Question 1

This question is based on a model that demonstrates moths flying in circles around a light. Below you find a short description of the model, and figures showing the model at the beginning and at the end of a run and the model's user interface.

Model description

Moths exhibit two basic kinds of behaviour. When they detect a light source from a distance (as far as 200 feet away) moths tend to fly straight toward the light. Then, when moths get close to the light, they tend to turn away from the light in order to avoid it. First, moths sense the light in their immediate vicinity and turn toward the direction where the light is greatest.
Second, moths compare the light immediately ahead of them with the light at their current position. If the ratio of 'light just ahead' to 'light here' is below a threshold value, then the moths fly forward toward the light. If the ratio of 'light just ahead' to 'light here' is above a threshold value, then moths turn away from the light. The threshold is determined by the moths' sensitivity to light.
If the moths do not detect any light, or if there simply are no lights in the space where the moths are flying, then the moths flutter about randomly.

space directly surrounding agent.

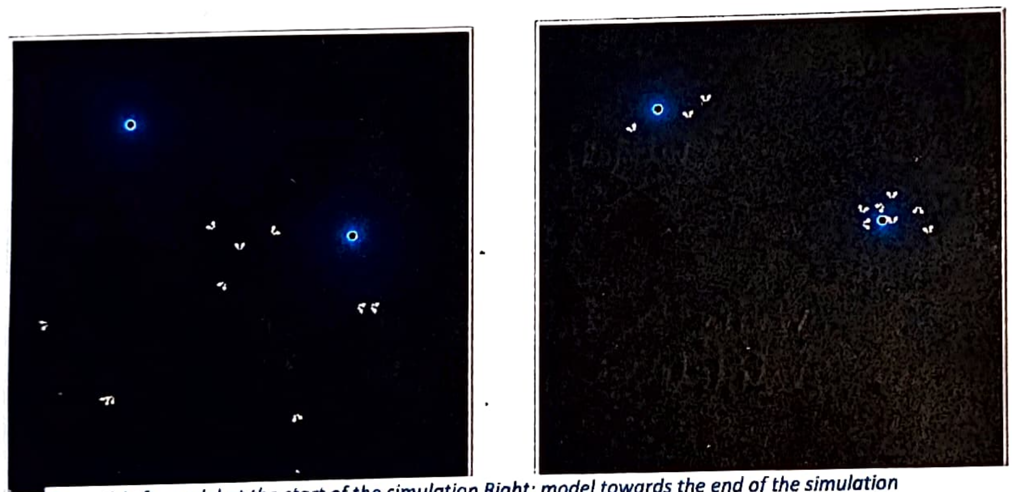

Figure 1 Left: model at the start of the simulation Right: model towards the end of the simulation

randomne in initial set has no effect

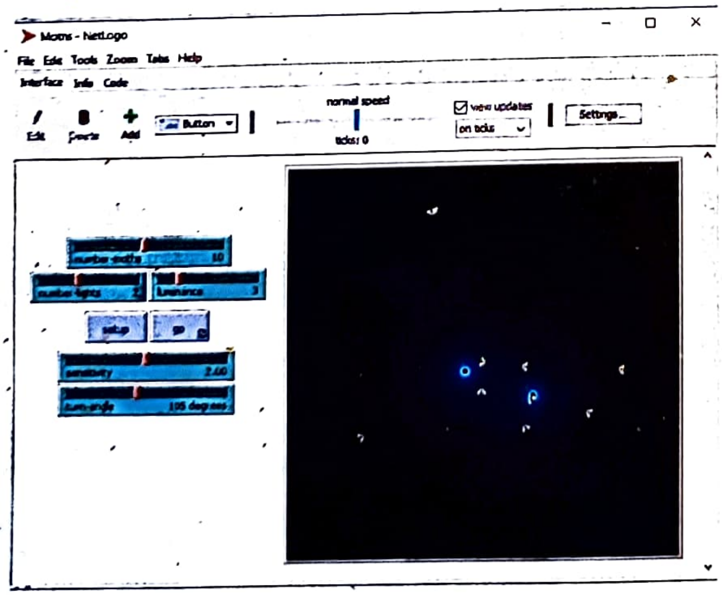

Figure 2: User Interface

w you
end of

r as
, they

space directly
surrounding
oward
away
agent.

are

Abstract
- simplified agent behavior (doesn't take all behavior of agent into account)
- simplified environment ??? (doesn't represent real world env. detail, e.g. wind)

Experimental. → test hypotheses
- controlled setting (UI that user can set)
- have some real characteristics (agent)

Historical → simulate past events based on historical data

Empirical → rely on data collected from real-world observations.

