

COMPLEX DYNAMICAL SYSTEMS

A SERIES OF TEN
LECTURES TO THE ROSS
INSTITUTE, 2011-2012
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SERIES OUTLINE

1. Nov 2, Intro: Epiphany, What, Why, How
2. Nov 9, Grs. K, 1: Dynamical Systems (DS)
3. Nov 16, Grs 2, 3, 4: Complex Dyn Sys (CDS)
4. Nov 21, Grs 5, 6, 7, 8: NetLogo CDS Models
5. Dec 7, Grs 9, 10, 11: NetLogo CDS Models

LEC. 1: INTRODUCTION

- ✻ A. My epiphany of the miracle year, 1972.
- ✻ B. WHAT: Systems thinking, General systems theory, cybernetics, system dynamics, and complex dynamical systems (CDS).
- ✻ C. WHY: The Spiral and World Cultural History as systems, systems thinking to understand the future.
- ✻ D. HOW: Foregrounding the systems of each grade with NetLogo (needs participation).

LEC. 2: DYNAMICAL SYS.

- ✱ A. Stairway 2 Chaos
- ✱ B. Attractors, Basins, and Separatrices
- ✱ C. Schemes and Bifurcations
- ✱ D. Animated Examples

LEC. 3: COMPLEX DS

- ✱ Grade K: Logistic, Period doubling bifurcation
- ✱ Grade 1: Van der Pol, Hopf bifurcation
- ✱ Grade 2: Daisyworld (CDS)
- ✱ Grade 3: Wolves and sheep
- ✱ Grade 4: Rabbits, grass, and weeds

LEC. 4: MIDDLE SCHOOL

- ✿ Grade 5: Riverine Civilizations, 3500-1450 BCE
Ecosystem, Markets, Warfare
- ✿ Grade 6: Cultural Transformation, 1450-350 BCE
Trade of ideas, paper, plunder
- ✿ Grade 7: Religions, Empires, 350 BCE -800 CE
Silk Road, Lingua Franca, Currency
- ✿ Grade 8: Medieval Climax, 800-1453 CE
Judeo-Christian-Islamic transmissions, Mecca

FIBERS/THEMES

- ✻ Threads (eg, systems thread) consist of fibers or themes (eg, ecosystem, trade route)
- ✻ Lower school exemplary systems (daisyworld, wolves-sheep, rabbits-grass-weeds) are all in the ecosystem theme
- ✻ Middle school exemplary systems will be in the trade route theme

LEC. 5: HIGH SCHOOL

- ✿ Grade 9: Modernism, World Economy, 1453-1688
Circulatory system, Solar system
- ✿ Grade 10: Revolution, Individual, 1688-1851
Statistics, Food riots, Malthus, Irish famine,
Catastrophe, Tragedy of the Commons
- ✿ Grade 11: Global economics, Visionary revolt
1851-1948, Class warfare, Arms races
- ✿ Grade 12: The Present, 1948-2000
Planetary dynamics, chaos, catastrophes

