Title: Simplification for generalization 2: Models and the bigger picture
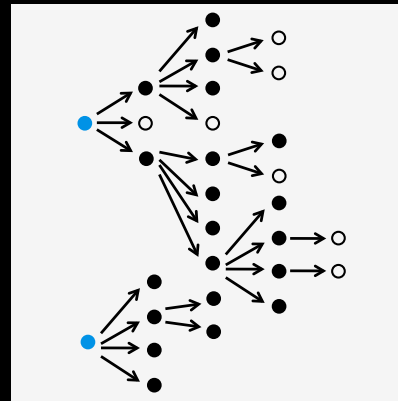
Attribution: Dr. Juliet Pulliam

Source URL: http://www.ici3d.org/DAIDD2016/Materials/Pulliam_S4G2.pdf

For further information please contact Dr. Juliet Pulliam (juliet@ici3d.org).

Simplification for Generalization 2:
Models and the bigger picture

Clinic on Dynamical Approaches to Infectious Disease Data

December 9, 2016

Juliet R.C. Pulliam, PhD

SACEMA, Stellenbosch University &

Department of Biology and Emerging Pathogens Institute, University of Florida

Outline

- Model taxonomy
- Review of models, and placement on taxonomy
- Discussion of model taxonomy decisions
- Big picture take-aways

- Instructions for this afternoon
- Instructions for tomorrow

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Model taxonomy

	CONTINUOUS TREATMENT OF INDIVIDUALS (averages, proportions, or population densities)	DISCRETE TREATMENT OF INDIVIDUALS
DETERMINISTIC	CONTINUOUS TIME • Ordinary differential equations • Partial differential equations DISCRETE TIME • Difference equations (eg, Reed-Frost type models)	
STOCHASTIC	CONTINUOUS TIME • Stochastic differential equations DISCRETE TIME • Stochastic difference equations	CONTINUOUS TIME • Gillespie algorithm DISCRETE TIME • Chain binomial type models (eg, Stochastic Reed-Frost models)

Model taxonomy

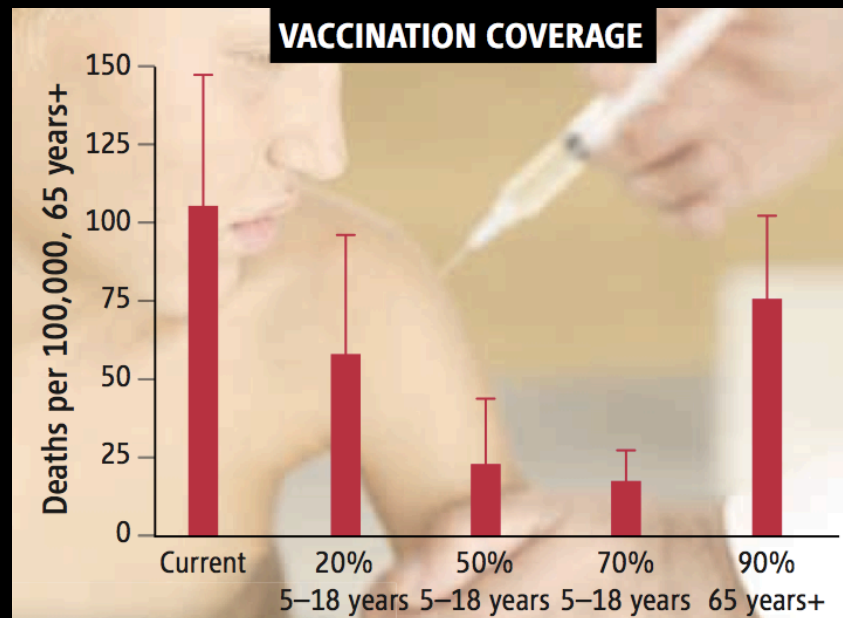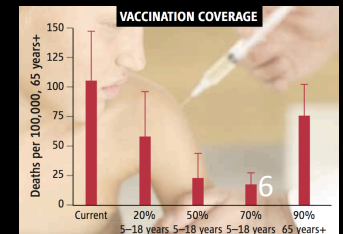|	CONTINUOUS TREATMENT OF INDIVIDUALS (averages, proportions, or population densities)	DISCRETE TREATMENT OF INDIVIDUALS
DETERMINISTIC	CONTINUOUS TIME DISCRETE TIME	
STOCHASTIC	CONTINUOUS TIME DISCRETE TIME	CONTINUOUS TIME DISCRETE TIME

SLIV program

- Can school-located influenza vaccination programs protect the elderly?

