

Skeleton Code Breakdown

Static Methods

Identifier / Data	Identifier / Data	Description
Main	Main	Main
Parameters	n/a	This is the main entrance point for the application. It obtains a simulation preset from the user and controls the main menu loop. It initialises an empty list SimulationParameters and prompts for a simulation number. On input: • '1' → [1, 5, 5, 500, 3, 5, 1000, 50] • '2' → [1, 5, 5, 500, 3, 5, 1000, 100] • '3' → [1, 10, 10, 500, 3, 9, 1000, 25] • '4' → [2, 10, 10, 500, 3, 6, 1000, 25] These eight integers represent, in order: starting number of nests, number of rows, number of columns, starting food in each nest, starting number of food cells, starting ants in each nest, new pheromone strength, and pheromone decay. A Simulation named ThisSimulation is created from those parameters. The method then loops until '9' is entered: • '1' → GetDetails() and print. • '2' → get two cell references then GetAreaDetails(...) and print. • '3' → get one cell reference then GetCellDetails(...) and print. • '4' → AdvanceStage(1) then print a confirmation. • '5' → read a number then AdvanceStage(NumberOfStages) and print a confirmation. Finally calls input() once to pause before exit.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
DisplayMenu	DisplayMenu	DisplayMenu
Parameters	n/a	Prints a blank line followed by the menu text for options 1–5 and 9. Quit. Ends with print('> ', end="") so that the next input appears on the same line.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetChoice	GetChoice	GetChoice
Parameters	n/a	Reads one line from standard input and returns it unchanged.
Return values	Choice : String	
Identifier / Data	Identifier / Data	Description
GetCellReference	GetCellReference	GetCellReference
Parameters	n/a	Prompts separately for row and column using int(input(...)). Returns the two integers and prints a trailing blank line.
Return values	Row : Int Column : Int	

Class: Simulation

Identifier / Data	Identifier / Data	Description
<<constructor>>	<<constructor>>	<<constructor>>
Parameters	SimulationParameters : List<Int>	Initialises a simulation using the eight supplied integers: _StartingNumberOfNests, _NumberOfRows, _NumberOfColumns, _StartingFoodInNest, _StartingNumberOfFoodCells, _StartingAntsInNest, _NewPheromoneStrength, _PheromoneDecay. - Creates empty lists _Nests, _Ants, _Pheromones, _Grid. - Populates _Grid with Cell objects for every coordinate 1..rows × 1..columns. - Calls SetUpANestAt(2, 4) for the initial nest. - For additional nests, repeatedly choose random coordinates not already used by a nest, then call SetUpANestAt(Row, Column). - Adds starting food cells by repeatedly choosing random non-nest coordinates and calling AddFoodToCell(Row, Column, 500).
Return values	n/a	
Identifier / Data	Identifier / Data	Description
SetUpANestAt (public)	SetUpANestAt (public)	SetUpANestAt (public)
Parameters	Row : Int Column : Int	Creates a Nest at the specified location with starting food _StartingFoodInNest . Adds one QueenAnt and then WorkerAnt instances for integers 2.._StartingAntsInNest .
Return values	n/a	
Identifier / Data	Identifier / Data	Description
AddFoodToCell (public)	AddFoodToCell (public)	AddFoodToCell (public)
Parameters	Row : Int Column : Int Quantity : Int	Locates the cell and increases its stored food by Quantity via UpdateFoodInCell(Change) .
Return values	n/a	
Identifier / Data	Identifier / Data	Description
__GetIndex (private)	__GetIndex (private)	__GetIndex (private)
Parameters	Row : Int Column : Int	Maps (row, column) to the one-dimensional index (Row - 1) × _NumberOfColumns + Column - 1 within _Grid .
Return values	Index : Int	
Identifier / Data	Identifier / Data	Description
__GetIndicesOfNeighbours (private)	__GetIndicesOfNeighbours (private)	__GetIndicesOfNeighbours (private)
Parameters	Row : Int Column : Int	Builds a 3×3 neighbourhood list (top-left to bottom-right). Valid neighbours contain their _Grid index; the centre and out-of-bounds positions contain -1 .
Return values	ListOfNeighbours : List<Int>	

