



SOCIETY OF ACTUARIES

**SOA 2010 Annual Meeting & Exhibit
Oct. 17-20, 2010**

**Session 51, Pension Section Continental
Breakfast: Recent Finance and Pension Research
Papers**

Moderator:

Alberto Luis Dominguez, FSA

Presenters:

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Oct. 17-20, 2010
New York, NY

SOA 2010

SESSION 51

Recent Finance and Pension Research Papers

Actuaries
Ethic in Opportunity®

SOA 2010

Presenters:

Alberto Dominguez – Towers Watson – Atlanta, GA

Emily Kessler – Society of Actuaries – Schaumburg, IL

Financial Analysts Journal

- Journal of the CFA Institute
- Published on a bi-monthly basis
- Almost every issue has one or more articles relevant to pension actuaries
- Three articles
 - Using Derivatives Overlays to Hedge Duration
 - The Longevity Annuity
 - Using Auctions to Price Employee Options

Derivatives Overlays

- Mind the Gap: Using Derivatives Overlays to Hedge Pension Duration
 - FAJ, July/August 2009
 - James Adams and Donald Smith

Derivatives Overlays

- Risk management argues for fixed income assets to match liabilities
- But plans aren't prepared to accept decreased EROA that results from increase in fixed income asset allocation
- A DB plan with a negative duration gap between assets and liabilities can enter an interest rate swap with positive duration

Derivatives Overlays

- Interest rate swap
 - Periodic exchange of cash flows
 - One cash flow based on a fixed interest rate; other based on a reference rate (e.g., LIBOR)
 - Settlement on net basis = annual rate difference x notional principal x fraction of year
 - Duration = difference between relatively high duration of fixed rate bond and very low duration of floating rate bond

Derivatives Overlays

- Example:
 - PBO = \$268.7 million (DR = 5%)
 - Liability duration = 8.4
 - Asset portfolio = 2/3 equities, 1/3 fixed income
 - Fixed income asset duration = 6.0
 - Therefore asset duration = 2.0
 - Negative duration gap = 6.4

Derivatives Overlays

- Could enter a 10-year swap to receive fixed interest at 4.75% against LIBOR
- Swap duration is 7.4
- Initial outlay is zero
- Notional Principal = $\$268.7\text{M}(8.4-2.0)/7.4$
= \$232.4 million
- Could also enter swaps with other terms
 - Different durations and notional principal amounts

Derivatives Overlays

- No assets in the trust have actually changed
- New duration of the asset portfolio = 8.4
- Model risk, operational risk, counterparty risk remain
- Most plans don't seek to eliminate 100% of the duration gap
- Can reset or exit swap mid-stream if conditions warrant

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Derivatives Overlays

- Could buy a receiver swaption
 - Plan purchases the **option** to enter into a receive-fixed **swap** at future date
- Illustrative swaption terms
 - Fixed (strike) rate = 4%; notional = \$50M
 - Premium = 200 bps
 - Initial outlay = 2% x \$50M = \$1M
- Below 4%, exercise swaption and offset increase in liability

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Derivatives Overlays

- Could enter into a swaption collar
 - Buy one swaption (say at 4%) and sell another (say at 5.75%) to minimize initial outlay
 - Between these rates, both options expire out of the money
 - Below 4%, gain on purchased swaption offsets increase in liability
 - Above 5.75%, loss on sold swaption offset by decrease in liability

Longevity Annuity

- The Longevity Annuity: An Annuity for Everyone?
 - FAJ, January/February 2008
 - Jason Scott

Longevity Annuity

- Americans have \$8.3 trillion¹ in IRA and employer DC plan accounts
- Question at retirement = how to convert assets into retirement income
- Annuity puzzle
 - Theory² suggests full immediate annuitization
 - Few retirees allocate any dollars to an immediate annuity

¹ Investment Company Institute, 12/31/2009

² Yaari (1965), *Review of Economic Studies*, vol 32 no 2, 137-150

Longevity Annuity

- Paper analyzes use of bonds (i.e., self insurance) vs annuities (insurance, taking advantage of survivorship)
- If all assets are shifted from a bond-based spending program to an immediate annuity, spending would increase 56%
- But what if retiree is uncomfortable with a 100% allocation to annuities?