IRISH FAMINE

BRITISH EMPIRE,
1845 - 1849

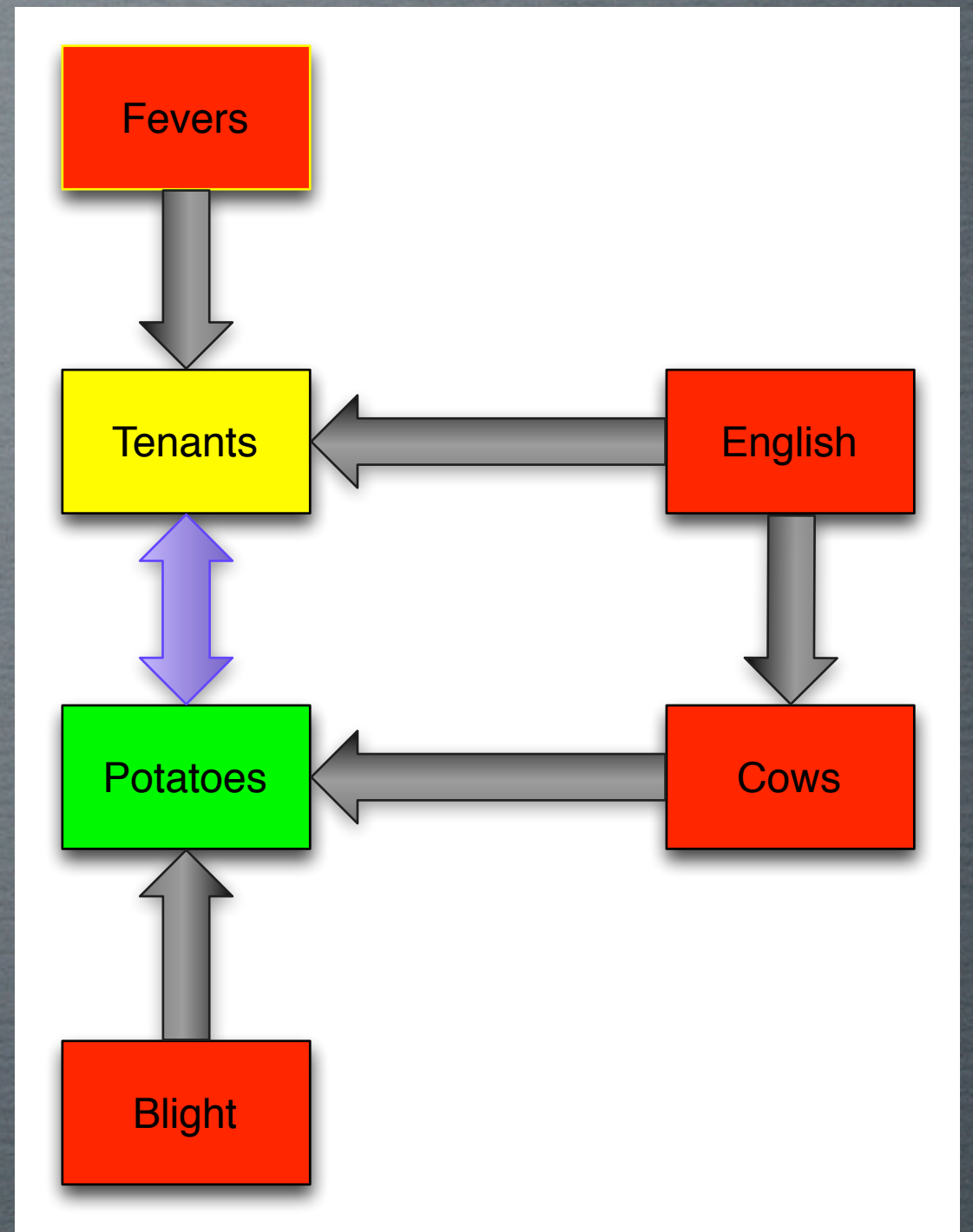
WHY THE IRISH FAMINE ???

- ✻ It is on Bill Thompson's list of top exempla
- ✻ It is on Bruce Stewart's list of top five
- ✻ It is on my list because:
 - ✻ It is somewhat like NOW
 - ✻ It is already central to Grade 10
 - ✻ It is super complex (a system of systems)

THE POTATO SYSTEM

6 N O D E S
6 L I N K S

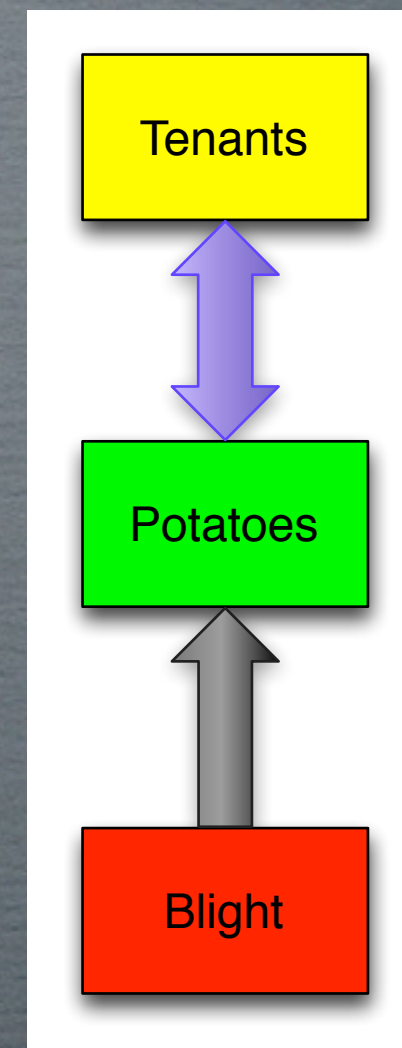
(P R E D A T O R /
P R E Y)



