Skeleton Code Breakdown

Static Methods

Identifier / Data	Identifier / Data	Description
main	main	main
Parameters	n/a	This is the main entry point for the Java application. It selects a preset, runs the main menu loop to inspect or advance the simulation, and finally reads one extra line with scanner.nextLine() so the console window pauses before the program exits.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
displayMenu	displayMenu	displayMenu
Parameters	n/a	Prints the menu for the user and leaves the cursor positioned after "> " ready for input.
Return values	n/a	
Identifier / Data	Identifier / Data	Description
getChoice	getChoice	getChoice
Parameters	n/a	Returns the string that the user typed at the prompt.
Return values	Choice : String	
Identifier / Data	Identifier / Data	Description
getCellReference	getCellReference	getCellReference
Parameters	Row : IntWrapper Column : IntWrapper	Prompts separately for row and column and writes the chosen coordinates into the supplied IntWrapper objects, then prints a trailing blank line.
Return values	Row : int (via row.value) Column : int (via column.value)	

Class: Simulation

Identifier / Data	Identifier / Data	Description
<<constructor>>	<<constructor>>	<<constructor>>
Parameters	simulationParameters : ArrayList<integer>	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
Return values	n/a	

		non-nest coordinates and calling addFoodToCell(Row, Column, 500).
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 : ArrayList<integer>	
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 null.
Return values	Nest | null	

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(...)). • For every nest: call Nest.advanceStage(...) and replace the lists with the returned versions.
Return values	n/a	

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 null).
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 | null	
Identifier / Data	Identifier / Data	Description
advanceStage (public)	advanceStage (public)	advanceStage (public)
Parameters	nests : ArrayList<Nest> ants : ArrayList<Ant> pheromones : ArrayList<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>> (inherits from Entity)	<<constructor>> (inherits from Entity)	<<constructor>> (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 : ArrayList<Nest> ants : ArrayList<Ant> pheromones : ArrayList<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 : ArrayList<integer>	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 : ArrayList<integer> 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, home nest is at <row> <column>.
Return values	Details : String	
Identifier / Data	**Identifier / Data**	**Description**
chooseCellToMoveTo (public, override)	chooseCellToMoveTo (public, override)	chooseCellToMoveTo (public, override)
Parameters	listOfNeighbours : ArrayList<integer> IndexOfNeighbourWithStrongestPheromone : int	If carrying food, move one step towards the home nest by reducing the row and then the column differences. Else if IndexOfNeighbourWithStrongestPheromone == -1, pick a random valid neighbour position index using chooseRandomNeighbour and update coordinates via changeCell. Else map the strongest-pheromone grid index back to its position in ListOfNeighbours and apply changeCell.
Return values	n/a	

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	

Return values	n/a	Adds Change to _FoodLevel; clamps to 0 if the result would be negative.
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 : ArrayList<Nest> ants : ArrayList<Ant> pheromones : ArrayList<Pheromone>	If Ants is null, return immediately. Otherwise: • Compute consumption for ants located at this nest: +10 per queen, +2 per worker; subtract the integer total from _FoodLevel. • 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.
Return values	nests : ArrayList<Nest> ants : ArrayList<Ant> pheromones : ArrayList<Pheromone>	

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 : ArrayList<Nest> ants : ArrayList<Ant> pheromones : ArrayList<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	