TWISTER MYSTERIES

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Overall Big Picture

- Personal interest project
- Always wondered how large downtown-style buildings withstand tornadoes with relatively little visual damage
- Models how different tornado attributes affect cities of different sizes and layouts
  - Do cities with higher building densities always get affected more?
- Models the different ways cars get destroyed during tornadoes
  - Direct impact from tornadoes?
  - Car accidents from irrational drivers?
  - Which of these happens more often?

Model Rules for 'Setup'

- User chooses values for tornado attributes
  - Lifetime, strength, speed, movement probability, permission to reproduce into 'families'
- User chooses number of cars to exist in the city
  - Also chooses the cars' speeds with which they try and escape
- User chooses a city size (large, medium, or small)
  - Large: higher building density, no suburban area
  - Medium: moderate building density, suburban area with trees
  - Small: tiny 'shopping center', large suburban area with many trees

Model Rules for 'Go'

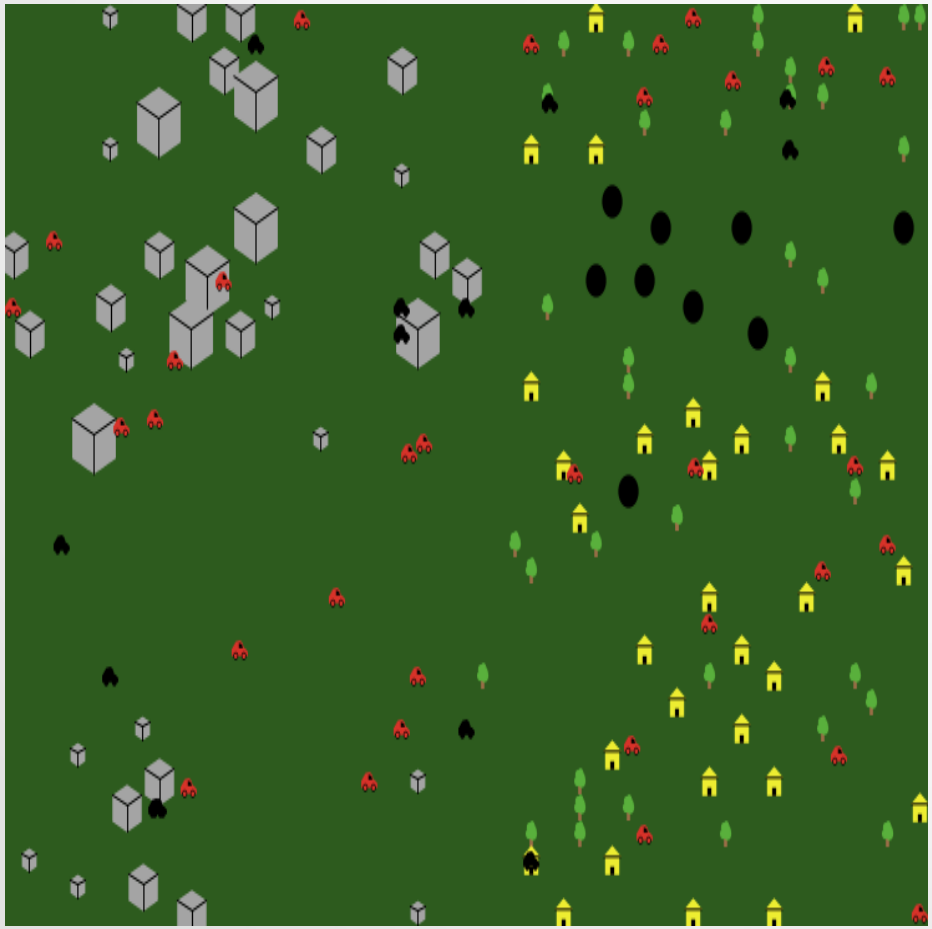
- Tornadoes:
  - Move according to probability set by user
  - Each tick, add one to lifetime and check to see if it's time to die
  - Check to see if reproduction is allowed
    - If yes: reproduce with 0.1% probability
- Trees:
  - If a tornado moves over me, get thrown somewhere
- Cars:
  - If a tornado approaches – try moving away from it
  - Try to avoid other objects at the same time
  - If I crash or am thrown by a tornado, immobilize me and set my color to black to indicate totally damaged

