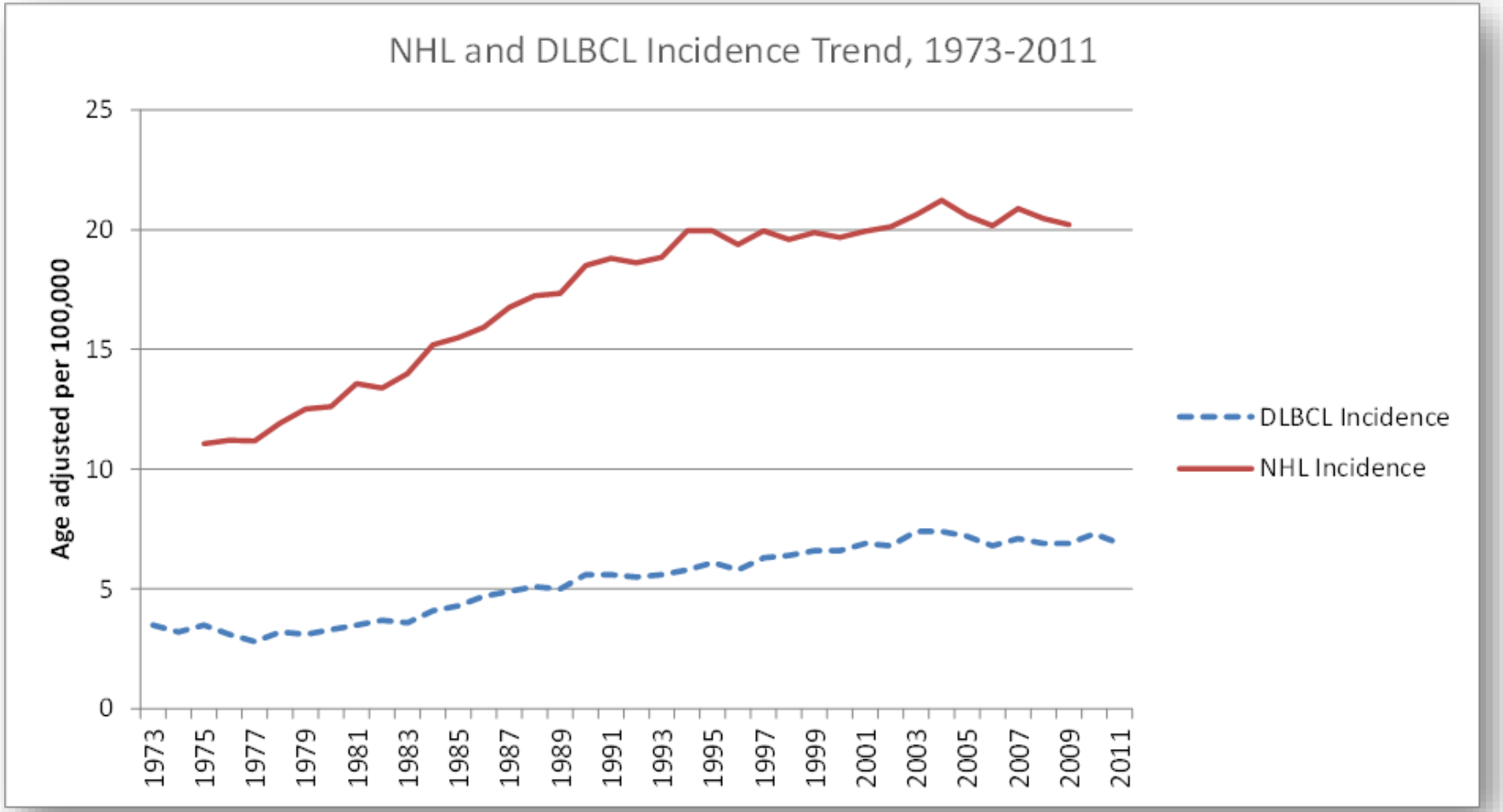
# TRANSDISCIPLINARY RESEARCH ON ENERGETICS AND CANCER (TREC)

- **NCI funded 15 Projects Across Four Institutions**
- **Washington University in St. Louis Project 4** Role of Social Determinants in the Link between Obesity and Cancer Across the Lifespan (Project Leads: Peter Hovmand, Ken Carson and Graham Colditz)
- **Initial Model Used Aging Chains for At-Risk Populations**