The moths have no control of the light intensity

- ➢ Is this a spatial model? Why?
- ✓ This is a spatial model but not a geographic explicit model. It is spatial for a number of reasons:
  - The moths are at a specific location within the environment
  - The moths use a spatial relationship: their distance and position in respect to the light to steer their behaviour

- ➢ According to the characteristics of agents and environment, how would you classify this simulation? Choose from the following list: Abstract, Experimental, Historical or Empirical. Motivate your answer.

  mean ???
- ✓ Agents have some 'real' characteristics. The environment can be tuned from the user interface, indicating that it is designed. Preferred answer: Experimental.

  Also accepted: Abstract (considering agents as totally designed)

randomness in initial set up has no effect →

- ➢ Is this environment (a) stochastic or (b) deterministic? If (a), what would you do to turn it into (b). If (b), what would you do to turn it into (a)?

  throughout the running model period, it should have some randomness
- ✓ This environment is deterministic (the subsequent state is wholly dependent on the preceding state). To turn it into an stochastic one: Let new light points popup or/and let the current light points disappear. To achieve this each light point should have a "duration" and when this duration has expired, it will dim out. Patches should get the possibility to sprout new light points

- ➢ What is the emergence in this model
- ✓ A spatial pattern of months circling around light points

Question 2

This question is based on a model that simulates the decision-making process of immigrates arriving in cities and boroughs of the Island of Montreal to choose a housing place and the resulting spatial segregation patterns. You will find a short description of the model, and a figure showing the results of two different runs of the model.

Model description

5 ticks (1 year ea

The initial number of immigrants is set to 12000 per year and they are randomly placed in residential areas of the island. As they arrive, the immigrants will start to look for a good area to live. Four rules are followed by the agents to decide where to locate:

1.-Immigrants will move to areas where a certain percentage of neighbours have the same ethnic origin and speak the same language

2.- Immigrants will move to areas where a certain percentage of neighbours have a similar economic status

3.- Immigrants will move to areas that are accessible by bus and/or metro

4.- Immigrants with infants or children will move to areas where schools are accessible. If the immigrant has no infants or children, this rule is ignored.

Each rule has a certain priority. Once all the rules are evaluated, the immigrant will move to a place where the requirements are better met. Once the agent chose a place to settle, it will not move anymore. Every year, 12000 new immigrants arrive and evaluate the rules. The model runs for 5 years.

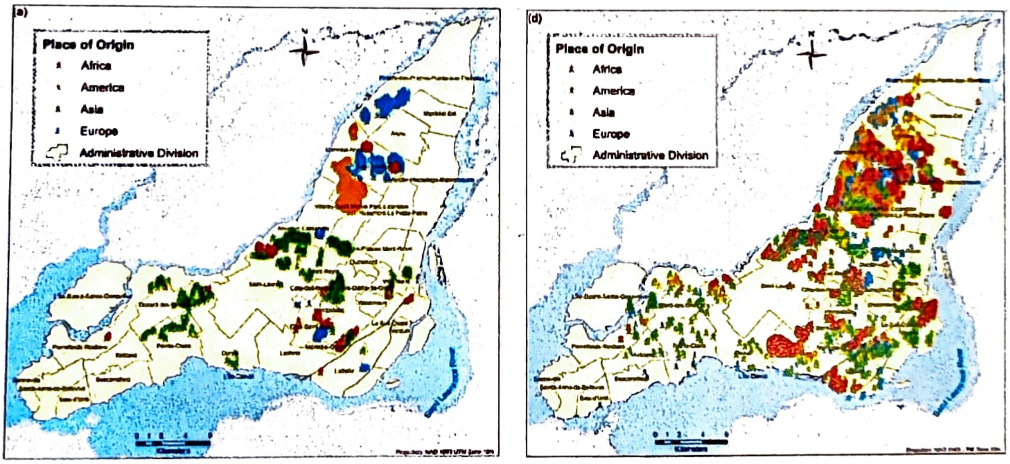

Figure 2 Left: End of simulation run (a) Right: situation at the end of simulation (d)