Model Rules for 'Go' – Continued

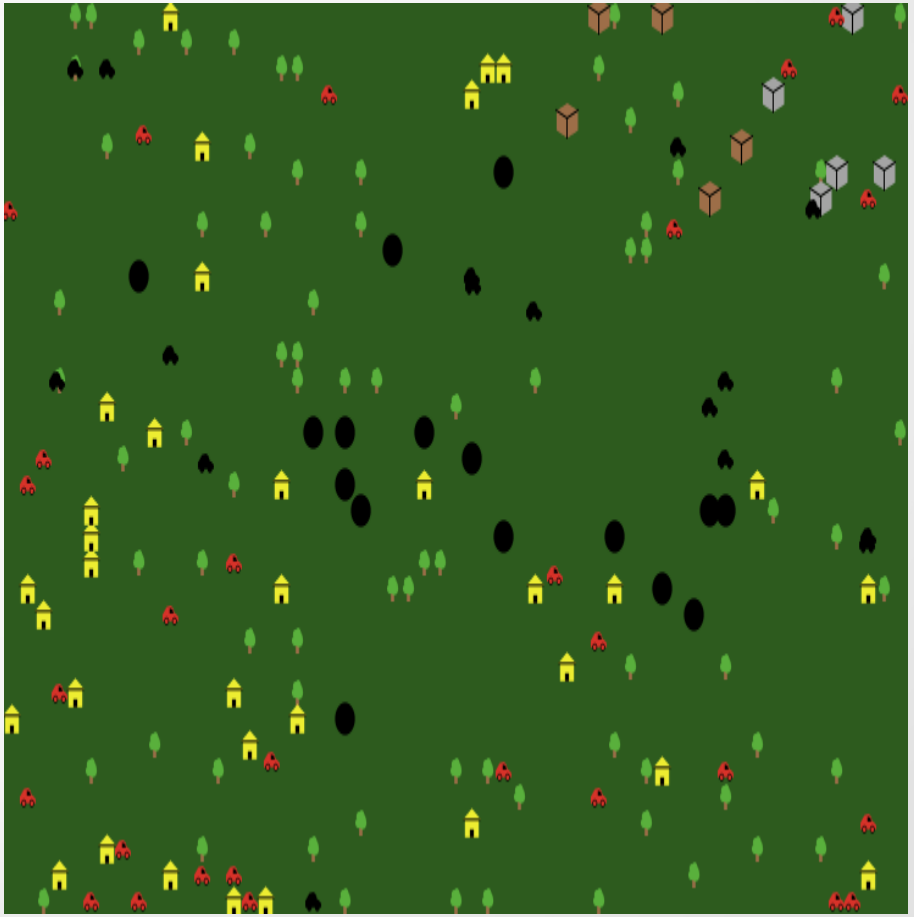
- Buildings:
  - If a tornado passes over me, increase damage done to me according to a math model
  - If a thrown tree lands on me, increase damage by a fixed amount
  - Turn other colors if a certain percentage of damage has been done
- Houses:
  - If a tornado passes over me, increase damage done to me according to a math model
  - If a thrown tree lands on me, increase damage by a fixed amount
  - If I'm completely damage, turned into a black circle to indicate a destroyed 'heap' of material

Results: Views of Damaged Cities

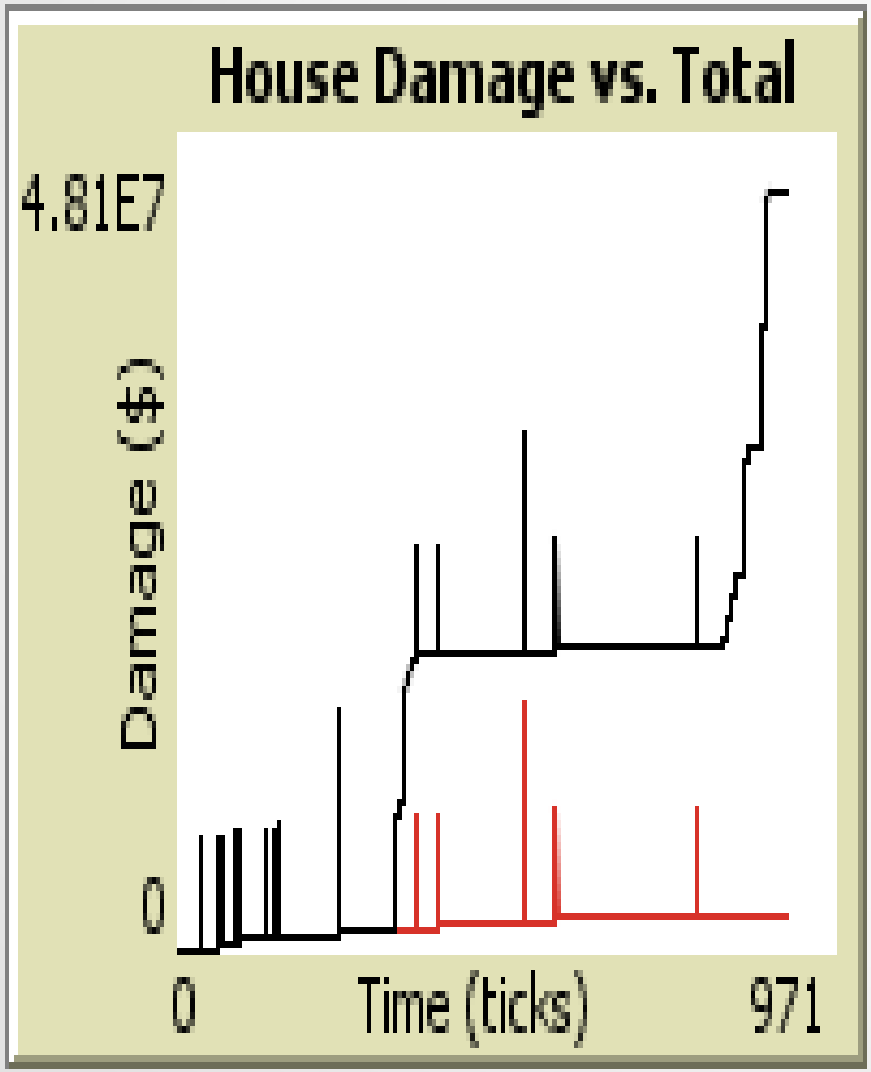
Medium (~$84 million in damage)