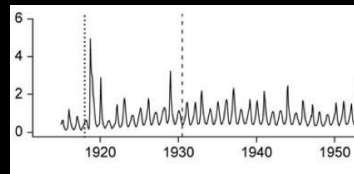Halloran & Longini 2006 Science

Model taxonomy

CONTINUOUS TREATMENT OF INDIVIDUALS

(averages, proportions, or population densities)

DISCRETE TREATMENT OF INDIVIDUALS
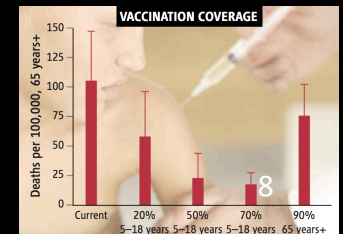
DETERMINISTIC

CONTINUOUS TIME

DISCRETE TIME

STOCHASTIC
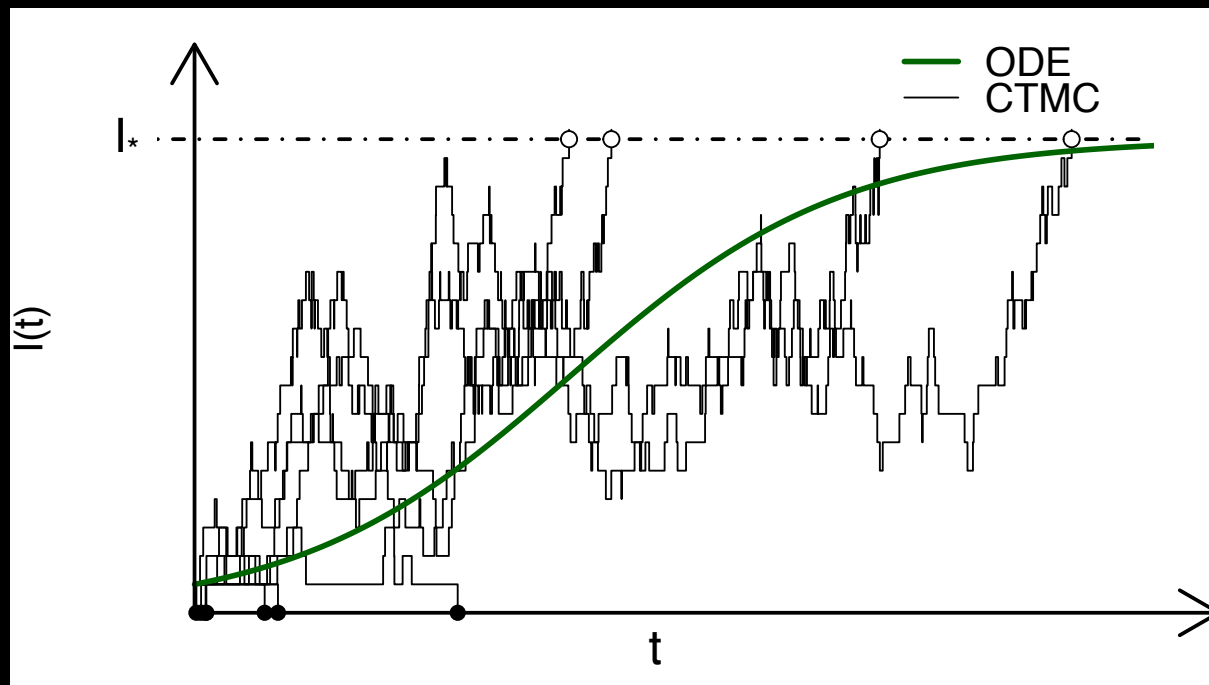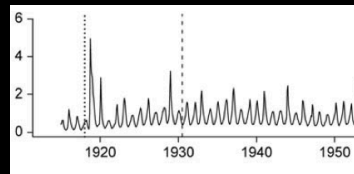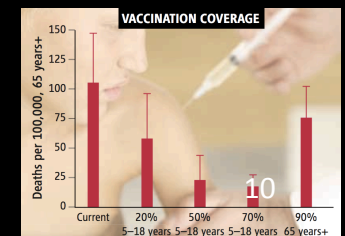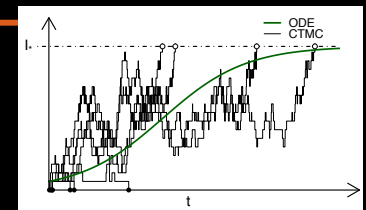
CONTINUOUS TIME