THE BLIGHT SUBSYSTEM

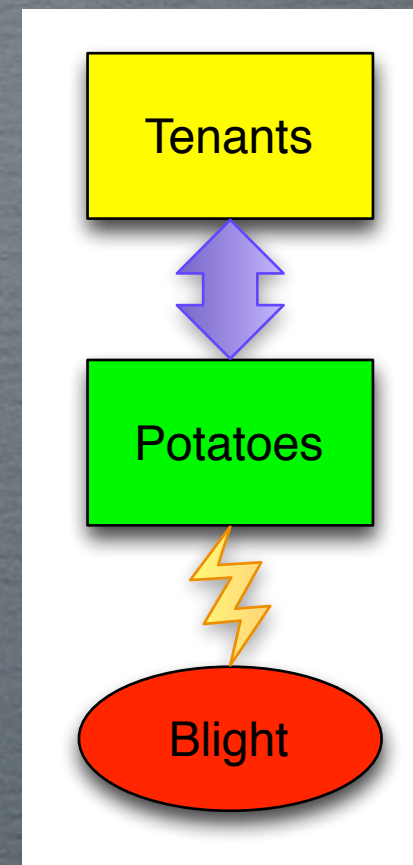
T E N A N T S
S U B S I S T O N
P O T A T O E S

B L I G H T I S A
R A R E E P I D E M I C



AFTER 1845

BLIGHT
SPORES ARE
EVERYWHERE



THE FAMINE SETUP

- ✻ 1700, Middleman system (absentee landlords)
- ✻ 1760, Potato became staple food for farmers
- ✻ English beef market for created potato dependency
- ✻ 1800, Tenants are confined to small plots due to the conacre system, overpopulation
- ✻ 1845, Irish population = 10M

COTTIER SYSTEM

- ✻ Small plots rented for one year to highest bidder (cottier), who plants potatoes, pays high rent to middlemen, English landlords
- ✻ Bound laborers work on cattle farms, are paid in potatoes, no cash
- ✻ Potato crop fails on average every five years due to curl, frost, dry rot

REFERENCES

- ✻ Cecil Woodham-Smith, 1962/1991.
The Great Hunger: Ireland, 1845-1849.
(Revisionist)
- ✻ Christine Kinealy, 1994/2006.
This Great Calamity: The Irish Famine, 1845-1852. (Post-revisionist)

THE BLIGHT

PHYTOPHTHORA INFESTANS
(FUNGUS)

BLIGHT CHRONOLOGY

- ✻ 1830, Blight observed in Germany
- ✻ 1842, First fully recorded outbreak, Atlantic seaboard from Nova Scotia to Boston
- ✻ 1845, First outbreak in Europe (Ireland)
- ✻ 1846, Total loss of Irish potato crop
- ✻ UK annual losses average 5M pounds sterling
- ✻ 1939, Last outbreak (cure found)

BLIGHT EPIDEMICS

- ✻ Minute fungus parasite on leaves and tubers
- ✻ Reproduces with lightning speed, zoospores of a single infected plant can infect many thousands of plants in a few days
- ✻ Spores propagate in the air
- ✻ The infected plant is destroyed within days

MODELING STRATEGY

- ☼ Tenants <---> Potatoes

- ☼ Predator Prey model (NetLogo SD or Docked)

- ☼ Potatoes <---> Blight

- ☼ Epidemic model (NetLogo SD or Docked)

FOR FUTURE

- ✻ Other nodes (Fever, English, Cows)
- ✻ Emigration (England, Canada, US)
- ✻ Relief agencies (eg, Quakers)
- ✻ Daily fluctuations with HubNet
(Participatory simulation aka
Multiplayer game)

HOMework

- ✻ No new assignments
- ✻ Please catch up HW #4

END OF LECTURE
FIVE OF TEN