

Code for Model 1B: First Responders' willingness to enter an area with radioactive contamination with radiation subject matter experts present

```
breed [doctors doctor]                ;; designates the first responder agents
breed [persons person]                ;; designates the radiation subject matter experts (SME) agents
```

```
doctors-own [                          ;; assigns which variables the first responder agents possess
  my-neighbors
  nearest-neighbor
  flockmates
  mineRadiationTolerance
]
```

```
persons-own [                          ;;assigns which variables the SME agents possess
  my-neighbors
  nearest-neighbor
  flockmates
  mineRadiationTolerance
]
```

```
patches-own [                          ;; assigns which variable patches possess
  falloutZone?                        ;; this variable report TRUE or FALSE if a patch is within the designated falloutZone
  radiation
];; a radiation variable is included in the background environment within the contaminated area
  pointsourceRad                      ;;an additional pointsource of radiation is overlapped within the contaminated area
]
```

```
to setup
  clear-all
  setup-patches
  setup-doctors
  reset-ticks
end
```

;; this command series determines the visual characteristics of the first responder agents and restricts generation of only one agent per patch area and also determines the "mineradiationtolerance" numerical value representative of the assigned personal perception radiation risk

```
to setup-doctors
  set-default-shape doctors "person doctor"
  ask n-of initial-number-FirstResponders
    (patches with [pxcor > -40 and pycor < -18] )
    [ sprout-doctors 1 ]
```

```

ask doctors [
  set color green
  set mineRadiationTolerance random-poisson 2.5
  if mineRadiationTolerance < 1
    [set mineRadiationTolerance 1]
  if mineRadiationTolerance > 5
    [set mineRadiationTolerance 5]
  ]
end

```

;; this command series determines the visual characteristics of the subject matter experts (SME) and restricts generation of only one agent per patch area and also determines the “mineradiationtolerance” numerical value representative of the assigned personal perception radiation risk

```

to setup-persons
  set-default-shape persons "person"
  ask n-of initial-number-SMEs
    (patches with [pxcor > -40 and pycor < -18] )
  [ sprout-persons 1 ]

```

```

ask persons [
  set color red
  set mineRadiationTolerance 10
]
end

```

;;this command series determines the background setup of the model and includes a series of commands affecting patches

```

to setup-patches
  ask patches [
    set pcolor 69
    set plabel-color black
    setup-pointsource
    setup-falloutZone?
    setup-radiation
    ask patch 35 28 [set plabel "Contaminated Zone"]
  ]
end

```

```

to go
  move-doctors
  flock1
  move-doctors1
  set-master-heading
  move-doctors1

```

```
    reset-heading
  move-doctors1
  flock1
  move-doctors1
  tick
end
```

;;this command series directs the first responder agents to move towards the area with radioactive contamination at varying speed based on their respective mineRadiationTolerance score, if they have a higher mineradiationtolerance individual score they move faster

```
to move-doctors
  let slowest 0.00000000000000000001
  let slow 0.0002
  let fast 0.0004
  let fastest 0.0006
  ask doctors [

    show-radiation-dread
    if mineRadiationTolerance < 1.5
      [fd slowest]
    if ((mineRadiationTolerance >= 1.5) and (mineRadiationTolerance < 2.5))
      [fd slow]
    if ((mineRadiationTolerance >= 2.5 and mineRadiationTolerance < 4))
      [fd fast]
    if mineRadiationTolerance >= 4
      [fd fastest]
  ]
end
```

;;this tells the agents to communicate the mean mineRadiationTolerance variable to each other

```
to-report average_mineRadiationTolerance
  let myRT mean [mineRadiationTolerance] of flockmates
  report mean myRT
end
```

;;this tells the first responder agents to consider the mean mineRadiationTolerance of their neighbors and move faster towards the area with radioactive contamination if that value is >= 2.5

```
to move-doctors1
  let speed_gungho 0.02
  ask doctors [
    show-radiation-dread
    if falloutZone? = True [set speed_gungho .3 * speed_gungho]
    let F count flockmates
    if F > 0
```

```

[ let myRT mean [mineRadiationTolerance] of flockmates
  if myRT >= 2.5
    [fd speed_gungho]
]
]
ask persons [
  show-radiation-dread
  if falloutZone? = True [set speed_gungho .3 * speed_gungho]
  let F count flockmates
  if F > 0
    [ let myRT mean [mineRadiationTolerance] of flockmates
      if myRT >= 2.5
        [fd speed_gungho]
    ]
  ]
end