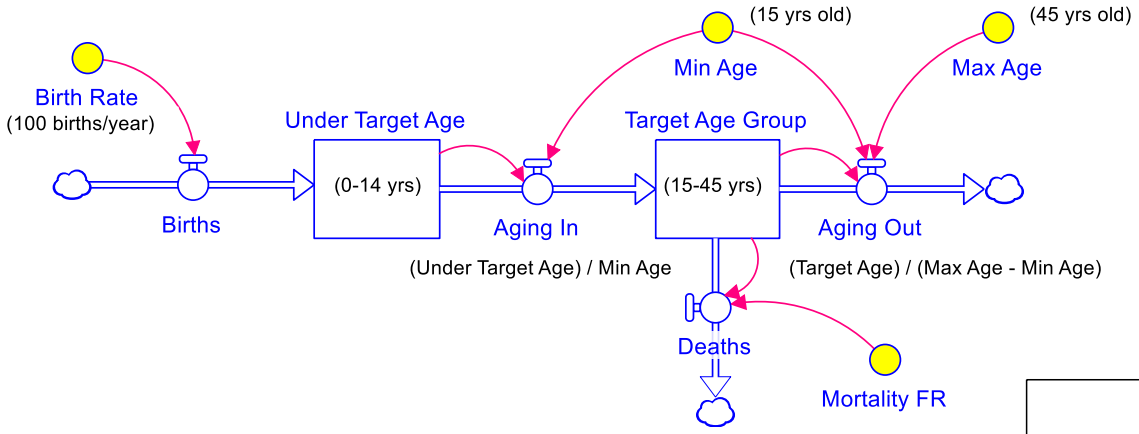
# TRANSDISCIPLINARY RESEARCH ON ENERGETICS AND CANCER (TREC)

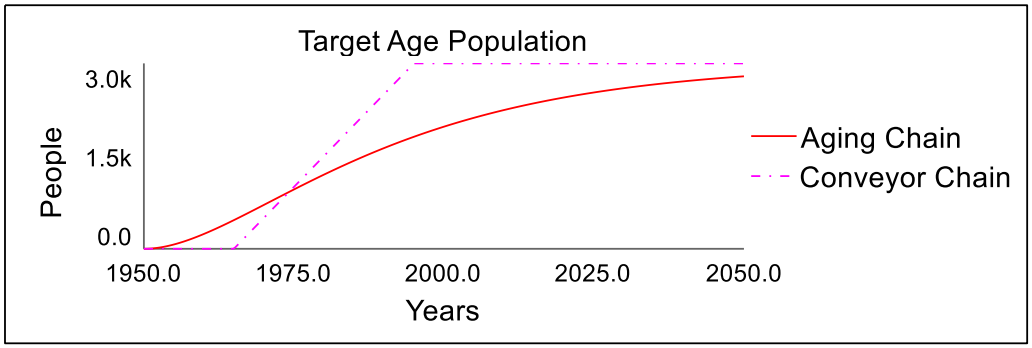


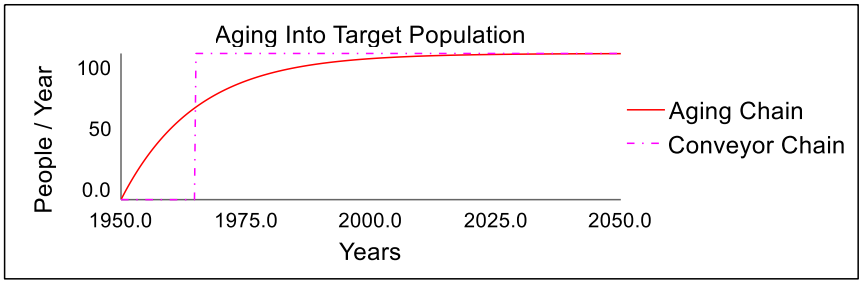
# AGING METHODS

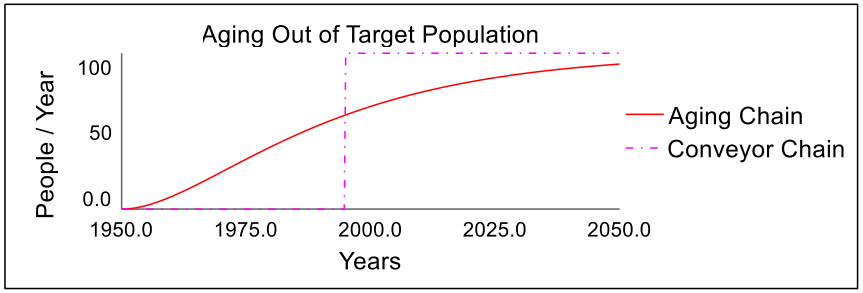
| Method | Strengths | Limitations |
|---|---|---|
| Aging Chain | • Distinguish Between Age Cohorts | • Cohort Blending *(Eberlein and Thompson, 2013)* |
| Discrete-Time Delay (e.g. Conveyors) | • No Age Distortion | • Continuous-Time Flows (e.g. Immigration and Attribute-based Transitions) |
| Annual Cohort Tracking | • No Age Distortion<br>• Accommodates Migration, Mortality | • One-Year Computation Interval |
| Continuous Cohorting *(Eberlein and Thompson, 2013)* | • No Age Distortion<br>• Accommodates Migration, Mortality<br>• Any Computation Interval | • Software-Specific Implementation<br>• Moderate Computational Burden |