Longevity Annuity

- Only retirees interested in fully annuitizing their assets should select an immediate annuity (e.g., no bequest).
- Other retirees should opt for the longevity annuity that exhausts their willingness to annuitize.
- At every point between 0% and 100% annuitized, the longevity annuity provides higher consumption per dollar annuitized.

Employee Stock Options

- Using Auctions to Price Employee Stock Options
 - FAJ, November/December 2009
 - Simon Mazumdar, Vikram Nanda, and Rahul Surana

Employee Stock Options

- Black-Scholes formula is arguably inappropriate for ESOs
- Lattice models require assumptions for early exercise
- Early exercise criteria used by models
 - Fixed maximum anticipated life is reached
 - Stock price reaches multiple of strike price
 - “Moneyness” reaches a fixed proportion of Black-Scholes value

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Employee Stock Options

- Models produce significantly different fair value estimates for the same ESOs
- Would like a market based approach as an alternative
- Zions Bancorporation designed and implemented multi-unit, uniform-price auctions similar to US Treasury auctions
 - June 2006 and May 2007

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Employee Stock Options

- Design flaws in the first auction
 - Conducted two months after ESO grants
 - Payoffs affected by pre-vesting forfeiture
 - Inefficient price discovery due to “sniping”
- SEC approved clearing price of second auction as a reasonable value of the ESOs in accordance with ASC 718 (FAS 123R)

Employee Stock Options

- Clearing prices within range produced by the various model-based approaches
- SEC: evaluation of future auctions would have to be based on particular facts and circumstances
- Concerns
 - Misaligned seller incentive – unlike typical auction, seller has incentive for low price
 - Small offering and restrictions on bidding

Complexity Science

- Report on the SOA website at <http://www.soa.org/research/research-projects/health/research-complexity-science.aspx>
 - Written by Alan Mills, FSA
 - Sponsored by Health Section
- Understanding of complex systems ...

Complexity Science

- How complex systems form, evolve & die
- “Collections of related agents with intriguing patterns of evolution that we find somewhere between randomness and simplicity.”
- Complex systems
 - Are built from a series of actions of agents (individuals) reacting to their environment
 - Created by the interactions of agents

Complex systems

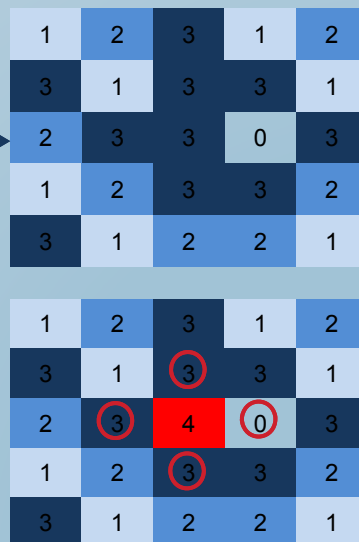
- Rely on their history
 - Result of a series of decisions, not (so much) the initial state
- What decisions do agents make?
- How do decisions change with environment?
- How does any agent change its decisions based on the decisions of others?
- How systems evolve from chaos into “order”
- Can be used to describe weather, disease, ant colonies, markets, health care ...

Basic concepts

- Computation (decision rules)
- Non-linear (whole \neq sum of parts)
- Emergence (of stable macro pattern)
- Evolution (mechanism of emergence)
- Self-organization (“order for free”)
- Robustness (or fragility, or both)
- Edge of chaos (is more interesting)