Identifier / Data	Identifier / Data	Description
__GetIndexOfNeighbourWithStrongestPheromone (private)	__GetIndexOfNeighbourWithStrongestPheromone (private)	__GetIndexOfNeighbourWithStrongestPheromone (private)
Parameters	Row : Int Column : Int	Returns the _Grid index of the neighbour with the greatest pheromone strength (checked using GetStrongestPheromoneInCell(Cell)). If no neighbour has pheromone, returns -1 .
Return values	IndexOfStrongestPheromone : Int	
Identifier / Data	Identifier / Data	Description
GetNestInCell (public)	GetNestInCell (public)	GetNestInCell (public)
Parameters	C : Cell	Returns the Nest at the same location as cell C , or None .
Return values	Nest None	
Identifier / Data	Identifier / Data	Description
UpdateAntsPheromoneInCell (public)	UpdateAntsPheromoneInCell (public)	UpdateAntsPheromoneInCell (public)
Parameters	A : Ant	If a pheromone at the ant's location already belongs to that ant, increases its strength by _NewPheromoneStrength . Otherwise appends a new Pheromone with initial strength _NewPheromoneStrength and per-stage decay PheromoneDecay .
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetNumberOfAntsInCell (public)	GetNumberOfAntsInCell (public)	GetNumberOfAntsInCell (public)
Parameters	C : Cell	Counts ants located in the same cell as C .
Return values	Count : Int	
Identifier / Data	Identifier / Data	Description
GetNumberOfPheromonesInCell (public)	GetNumberOfPheromonesInCell (public)	GetNumberOfPheromonesInCell (public)
Parameters	C : Cell	Counts pheromones located in the same cell as C .
Return values	Count : Int	
Identifier / Data	Identifier / Data	Description
GetStrongestPheromoneInCell (public)	GetStrongestPheromoneInCell (public)	GetStrongestPheromoneInCell (public)
Parameters	C : Cell	Maximum pheromone strength present in the same cell as C .
Return values	Strength : Int	

Identifier / Data	Identifier / Data	Description
GetDetails (public)	GetDetails (public)	GetDetails (public)
Parameters	n/a	Builds a multi-line report for each cell: coordinates, 'Nest' if present, 'Ants: <count>' if any, 'Pheromones: <count>' if any, and '<food> food' if non-zero.
Return values	Details : String	
Identifier / Data	Identifier / Data	Description
GetAreaDetails (public)	GetAreaDetails (public)	GetAreaDetails (public)
Parameters	StartRow : Int StartColumn : Int EndRow : Int EndColumn : Int	As GetDetails() but only for the inclusive rectangle [StartRow..EndRow] × [StartColumn..EndColumn] .
Return values	Details : String	
Identifier / Data	Identifier / Data	Description
AddFoodToNest (public)	AddFoodToNest (public)	AddFoodToNest (public)
Parameters	Food : Int Row : Int Column : Int	Finds the nest at the given coordinates and applies ChangeFood(Food) .
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetCellDetails (public)	GetCellDetails (public)	GetCellDetails (public)
Parameters	Row : Int Column : Int	Creates a detailed string for a single cell: the cell's details; Nest present (<food> food) if a nest exists; an ANTS section containing GetDetails() for each Ant there; and a PHEROMONES section listing each pheromone's owner id and strength.
Return values	Details : String	
Identifier / Data	Identifier / Data	Description
AdvanceStage (public)	AdvanceStage (public)	AdvanceStage (public)
Parameters	NumberOfStages : Int	Advances the simulation repeatedly. Each stage: • Calls Pheromone.AdvanceStage(...) on all pheromones and removes those with strength 0. • For every ant: call AdvanceStage(...), obtain the current cell and then: – If carrying food at its own nest, transfer it via AddFoodToNest(...) and reset the carried amount. – Else if the cell contains food and the ant carries none, draw FoodObtained as a random integer up to GetFoodCapacity() not exceeding the cell's remaining food; subtract from the cell and add to the ant. – Else (no pickup): if carrying food, reinforce the current cell's pheromone via UpdateAntsPheromoneInCell(A). Move using ChooseCellToMoveTo(GetIndicesOfNeighbours(...), GetIndexOfNeighbourWithStrongestPheromone(...)).
Return values	n/a	

		For every nest: call Nest.AdvanceStage(...) and replace the lists with the returned versions.
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Class: Entity

