

UNIVERSITY OF COPENHAGEN

XMP: Exam

- Programming

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Implementation

The implementation consists of several different processes, in addition to a few helper functions, types and data structures. The processes largely communicate as outlined in Figure 1.

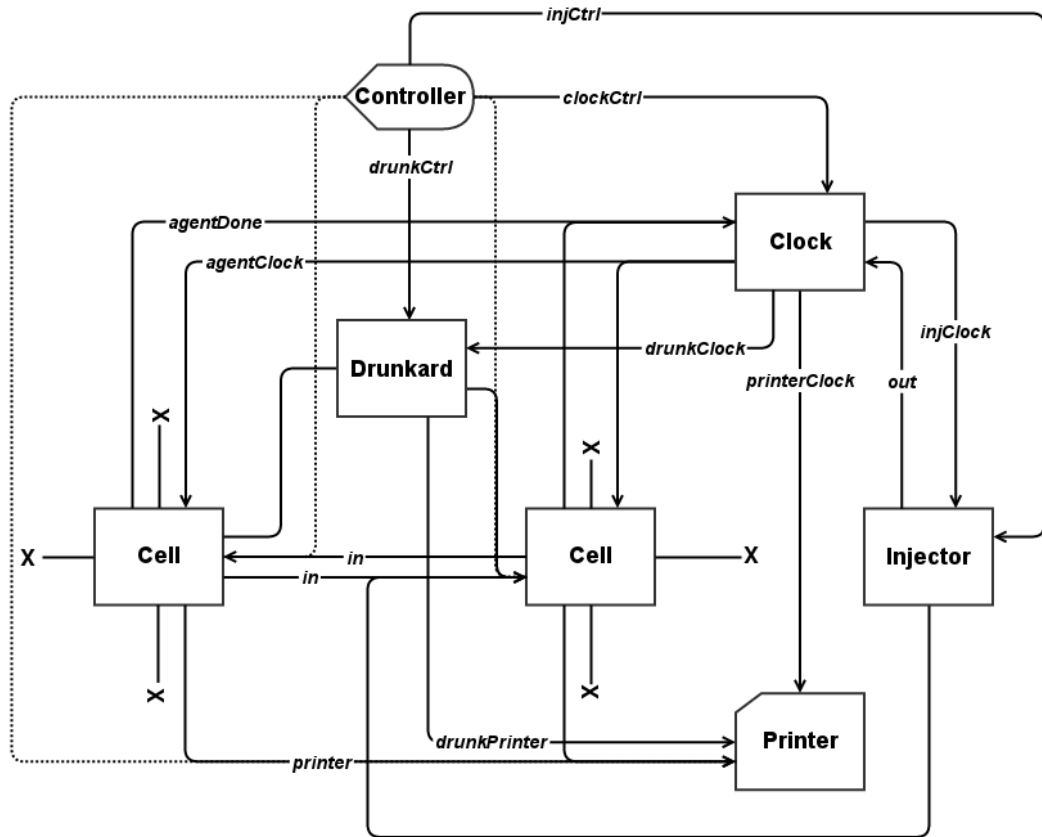


Figure 1: Communication between the processes of a pedestrian simulation. Here only two cells are shown, to keep the figure clearer. The dotted lines indicate that the controller only holds these channels for the purpose of closing them in the exit phase.

As can be seen from the figure the pedestrians themselves are not a process. These are instead data passed between the other processes on their respective channels. In general the communication of the implementation is as follows.

Cell A cell starts by waiting for messages from other cells, injectors and drunkards. When it receive such a message it will respond whether it has accepted the pedestrian, or drunk, in the message or not. It it only declines if it already has a pedestrian or a drunk. When a cell holds a pedestrian it will also wait for the clock to send a tick, after which it will try to send the pedestrian to on of its neighbors. If the cell has no neighbor in a direction it tries to send, it will instead let the pedestrian walk off the board and inform the clock that one less pedestrian exists. The cell also informs the printer each turn when it has a pedestrian. If the

cell receives a drunk, it will not try to move it, but instead only decline on its input channel, until the drunkard process informs the cell that the drunk has moved, after which the cell is back to its original state.