# ILLUSTRATION OF COHORT BLENDING



# TREC PROJECT CONSIDERATIONS

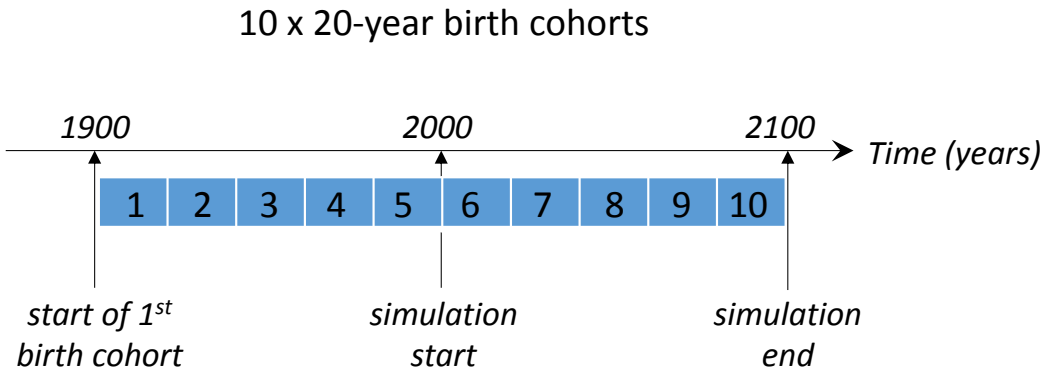
- Accurate Aging, But Process Is Secondary
- CISNET (Cancer Intervention and Surveillance Modeling Network) Guidance for Cancer Modeling:
  - Multiple Cohorts (e.g. Sex, Race, Age)
  - Time-Varying Factors (e.g. Smoking Prevalence, HIV/AIDS Impact on Non-Hodgkin Lymphoma, Available Cancer Treatments)
- Traditional Aging Methods Time-Invariant
- Switched to Time-Varying Approach

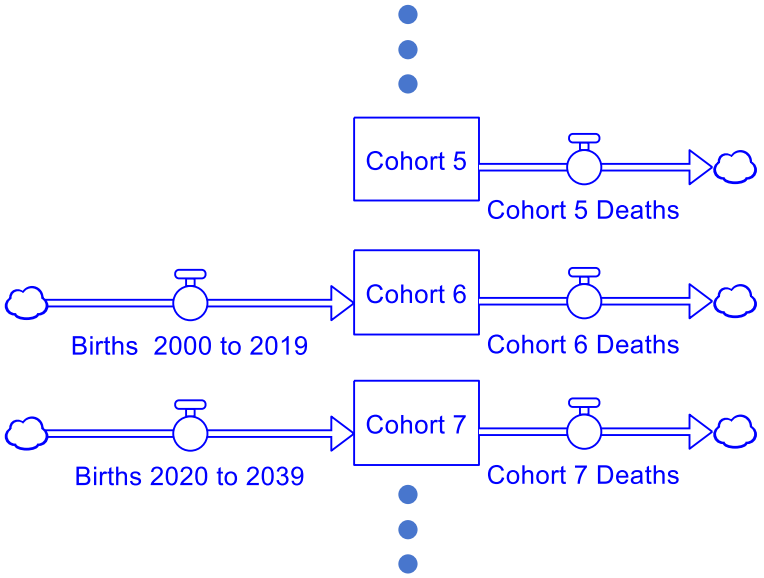
Time-invariant models $\dot{x} = f(x)$

Time-varying models $\dot{x} = f(x,t)$

# CENTRAL IDEA FOR BIRTH COHORTS

- Cohorts Defined by Birth Year Instead of Age
- Age is Time-Varying
- Population Risk Factors are Age- and Time-varying