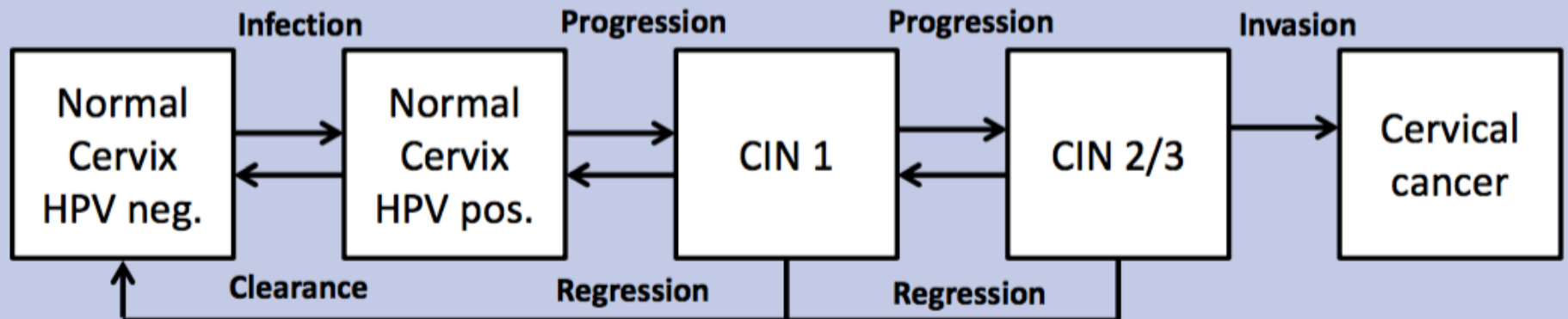DISCRETE TIME

CONTINUOUS TIME

DISCRETE TIME

6

Simple = general

- How do acute immunizing infections persist, and what causes recurrent epidemics?