Injector The injector waits on input from either the clock or the controller. If it receives a tick from the clock it will check whether it should inject a pedestrian, and if so try to do this. If the cell it tries to inject at declines, i.e. it is occupied, the injector simply skips the injections this turn. The injector then informs the clock whether or not an extra pedestrian now exists on the board. If the injector receives a input from the controller it will change its injection rate to the one it has received.

Clock The clock is in charge of keeping, pedestrians (i.e. cell containing a pedestrian), injectors, the drunk and the printer in lock-step with each other. This is achieved by the clock sending a tick on its pedestrian clock for each pedestrian that exists, a tick to the drunkard, a tick to each injector and tick to the printer. After a tick, the clock expects a response back when the processes are done with their turn. When initialized the clock knows of no pedestrians and thus no ticks are being sent to cells. When the injectors receive a tick, they respond back informing the clock whether they successfully have injected a pedestrian. If so the pedestrian count is increased for the next turn. When cells holding a pedestrian receives a tick, they after a ended turn respond back whether the pedestrian still exists. A player ceases to exists if it walks off the board. After each turn the clock check whether the controller is ready to send a command. If it is the command is executed, else the clock moves on to executing the next turn. The clock is artificially delayed using a sleep-command, to allow humans to actually perceive every step. The default is 500ms between steps, but this can be changed from the controller to anything between 0 and the maximum size of an integer.

Drunkard The drunkard controls the drunk on the board. The drunkard accepts messages from the controller, the clock and the cells. When the drunkard receives a message from the controller it tries to place the drunk at the specified coordinates, by sending to the correct cell. If successful a drunk will now be active. When a drunk is placed on the board the drunkard tries to move it in a random direction every time it receives a message from the clock. should the drunk walk off the board, it will be gone and a new one can be placed from the controller if so desired. When the drunkard receives a message from a cell it will respond, on the piggybacked response channel from the message, whether or not a drunk is within 3 cells of the cell in question. The drunkard uses the euclidean distance formula in two dimensions to calculate this.

Printer The printer is in charge of printing out the state of the board/sidewalk every time-step. Is is done, by the printer receiving messages from the clock, the cells and the drunkard. Every time a clock tick is received the state is printed to the console and the printer resets itself. When the printer receives messages from either the drunkard or the cells its stores these positions in its state so that it can print them on the next clock tick. Because the clock synchronizes with the other processes the printer is certain that when it receives the tick, it must have received all state updates from the drunkard or the cells. When printing to the screen the

printer utilizes ANSI escape characters to overwrite the old state and thus keep a uncluttered, consistent console interface.

Controller The controller is the process which handles all input from the user. The controller can communicate with the clock, the injectors and the drunkard, to let them know when a user decision has been made. The controller as with the printer utilizes ANSI escape characters, and prints a simple console interface underneath the state of the board. When a user requests to exit the program the controller first informs the clock, effectively pausing the simulation. This ensures us that all processes are waiting on specific channels, which we then close from the controller. When the processes see that their channel is closed they return, thus closing themselves. The trickiest of the processes is the cell which can be waiting in many different places, however as we pause the simulation we now can be sure that the cell will either wait at its initial state, after it has gotten a drunk, or when it has a pedestrian, but has not yet received a clock tick. Finally the controller closes the channel to the clock and then returns, effectively exiting the complete simulation cleanly.

Sidewalk The sidewalk process simply binds all the other process together in a $X \times Y$ sized sidewalk with injectors at the requested locations. This process is thus used to instantiate a simulation with the requested amount of steps.