Answer the following sub-questions:

- Describe this model in terms of space and time. How are these two aspects modelled?
- ✓ Space: this is a geographically explicit model. The environment represents a geographic space

  Time: 5 discrete steps (1 year each)

Space: geographically explicit → island of Montreal (exist in real-world)

Time: 5 ticks (1 year each)

agent → immigrant

attribute → - ethnicity
- spoken language

- economic status
- have kids ?
- status (settle, not settle)

- Which agent breeds would you create and which attributes would you use for this/these agents (name all)?

✓ One agent breed: immigrant
Attributes: place of origin, income level, children/no children, language probably add state variable?

- Is this an explanatory or a predictive model? Motivate your answer.

✓ The model is explanatory. The purpose is to program plausible agent behaviors and interactions that, when run as a simulation, produce similar trends and patterns to those observable in the real system.

- initial location that immigrants were placed ???
- priority of each rule

- Look at the figures. Although the original number and composition of the agents as well as the base data are the same in both runs, the results are different. Imagine different factors that may have had such an impact on the emergent pattern?

✓ The weight assigned to each rule. The percentage of neighbours having same ethnic origin, language or economic status. The definition of 'accessible' ???

verify → ensure that model satisfy specification
evaluate details of simulation "history"
- sensitivity analysis

- Suppose that you want to verify this model. What would you do? ???

✓ Check a number of individual agents and see how they relocated to see if this is according to the rules. Generate overall statistics that indicate per income group where they are (how homogeneous the clusters are) and per ethnic background. Check if immigrants with children are closer to schools compared to immigrants without children etc.

- Suppose that you want to ~~verify~~ validate this model. What would you do?
Compare results with real census data → input validation ?
Use real census data, train a ML algorithm, compare the outcomes of the ABM with the outcomes of the ML and tune the preferences

verify → ensure model is implemented correctly
validate → ensure model is accurate representation of real-world

Question 3

Below you see a list of text fragments, extracted from a published ODD protocol. This ODD protocol describes the SLUDGE model: a spatially explicit agent-based model used to understand land use change in the context of urban growth processes.
Identify for each of these fragments in which part of the ODD protocol it belongs. Motivate each of your answers.

Model description

overview: ~~sta~~ entities, state vars, and scales.

- *Text a: the model comprises of a landscape consisting of Cells and two agent types: Residents and Service Centres, both of whose primary behaviours are to locate themselves on a grid-based landscape following a location decision-making process. For use in the model all state variables are scaled into the range [0,1].*

✓ Overview: Entities, State Variables

- *Text b: Agents interact indirectly at both a local and global level. At a local level, the land-use choice of one agent affects the profits of its four local neighbours. At a global level, the agent's choice affects the returns to urban land.*

✓ Design concepts: Interaction

Design: Interaction

- **Text c:** *The state of the model world is initialized by setting an initial configuration of land uses (for the Java model, either all land use 0 or a random distribution of 50% 0 and 50% 1).*

✓ Details: Initialization

Details: initialization

- **Text d:** *SLUDGE explores the relationship between two related phenomena: landscape pattern and economic value. The landscape patterns and associated landscape productivity measures the result of the decentralized decisions of autonomous land-manager agents.*

model

✓ Design concepts: Emergence ???

Also accepted: Overview - Purpose

Overview : Purpose

- **Text e:** *The Landscape submodel calculates supply for each cell for each Land Use, based on the current neighbors of the cell. For Land Use 0, that productivity is multiplied by the fixed Output_Price_0 to calculate profits for Land Use 0 for that cell.*

✓ Details: Submodels

Details : sub models

- **Text f:** *Agents are assumed to know the current landscape pattern and the profit-maximizing choices of other agents. Information is complete and certain.*

✓ Design concepts: Sensing

Design : sensing

- **Text g:** *The agents form an Expected Price for urban land by anticipating the fitness (profit) maximizing decisions of other agents and the price that would result if other agents behaved optimally.*

✓ Design concepts: Prediction

Design : prediction