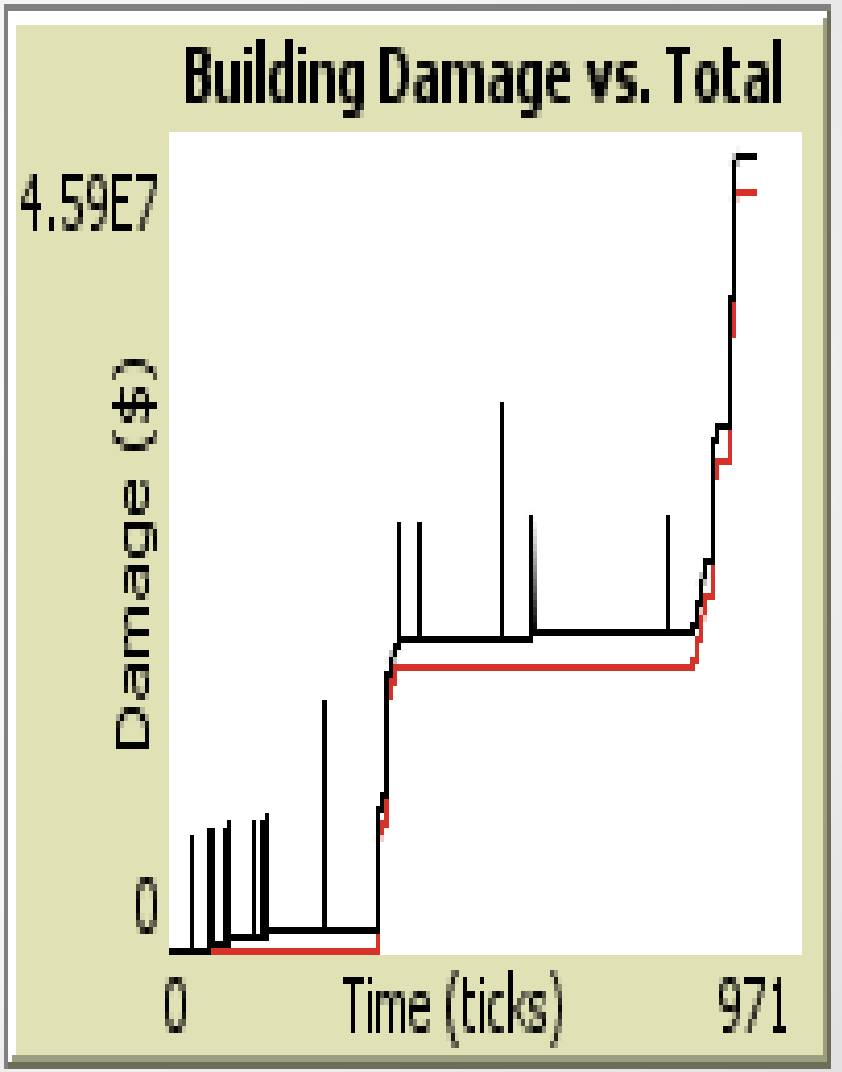


Small (~$46 million in damage)



Results – Plots of House and Building vs. Total Damage





Results – Cars Destroyed

- At setup, originally 45 cars in the city
- Speed of each car: 75 mph
- Movement speed of tornado: 65 mph
- 16 cars total were destroyed (35.56% of original)
- Of those:
  - 12.5% due to tornado impact
  - 87.5% due to car accidents

Discussion

- In terms of economic damage (dollars), larger cities with higher building densities are damaged more
- In terms of destruction and reconstruction needed, smaller, suburban areas get damaged more
- More cars are destroyed by car accidents instead of by direct tornado impact
  - Drivers are frenzied in their attempt to escape – drive irrationally
  - Crash into trees, houses, buildings, or other cars
  - Lesson: Cars are the most unsafe places to be during tornadoes – find shelter in buildings instead

Future Work

- Infinite topology rather than bouncing off boundaries
- Roads for cars rather than move all over the place
- Make tornadoes appear randomly rather than generated at setup
- Have tornadoes move at random probabilities rather than a probability set by the user
- Pedestrians with different safe zones in the city
  - Crowd limits?
  - Estimating what safe zones might be free rather than picking closest one?