Iceland

US

Denmark

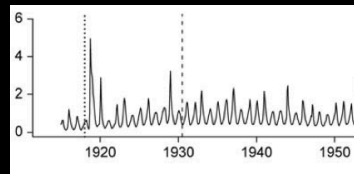Sqrt(Influenza incidence)
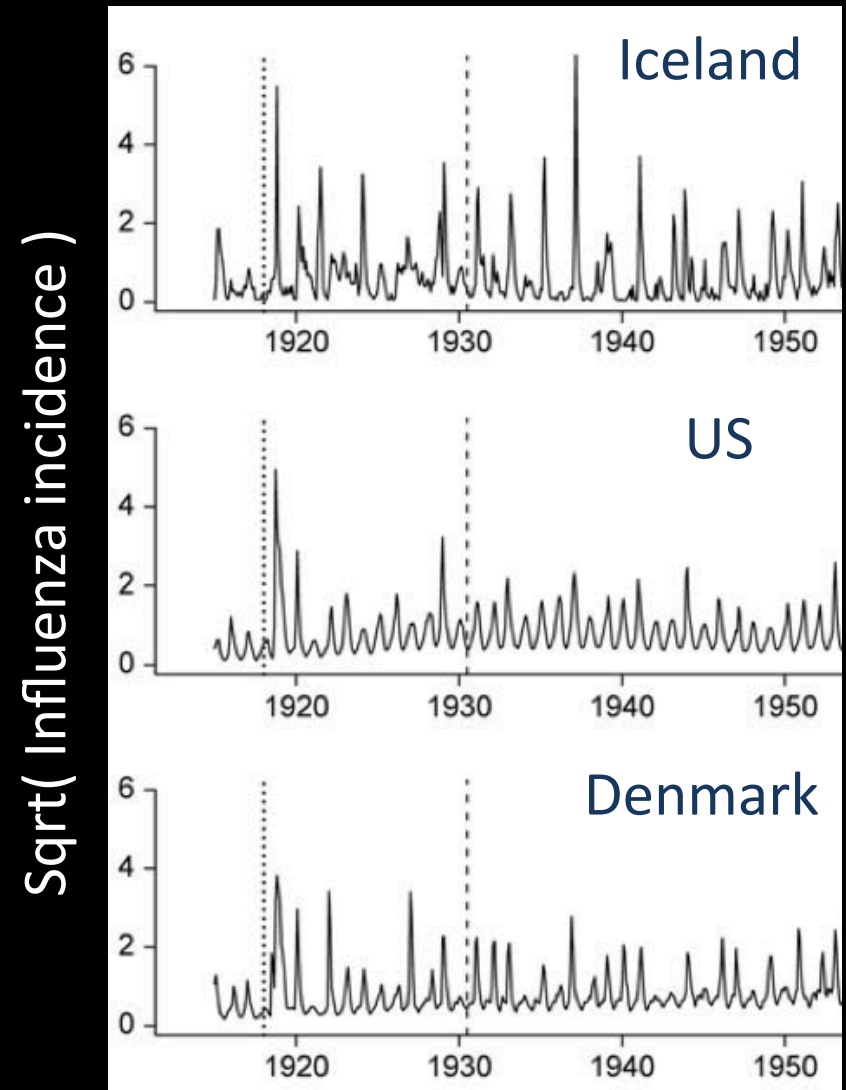
Weinberger *et al*. 2012 Am J Epidemiol

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Model taxonomy

	CONTINUOUS TREATMENT OF INDIVIDUALS (averages, proportions, or population densities)	DISCRETE TREATMENT OF INDIVIDUALS
DETERMINISTIC	CONTINUOUS TIME DISCRETE TIME	
STOCHASTIC	CONTINUOUS TIME DISCRETE TIME	CONTINUOUS TIME DISCRETE TIME

Jackal rabies

- Can seasonal abundance of anthrax carcasses drive rabies invasion in a wild jackal population?

Borchering *et al*. bioRxiv

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Model taxonomy

CONTINUOUS TREATMENT OF INDIVIDUALS

(averages, proportions, or population densities)

DISCRETE TREATMENT OF INDIVIDUALS
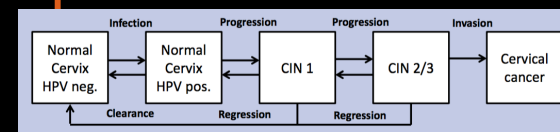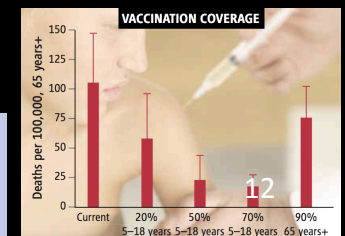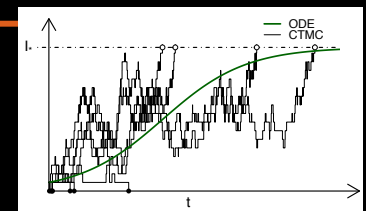
DETERMINISTIC

CONTINUOUS TIME

DISCRETE TIME

STOCHASTIC

CONTINUOUS TIME

DISCRETE TIME

CONTINUOUS TIME

DISCRETE TIME

HPV in RSA

- Will HPV vaccination reduce HIV incidence?