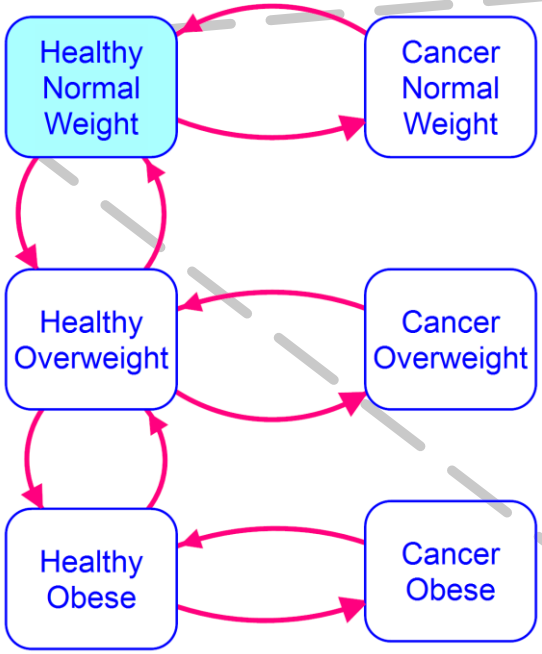




Age (*cohort i, year t*) = $t$ – Birth Year (*cohort i*).

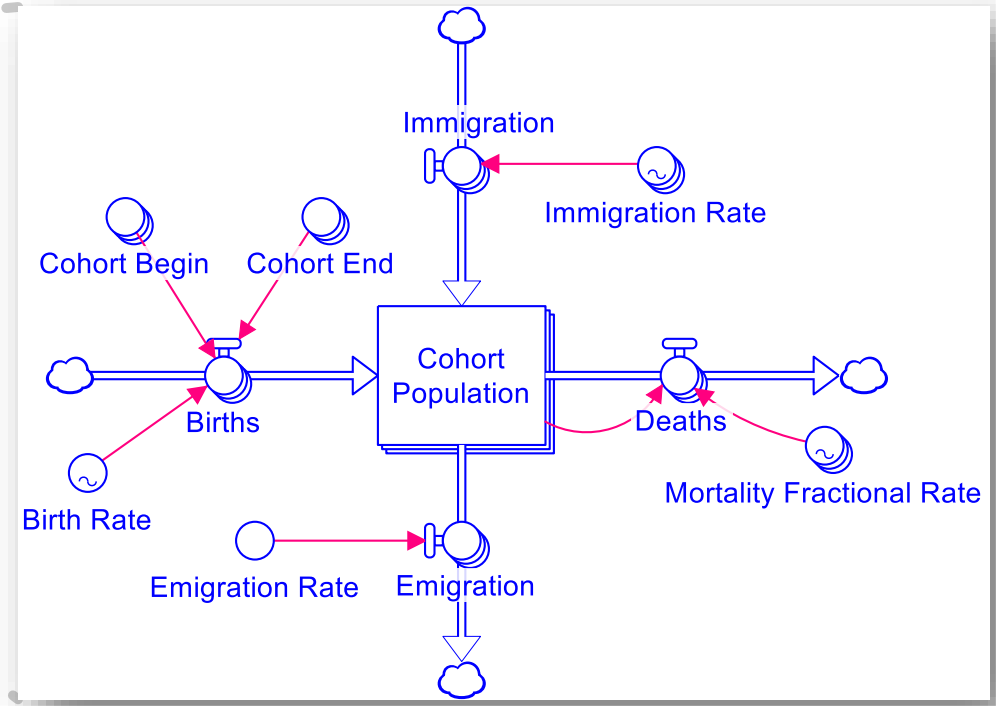
Cancer incidence fractional rate (*cohort i, year t*) = $f$ (*cohort i*, $t$)