```

;;this directs the agents to move in a northern direction towards the area with radioactive contamination

```

to set-master-heading
  ask turtles [
    set heading 2
  ]
end

```

;;this directs the agents to reset their direction to a random point

```

to reset-heading
  ask turtles [
    set heading random 10
    fd 0.02
  ]
End

```

;;this directs the agents to look and see if they have any neighbors and move towards them

```

to flock1
  ask doctors [
    ;;this command line doesn't affect the agent behavior the model is designed to simulate
    let myx mineRadiationTolerance
    find-flockmates
    if any? flockmates
      [ find-nearest-neighbor
        ifelse mineRadiationTolerance >= myx
          [align cohere]
          [separate]
      ]
  ]

```

```

]
ask persons [
;;this command line doesn't affect the agent behavior the model is designed to simulate
  let myx mineRadiationTolerance
  find-flockmates
  if any? flockmates
    [ find-nearest-neighbor
      ifelse mineRadiationTolerance <= myx
        [align cohere]
        [separate]
    ]
  ]
end

```

;;this directs first responder agents to consider their neighbors or "flockmates" within whatever distance the Communication variable is set to

```

to find-flockmates
  set flockmates other turtles in-radius Communication
end

```

;;this directs the agents to locate their nearest neighbor

```

to find-nearest-neighbor
  set nearest-neighbor min-one-of flockmates [distance myself]
end

```

;;this directs the agents to move away from their nearest neighbor

```

to separate
  turn-away ([heading] of nearest-neighbor) 2.0
end

```

;; this directs the agents to move towards their neighbors

```

to align
  turn-towards average-flockmate-heading 2.0
end

```

;; this directs the agents to keep moving relative to their neighbors

```

to cohere
  turn-towards average-heading-towards-flockmates 2.0
end

```

;;this directs the agents to communicate the mean directional heading of their neighbors and is referenced from the flocking model in the NetLogo library of models

```

to-report average-flockmate-heading
  let x-component sum [dx] of flockmates
  let y-component sum [dy] of flockmates
  ifelse x-component = 0 and y-component = 0
    [ report heading ]
    [ report atan x-component y-component ]
end

```

;;this directs the agents to communicate the mean directional heading of themselves towards their neighbors

```

to-report average-heading-towards-flockmates
  let x-component mean [sin (towards myself + 180)] of flockmates
  let y-component mean [cos (towards myself + 180)] of flockmates
  ifelse x-component = 0 and y-component = 0
    [ report heading ]
    [ report atan x-component y-component ]
end

```

;;these following commands direct "flocking" movement of the agents like birds or "boyds" the agents move continually with respect to each other

```

to turn-towards [new-heading max-turn]
  turn-at-most (subtract-headings new-heading heading) max-turn
end

```

```

to turn-away [new-heading max-turn]
  turn-at-most (subtract-headings heading new-heading) max-turn
end

```

```

to turn-at-most [turn max-turn]
  ifelse abs turn > max-turn
    [ ifelse turn > 0
      [ rt max-turn ]
      [ lt max-turn ] ]
    [ rt turn ]
end

```

;;these following commands direct the first responders to respond to the presence of radiation within the contaminated area with directed movement to pause redirect their heading and move forward until they find an area with less radiation

```

to show-radiation-dread
  ask doctors [
    if ((radiation >= 9 or pointsourceRad >= 9) and mineRadiationTolerance >= 2.5)
      [wiggle]
    if ((radiation >= 9 or pointsourceRad >= 9) and mineRadiationTolerance < 2.5)
      [wiggle1]
  ]
end

```

```
]
end
```

```
;; directs "wiggle" movement of agents to turn right 40 degrees in a random direction and move back 2
patches
```

```
to wiggle
  back .1
  rt random 40 - 80
  forward .2
end
```

```
to wiggle1
  back .1
  rt random 40 - 80
  forward .1
end
```

```
;;these commands direct setup of the background environment within the model
```

```
to setup-radiation
  if falloutZone? [
    set radiation random-poisson 9
    set pcolor scale-color red radiation 50 0
  ]
end
```

```
to setup-pointsource
  set pointsourceRad 17 - distancexy 0 30
  set pcolor scale-color orange pointsourceRad 30 0
  if (pointsourceRad <= 0) [set pcolor 69]
  if (pointsourceRad < 0) [ set pointsourceRad 0]
end
```

```
to setup-falloutZone?
  set falloutZone?
  random pycor > 10
end
```