Model taxonomy

(averages, proportions, or population densities)

DISCRETE TREATMENT OF INDIVIDUALS

DETERMINISTIC

CONTINUOUS TIME
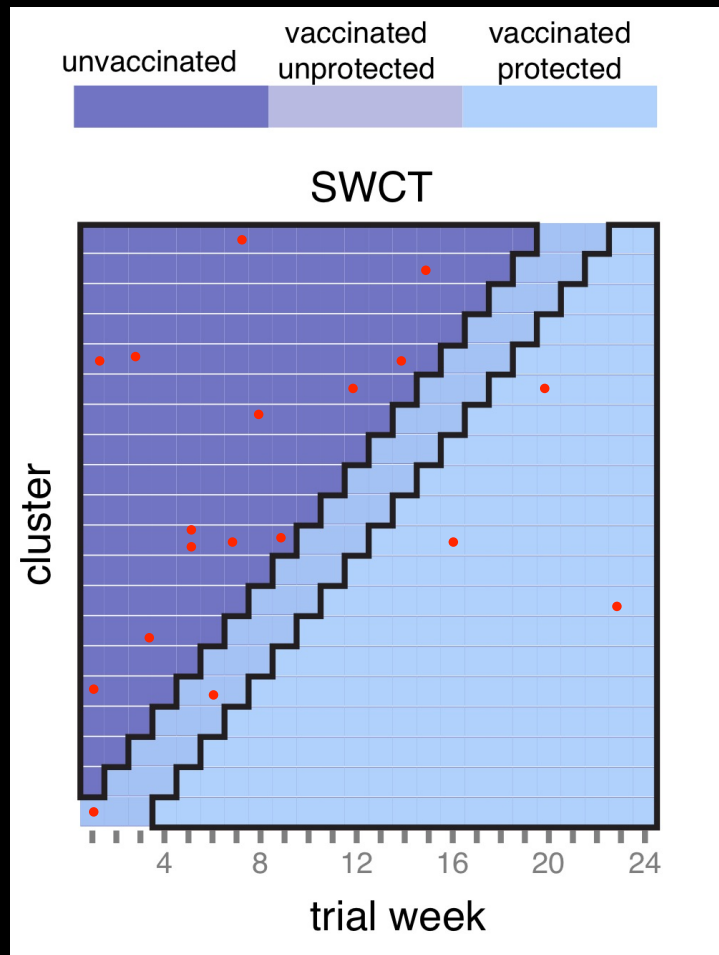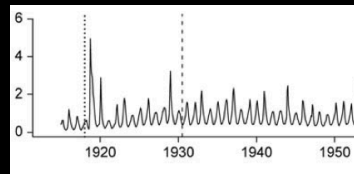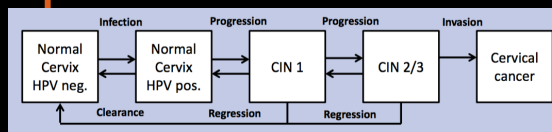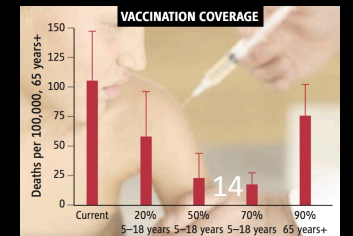

DISCRETE TIME

STOCHASTIC

CONTINUOUS TIME

DISCRETE TIME

CONTINUOUS TIME

DISCRETE TIME

12

Ebola trial design

Bellan *et al.* 2015 *Lancet ID*

- Was an SWCT or RCT preferable to evaluate efficacy of an Ebola vaccine in Sierra Leone?

Model taxonomy

Drivers of HIV decline

- Why has HIV prevalence declined in Harare?