# APPLICATION: OBESITY AND CANCER

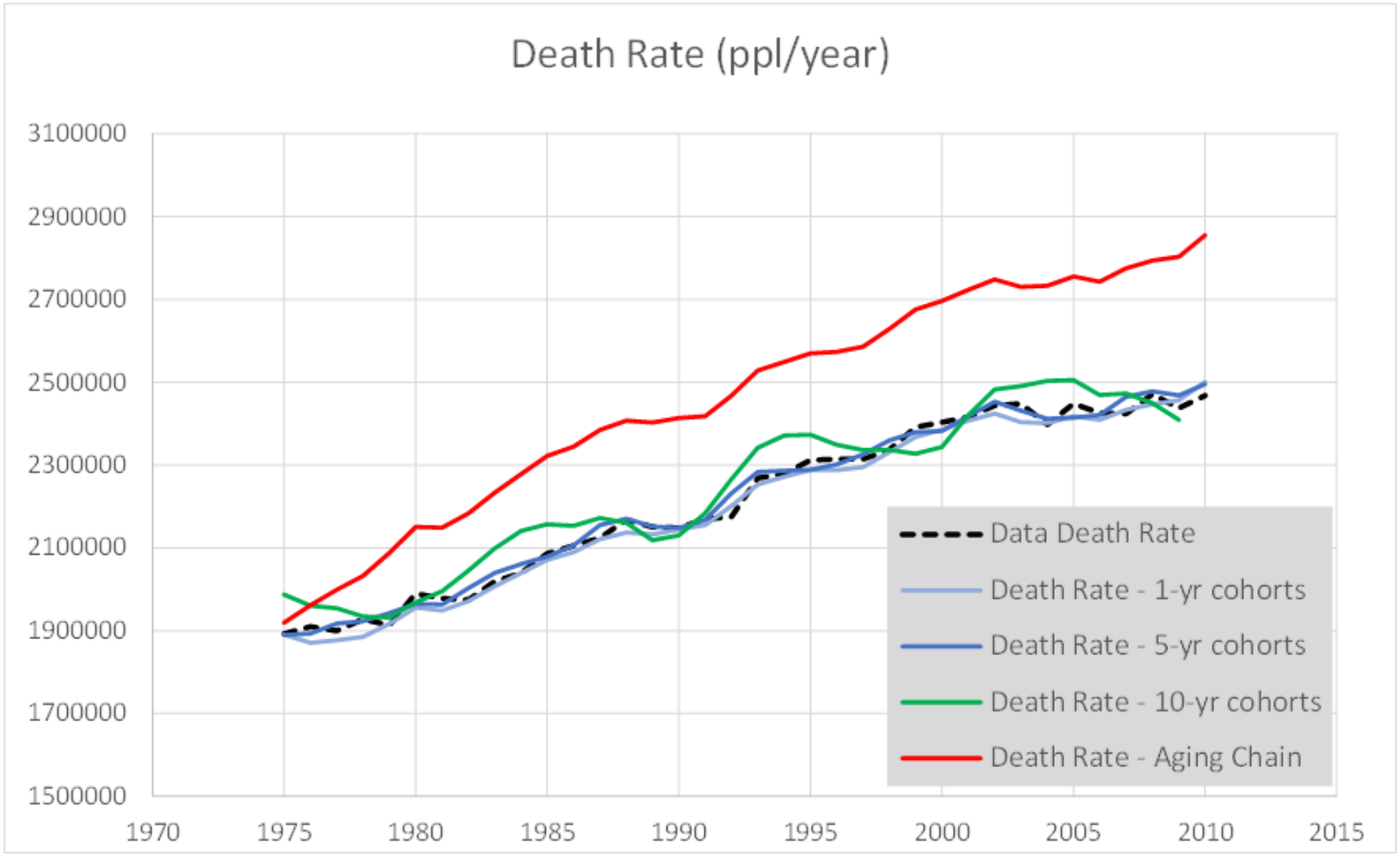
Obesity and Cancer




National Population Dynamics



# SIMULATION RESULTS: NATIONAL POPULATION

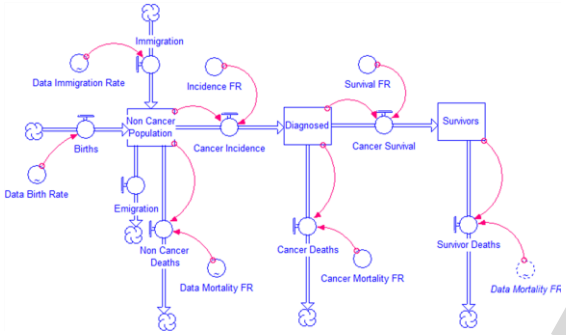


# IMPLEMENTATION NOTES

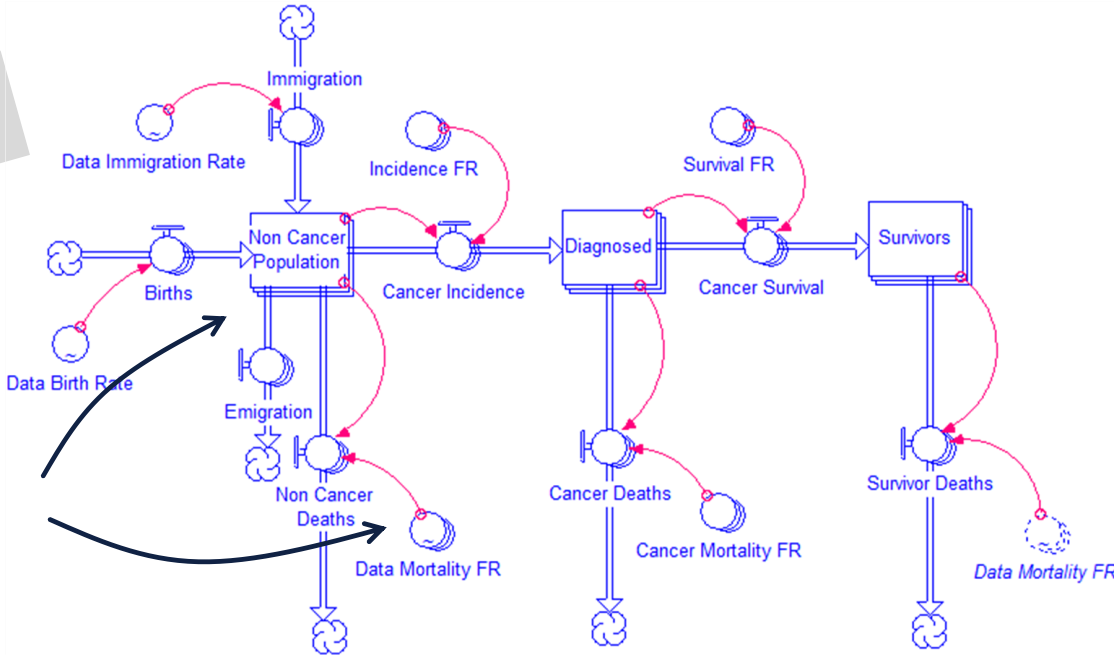
1. Defining Cohorts and Using Arrays
2. Births
3. Deaths
4. Aging Out