Identifier / Data	Identifier / Data	Description
<<constructor>>	<<constructor>>	<<constructor>>
Parameters	StartRow : Int StartColumn : Int	Initialises shared attributes: position _Row, _Column and identifier _ID (initially None).
Return values	n/a	
Identifier / Data	Identifier / Data	Description
InSameLocation (public)	InSameLocation (public)	InSameLocation (public)
Parameters	E : Entity	True if E has the same row and column as this entity.
Return values	Boolean	
Identifier / Data	Identifier / Data	Description
GetRow / GetColumn / GetID (public)	GetRow / GetColumn / GetID (public)	GetRow / GetColumn / GetID (public)
Parameters	n/a	Accessors for row, column and identifier.
Return values	Row : Int Column : Int ID : Int None	
Identifier / Data	Identifier / Data	Description
AdvanceStage (public)	AdvanceStage (public)	AdvanceStage (public)
Parameters	Nests : List[Nest] Ants : List[Ant] Pheromones : List[Pheromone]	Base method that does nothing; subclasses override where needed.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetDetails (public)	GetDetails (public)	GetDetails (public)
Parameters	n/a	Base method returning an empty string; subclasses extend with details.
Return values	String	

Class: Cell

Identifier / Data	Identifier / Data	Description
<<constructor>>	<<constructor>> (inherits from Entity)	<<constructor>> (inherits from Entity)

(inherits from Entity)		
Parameters	StartRow : Int StartColumn : Int	Calls the Entity constructor and sets _AmountOfFood = 0 .
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetAmountOfFood (public)	GetAmountOfFood (public)	GetAmountOfFood (public)
Parameters	n/a	Returns the cell's stored food amount.
Return values	AmountOfFood : Int	
Identifier / Data	Identifier / Data	Description
GetDetails (public)	GetDetails (public)	GetDetails (public)
Parameters	n/a	Returns text ' "<amount> food present" ' followed by a blank line.
Return values	Details : String	
Identifier / Data	Identifier / Data	Description
UpdateFoodInCell (public)	UpdateFoodInCell (public)	UpdateFoodInCell (public)
Parameters	Change : Int	Adds the signed Change to _AmountOfFood .
Return values	n/a	

Class: Ant

Identifier / Data	Identifier / Data	Description
<<constructor>> (inherits from Entity)	<<constructor>> (inherits from Entity)	<<constructor>> (inherits from Entity)
Parameters	StartRow : Int StartColumn : Int NestInRow : Int NestInColumn : Int	Initialises position and home nest (_NestRow , _NestColumn). Assigns a unique _ID from Ant . NextAntID and increments it. Sets _Stages = 0 , _AmountOfFoodCarried = 0 , _FoodCapacity = 0 , _TypeOfAnt = " .
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetFoodCapacity / GetFoodCarried / GetNestRow / GetNestColumn / GetTypeOfAnt (public)	GetFoodCapacity / GetFoodCarried / GetNestRow / GetNestColumn / GetTypeOfAnt (public)	GetFoodCapacity / GetFoodCarried / GetNestRow / GetNestColumn / GetTypeOfAnt (public)

Parameters	n/a	Accessors returning capacity, amount carried, home nest coordinates and type ('queen' or 'worker').
Return values	Various	
Identifier / Data	Identifier / Data	Description
IsAtOwnNest (public)	IsAtOwnNest (public)	IsAtOwnNest (public)
Parameters	n/a	True if current position equals the home nest coordinates.
Return values	Boolean	
Identifier / Data	Identifier / Data	Description
AdvanceStage (public)	AdvanceStage (public)	AdvanceStage (public)
Parameters	Nests : List[Nest] Ants : List[Ant] Pheromones : List[Pheromone]	Increments _Stages by 1.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetDetails (public)	GetDetails (public)	GetDetails (public)
Parameters	n/a	Returns ' _Ant <ID>, <type>, stages alive: <count> '.
Return values	Details : String	
Identifier / Data	Identifier / Data	Description
UpdateFoodCarried (public)	UpdateFoodCarried (public)	UpdateFoodCarried (public)
Parameters	Change : Int	Adds the signed Change to _AmountOfFoodCarried .
Return values	n/a	
Identifier / Data	Identifier / Data	Description
_ChangeCell (private helper)	_ChangeCell (private helper)	_ChangeCell (private helper)
Parameters	NewCellIndicator : Int RowToChange : Int ColumnToChange : Int	Translates a neighbour position index (0..8) to row/column deltas: indices < 3 move up, > 5 move down; 0/3/6 move left; 2/5/8 move right. Returns the updated coordinates.
Return values	NewRow : Int NewColumn : Int	
Identifier / Data	Identifier / Data	Description
_ChooseRandomNeighbour (private helper)	_ChooseRandomNeighbour (private helper)	_ChooseRandomNeighbour (private helper)
Parameters	ListOfNeighbours : List[Int]	Loops until a random position index into the list is chosen where the entry is not -1 . Returns that position 0..8.