Model taxonomy

CONTINUOUS TREATMENT OF INDIVIDUALS

(averages, proportions, or population densities)

DISCRETE TREATMENT OF INDIVIDUALS

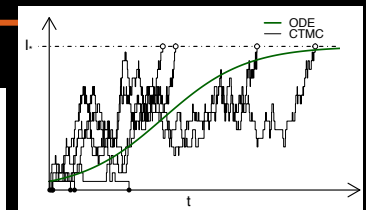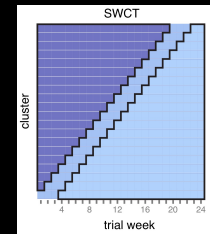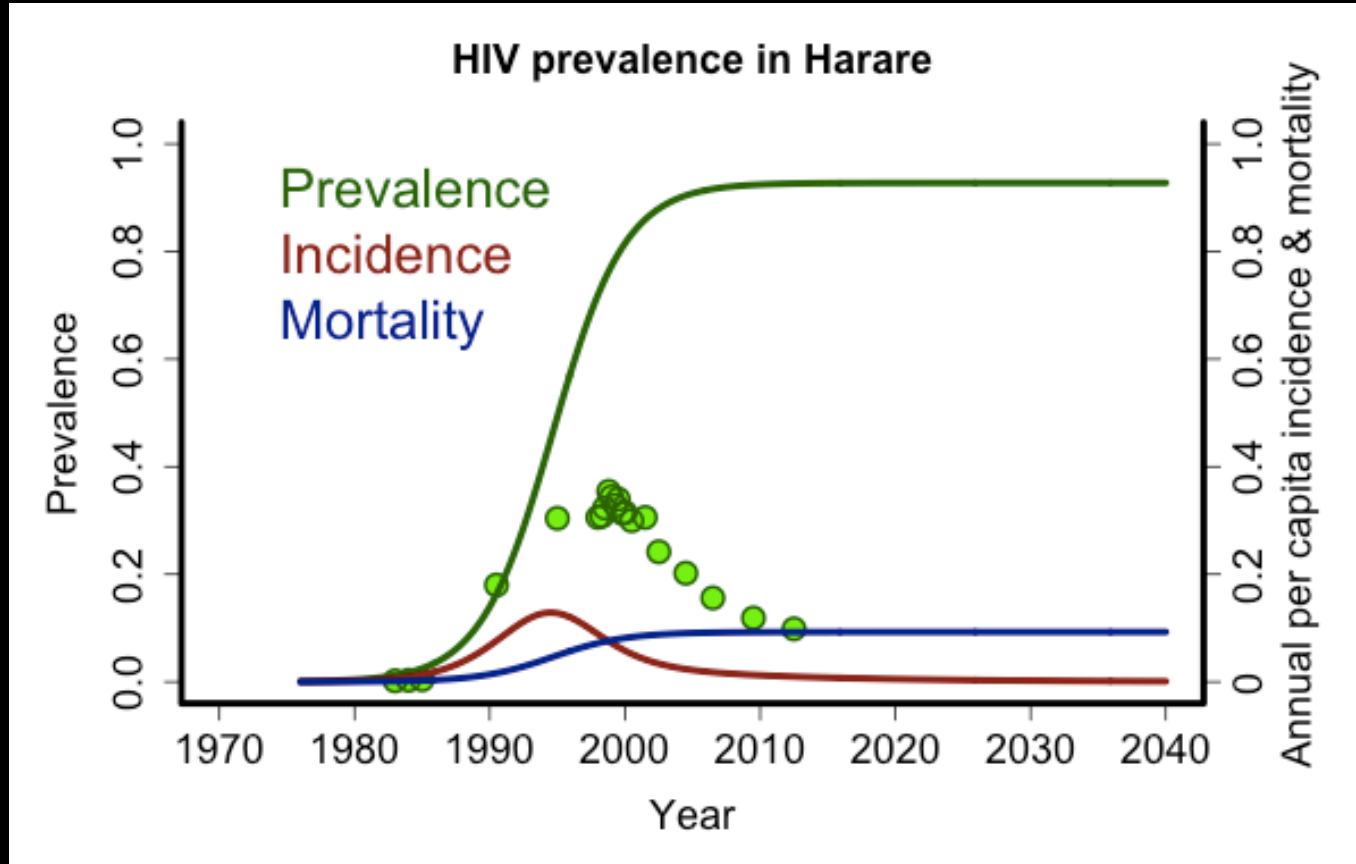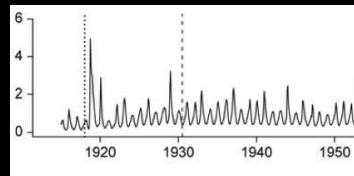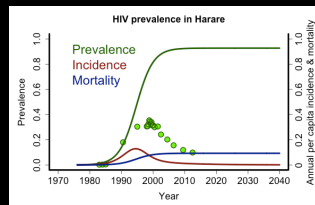DETERMINISTIC