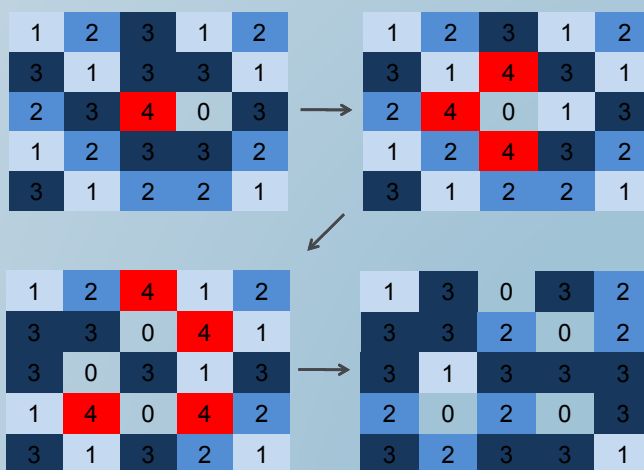
Sand pile: order for free

- Effect of avalanches
- Initial state: Random distribution of grains of sand, 0 to 3
- “Avalanche” occurs if grain is added so a cell has 4 grains
- Sand redistributed to nearest neighbors (ignore diagonals)
- If any of those cells has 4 grains, more avalanches



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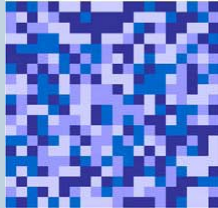
Sand pile: order for free



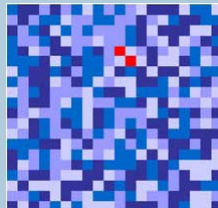
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Sand pile: order for free

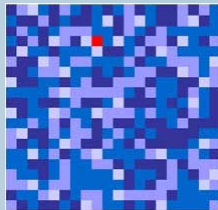
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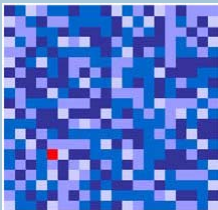
Step 100



Step 1000



Step 5000



- 400 agents (20 x 20)
- 5,000 time steps
- Over time, fewer contiguous agents
- Over time, more “quilt like” than random

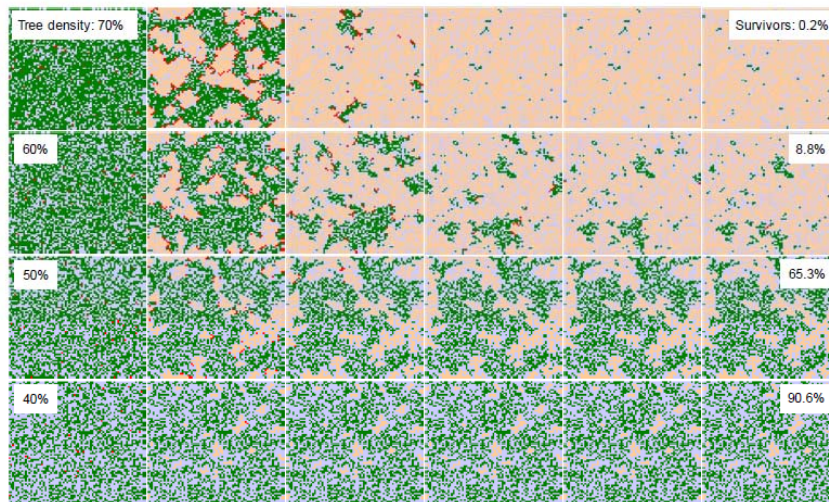
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Forest fire (no replacement)



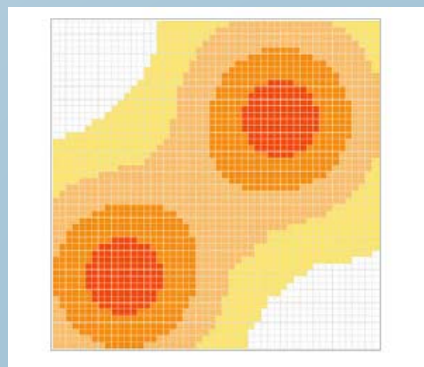
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Forest fire (with replacement)



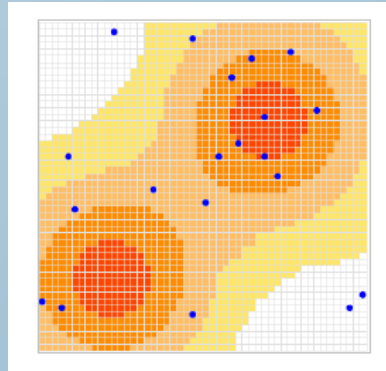
Sugarscape

- 50 x 50 grid
- Two mountains of sugar
- 1-4 units of sugar (higher elevations represented by darker colors)
- Sugar is replenished (at some rate) as consumed