Return values	IndexPosition : Int	
Identifier / Data	Identifier / Data	Description
ChooseCellToMoveTo (public, virtual)	ChooseCellToMoveTo (public, virtual)	ChooseCellToMoveTo (public, virtual)
Parameters	ListOfNeighbours : List<Int> IndexOfNeighbourWithStrongestPheromone : Int	Base method (no movement). Overridden in WorkerAnt .
Return values	n/a	

Class: QueenAnt (inherits from Ant)

Identifier / Data	Identifier / Data	Description
<<constructor>>	<<constructor>>	<<constructor>>
Parameters	StartRow : Int StartColumn : Int NestInRow : Int NestInColumn : Int	Calls the Ant constructor and sets _TypeOfAnt = 'queen' .
Return values	n/a	

Class: WorkerAnt (inherits from Ant)

Identifier / Data	Identifier / Data	Description
<<constructor>>	<<constructor>>	<<constructor>>
Parameters	StartRow : Int StartColumn : Int NestInRow : Int NestInColumn : Int	Calls the Ant constructor, sets _TypeOfAnt = 'worker' and _FoodCapacity = 30 .
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetDetails (public)	GetDetails (public)	GetDetails (public)
Parameters	n/a	Extends the Ant string to include carrying <amount> food .
Return values	Details : String	home nest is at <row> <column> .
Identifier / Data	Identifier / Data	Description
ChooseCellToMoveTo (public, override)	ChooseCellToMoveTo (public, override)	ChooseCellToMoveTo (public, override)
Parameters	ListOfNeighbours : List<Int> IndexOfNeighbour	If carrying food, move one step towards the home nest by reducing the row and then the column differences. Else if IndexOfNeighbourWithStrongestPheromone == -1 , pick

	WithStrongestPheromone : Int	a random valid neighbour position index using ChooseRandomNeighbour and update coordinates via ChangeCell .
Return values	n/a	
		Else map the strongest-pheromone <i>grid index</i> back to its <i>position</i> in ListOfNeighbours and apply ChangeCell .

Class: Nest (inherits from Entity)

Identifier / Data	Identifier / Data	Description
<<constructor>>	<<constructor>>	<<constructor>>
Parameters	StartRow : Int StartColumn : Int StartFood : Int	Sets _FoodLevel = StartFood , NumberOfQueens = 1 , assigns a unique id from Nest. NextNestID and increments it.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
ChangeFood (public)	ChangeFood (public)	ChangeFood (public)
Parameters	Change : Int	Adds Change to _FoodLevel ; clamps to 0 if the result would be negative.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
GetFoodLevel (public)	GetFoodLevel (public)	GetFoodLevel (public)
Parameters	n/a	Returns the current stored food level.
Return values	FoodLevel : Int	
Identifier / Data	Identifier / Data	Description
AdvanceStage (public)	AdvanceStage (public)	AdvanceStage (public)
Parameters	Nests : List[Nest] Ants : List[Ant] Pheromones : List[Pheromone]	If Ants is None , return immediately. Otherwise: • Compute consumption for ants located at this nest: +10 per queen, +2 per worker; subtract the integer total from _FoodLevel .
Return values	Nests : List[Nest] Ants : List[Ant] Pheromones : List[Pheromone]	• If _FoodLevel == 0 and there are ants, increment a local AntsToCull by 1. If _FoodLevel < len(Ants) , increment again. If _FoodLevel < len(Ants) × 5 , increment again (capped to the number of ants). Remove that many randomly selected ants; if a queen is removed, decrement NumberOfQueens . • Else (sufficient food): for each queen, with 50% probability spawn a new ant at the nest; within that, 2% chance to spawn a queen otherwise a worker.
		Returns the updated lists of nests, ants and pheromones.

Class: Pheromone (inherits from Entity)

Identifier / Data	Identifier / Data	Description
<<constructor>>	<<constructor>>	<<constructor>>
Parameters	Row : Int Column : Int	

	BelongsToAnt : Int InitialStrength : Int Decay : Int	Initialises owner id, current strength and per-stage decay amount for the pheromone at the given position.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
AdvanceStage (public)	AdvanceStage (public)	AdvanceStage (public)
Parameters	Nests : List[Nest] Ants : List[Ant] Pheromones : List[Pheromone]	Reduces _Strength by _PheromoneDecay each stage; if _Strength falls below 0 it is set to 0.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
UpdateStrength / GetStrength / GetBelongsTo (public)	UpdateStrength / GetStrength / GetBelongsTo (public)	UpdateStrength / GetStrength / GetBelongsTo (public)
Parameters	Change : Int (for UpdateStrength)	Updates or reads the pheromone's strength and returns its owner id.
Return values	Various	

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