CONTINUOUS TIME

DISCRETE TIME

STOCHASTIC

CONTINUOUS TIME

DISCRETE TIME

CONTINUOUS TIME

DISCRETE TIME

HIV infection

- How important is acute phase transmission?
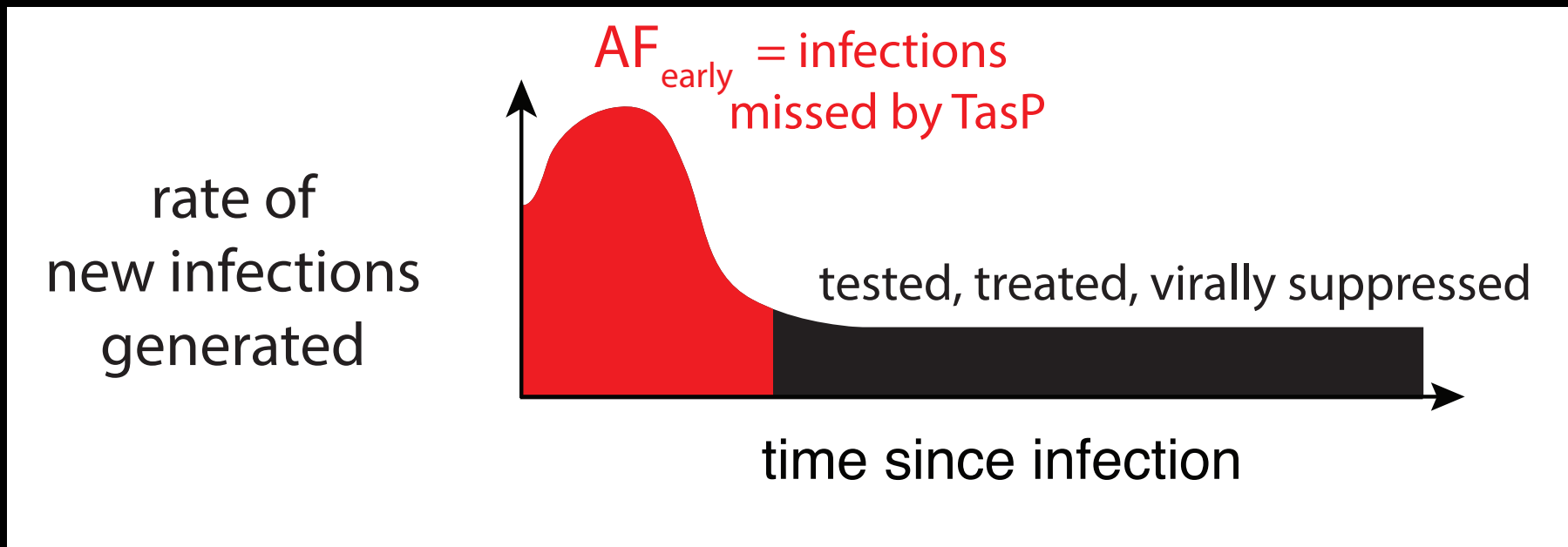
AF$_{early}$ = infections missed by TasP

rate of new infections generated

tested, treated, virally suppressed

time since infection

Model taxonomy

CONTINUOUS TREATMENT OF INDIVIDUALS

(averages, proportions, or population densities)