Sugarscape

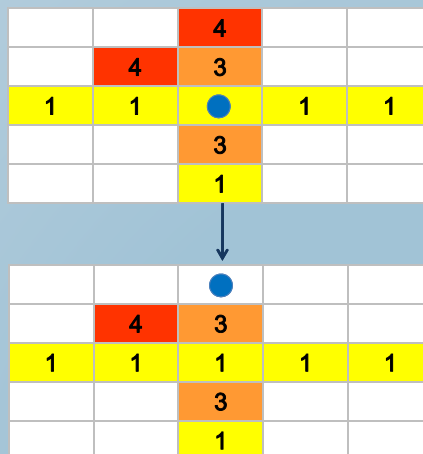
- Introduce agents at random locations
- Agents consume sugar
- Agent attributes
 - Metabolic rate
 - Vision
 - Death age
 - Location
 - Wealth



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Sugarscape

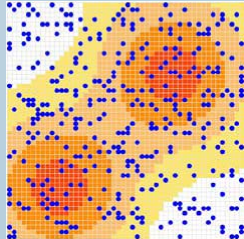
- Agent (blue dot)
 - Metabolic rate = 1
 - Wealth = 10
 - Vision = 2
- Moves to nearest location with most sugar
- Moves “north 2”
 - Adds 4 to wealth
 - Consumes 1
 - New wealth = 13



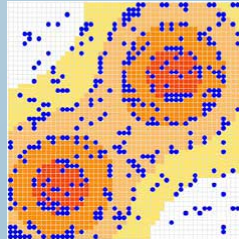
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Sugarscape (full replacement)

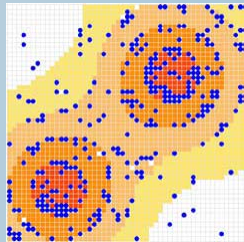
Step 0



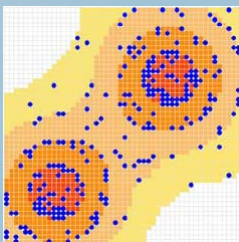
Step 1



Step 10

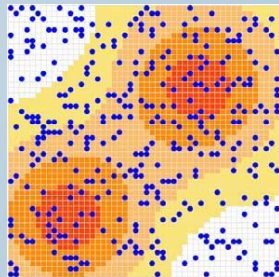


Step 50

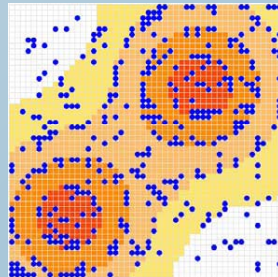


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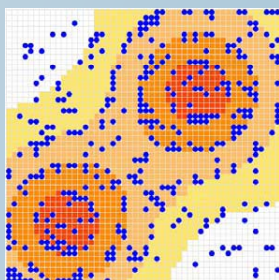
Sugarscape (replacement = 1)



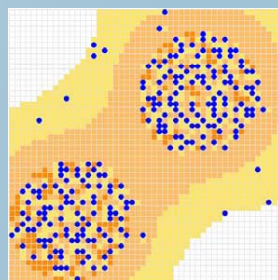
Step 0



Step 1



Step 10



Step 250

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Sugarscape & wealth distribution

- Introducing birth & death
 - Death between 60 & 100
 - Death naturally (randomly) or from starvation
 - Agents born when agents die
- What happens
 - Still stabilize around 250
 - Superior vision & lower metabolic rates favored
 - **Skewed wealth distribution**

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Retirement implications

- What does this mean for retirement system design (e.g. Retirement 20/20)?
- Use a Sugarscape type model to look at
 - Effects of annuitization vs. lump sums on longevity, wealth distribution
 - What effect does “wealth leakage” have at death?
 - Redistribution of wealth from wealthier to poorer citizens (social insurance)