# IMPLEMENTATION NOTES: ARRAYS

Step 1: Build Model for Representative Cohort

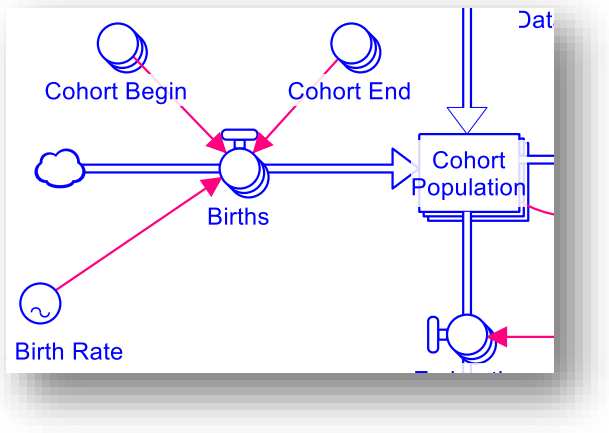


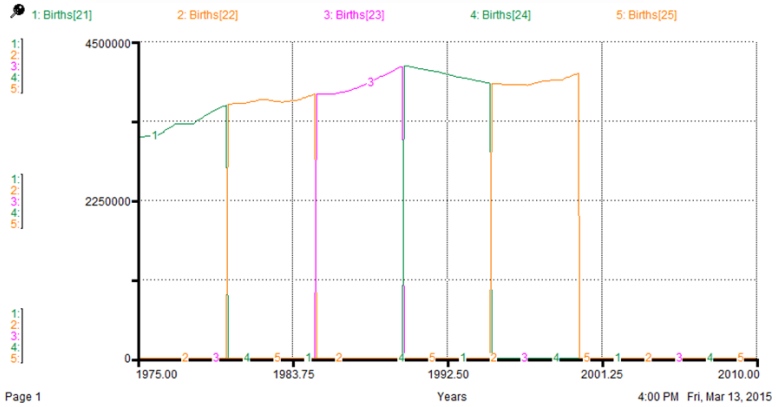

Step 2: Define Cohorts; Convert to Arrays

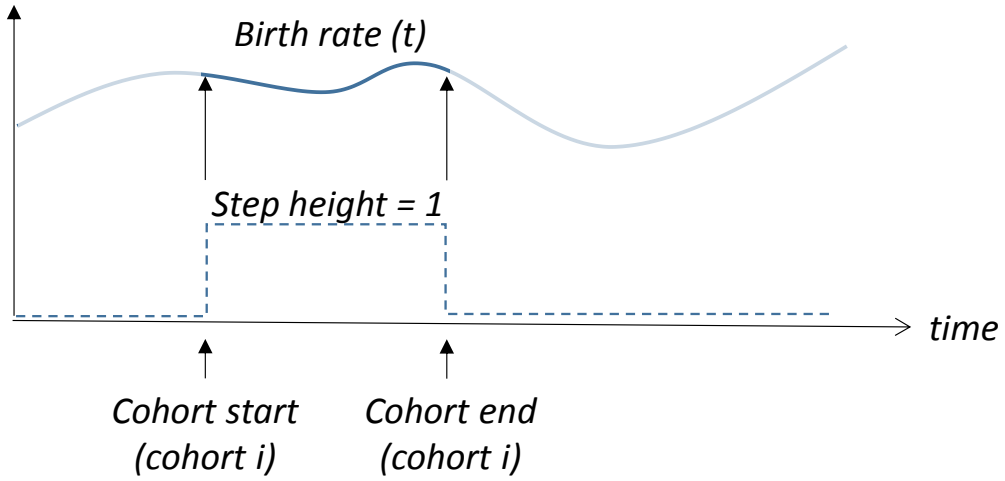



Step 3: Initialize Stocks and Define Age- and Time-Varying Parameters

# IMPLEMENTATION NOTES: BIRTHS

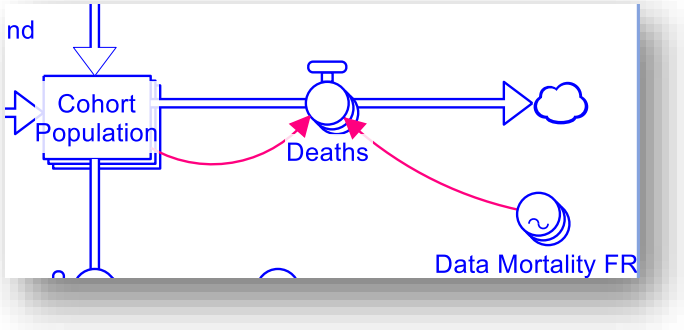


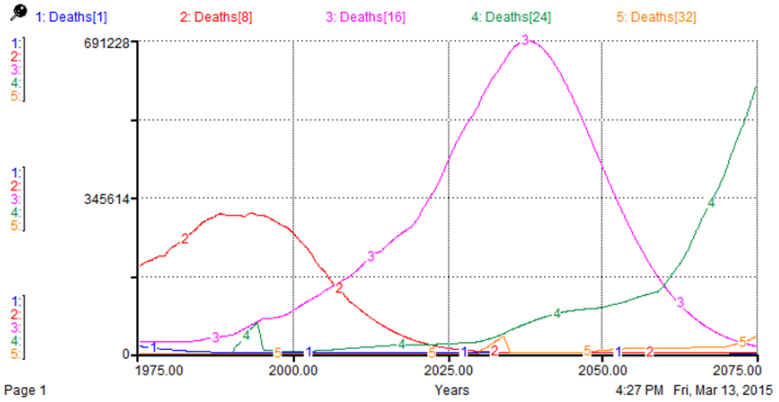



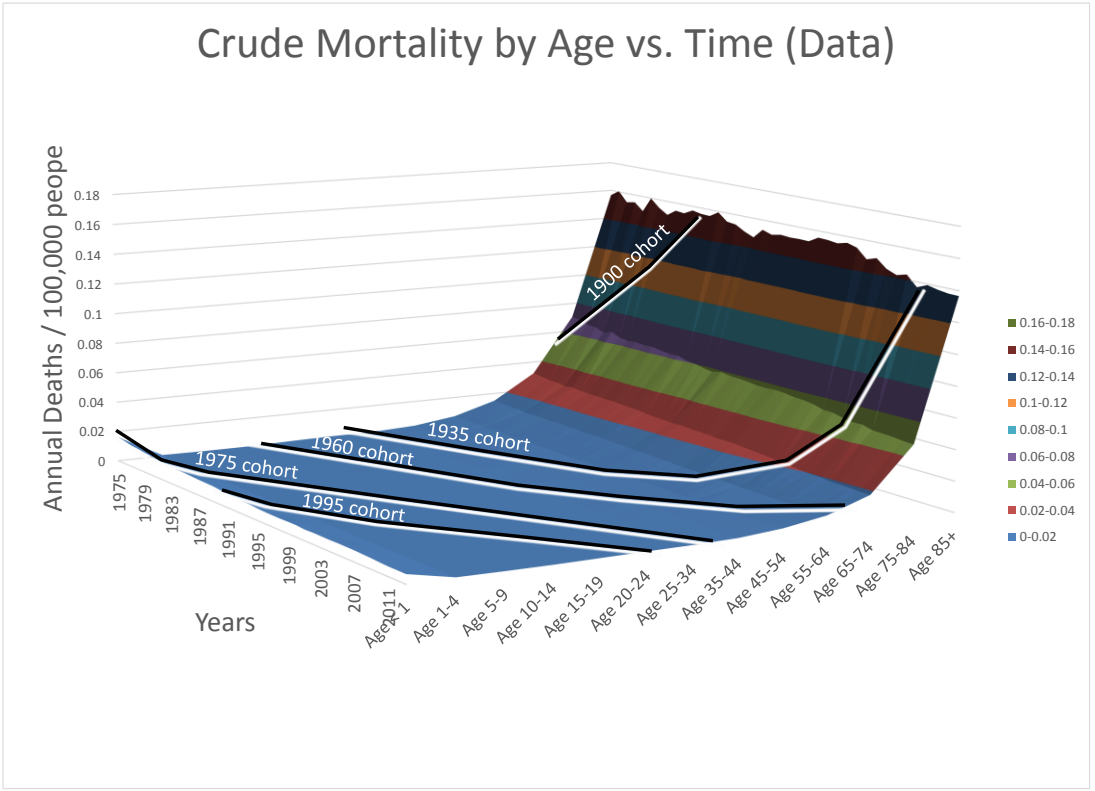