DISCRETE TREATMENT OF INDIVIDUALS

DETERMINISTIC
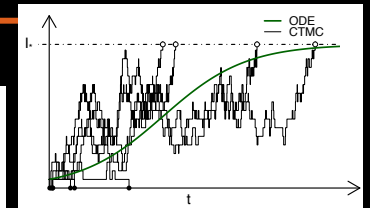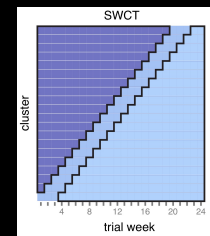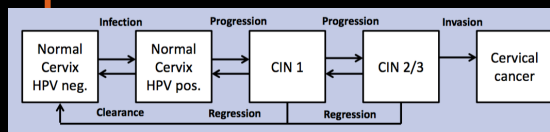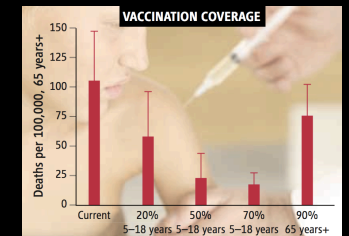
CONTINUOUS TIME

DISCRETE TIME

STOCHASTIC

CONTINUOUS TIME
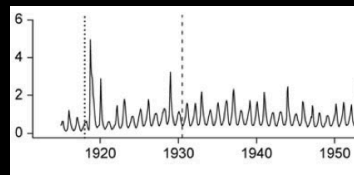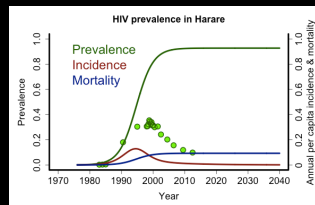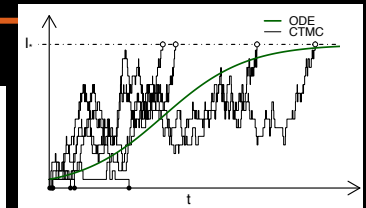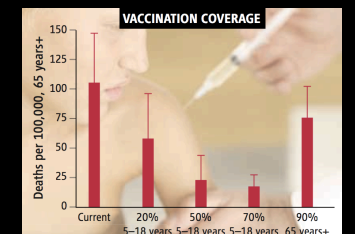
DISCRETE TIME
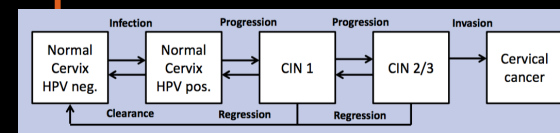
CONTINUOUS TIME

DISCRETE TIME

Model taxonomy

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STOCHASTIC	CONTINUOUS TIME • Stochastic differential equations DISCRETE TIME • Stochastic difference equations	CONTINUOUS TIME • Gillespie algorithm DISCRETE TIME • Chain binomial type models (eg, Stochastic Reed-Frost models)

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Take home points

- Models help us identify the most important features of a system

- Model worlds should be constructed to address a question of biological or public health relevance!

- Models can inform study design and data analysis

- Models can inform policy discussions and motivate change

This afternoon

- By 2pm
  - Post updated model diagram
  - Post updated model description
- 2-3:30
  - One-on-one meetings with faculty (see assignments and locations)
  - Pack / ready to depart by 3:30
  - Pay your bar tab (if applicable)!
- 3:30-4
  - Departure (shuttles will pick up at lodging)
- 4:30-6
  - Individual work session; research plan due at 9am

Tomorrow

- Breakfast 8:15-9
- By 9am
  - Post final research plan
  - Post slide for final presentation
    - Include final model diagram and research question
- 9-11:30 final presentations
- 11:30-12:15 final feedback session
- 12:15-12:30 closing session
- 12:30 lunch & departure