Births (*cohort i, t*) = Birth rate (*t*) * (STEP(1, Cohort Start(*cohort i*)) – STEP(1, Cohort End(*cohort i*))

# IMPLEMENTATION NOTES: DEATHS

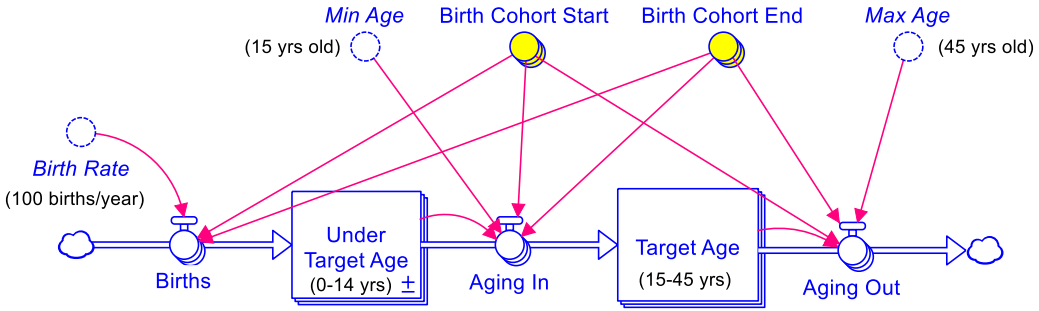


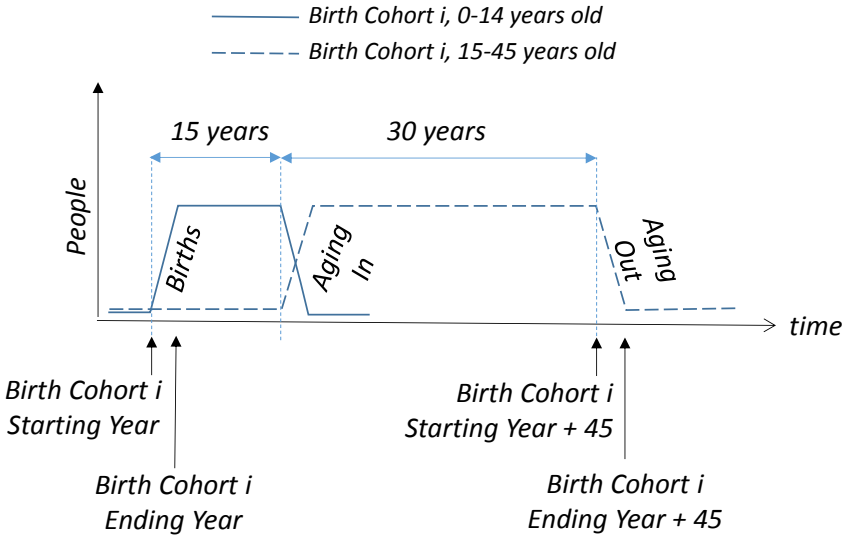




Deaths (*cohort i, t*) = Cohort_Population (*cohort i*) * Data_Mortality_FR (*cohort i, t*)

# IMPLEMENTATION NOTES: AGING OUT




Aging Out (*Cohort i, t)* =

Population (*Cohort i*) / (Ending Year (*Cohort i) + 45 - t)*

*for:*

Starting Year (*Cohort i) + 45 <= t <* Ending Year (*Cohort i) + 45*

# SUMMARY

- Continuous Time-Varying Approach Captures Period-Specific Exogenous Factors Such as Smoking and HIV/AIDS
- Model Focuses on Obesity and Cancer Without Sacrificing Age Distribution Accuracy
- Accommodates Multiple Inflows/Outlfows (e.g. Immigration and Weight Transitions)
- Straightforward Implementation Using Stocks and Arrays
- Developed a Re-Usable National Population Dynamics Model