Source code

```
1 package main
2
3 import (
4     . "sidewalk"
5 )
6
7 func main() {
8     Sidewalk(5, 10, []Coordinate{Coordinate{2, 0}, Coordinate{2, 9}}, []Direction{Up, Down}, 200)
9 }
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```

22         switch cmd.Cmd {
23         case CmdPause:
24             paused := true
25             for paused {
26                 cmd := <-controller
27                 switch cmd.Cmd {
28                 case CmdResume:
29                     paused = false
30                 case CmdTime:
31                     wait = cmd.Arg[0]
32                 default:
33                     // Do nothing
34                 }
35             }
36         case CmdTime:
37             wait = cmd.Arg[0]
38         case CmdExit:
39             // Pause the clock until controller is closed after which, close
40             ok := true
41             for ok {
42                 _, ok = <-controller
43             }
44             return
45         default:
46             // Do nothing
47         }
48     default:
49         // do nothing
50     }
51     for i := 0; i < agents; i++ {
52         // tick the clock for agents
53         agentClock <- true
54     }
55     agentRemove := 0
56     for i := 0; i < agents; i++ {
57         // get response from agents
58         if !<-agentDone {
59             agentRemove++
60         }
61     }
62     agents -= agentRemove
63     drunkClock <- true
64     for _, inj := range injClock {
65         // tick every injector
66         inj <- true
67     }
68     for i := 0; i < len(injClock); i++ {
69         // as many times as there are injectors check input
70         agent := <-in
71         if agent.Ok {
72             agents++
73         }
74     }
75     // Now everyone has moved and the printer can print
76     printerClock <- true
77     <-printerClock
78     time.Sleep(time.Duration(wait) * time.Millisecond)
79 }
80 }
81
82 /**
83  * Injects players a specific cell every given step (default = 4).
84  */
85 func Injector(clock chan bool, cell chan Msg, out chan Pedestrian, d Direction,
86 ctrl chan int) {
87     step := 4
88     n := 0

```

```

89     rsp := make(chan bool)
90     for {
91         select {
92             case i, ok := <-ctrl:
93                 if !ok {
94                     return
95                 }
96                 step = i
97             case <-clock:
98                 var agent Pedestrian
99                 if n%step == 0 { // create a new player
100                     agent = Pedestrian{d, true}
101                     cell <- Msg{rsp, agent, Regular}
102                     if !<-rsp {
103                         agent.Ok = false
104                     }
105                 }
106                 out <- agent
107                 n++
108             }
109         }
110     }
111
112     /**
113     * Prints the sidewalk every timestep. The printer expects that
114     * ANSI escape characters work in the terminal, as these are used to
115     * overwrite the board every step.
116     */
117     func Printer(in chan Coordinate, drunkPrinter chan Coordinate, clock chan bool,
118         x int, y int) {
119         coords := makeCoords(x, y)
120         drunkCoord := Coordinate{-1, -1}
121         step := 0
122         for {
123             select {
124                 case c, ok := <-in:
125                     if !ok {
126                         return
127                     }
128                     coords[c.Y][c.X] = true // An agent is here in this turn
129                 case c := <-drunkPrinter:
130                     drunkCoord = c
131                 case <-clock:
132                     os.Stdout.WriteString("\033[s\033[0;0H\r\nStep: " +
133                         strconv.Itoa(step) + "\r\n")
134                     hline := ""
135                     for i := 0; i < x+2; i++ {
136                         hline += "="
137                     }
138                     hline += "\r\n"
139                     os.Stdout.WriteString(hline)
140                     for i, _ := range coords {
141                         line := "|"
142                         for j, _ := range coords[len(coords)-i-1] {
143                             switch {
144                                 case drunkCoord.X == j && drunkCoord.Y == (len(coords)-i-1):
145                                     line += "@"
146                                 case coords[len(coords)-i-1][j]:
147                                     line += "O"
148                                 default:
149                                     line += " "
150                             }
151                         }
152                         line += "|\n"
153                         os.Stdout.WriteString(line)
154                     }
155                 }

```

```

156         os.Stdout.WriteString(hline)
157         os.Stdout.WriteString("o = pedestrian, @ = drunk\r\n")
158         os.Stdout.WriteString("\033[u")
159         setCoords(false, &coords)
160         step++
161         clock <- true
162     }
163 }
164 }
165
166 /**
167  * Represents a single cell on the sidewalk. The cells handle moving
168  * pedestrians around. Whenever a cell holds a pedestrian it will try to move
169  * it every timestep, until it succeeds.
170  */
171 func Cell(in chan Msg, out [](chan Msg), printer chan Coordinate, coord Coordinate,
172 agentClock chan bool, agentDone chan bool, drunk chan DrunkRequest) {
173     var agent Pedestrian
174     oldAgent := false
175     rsp := make(chan bool)
176     isDrunk := false
177     for {
178         done := false
179         if !oldAgent {
180             msg, ok := <-in
181             if !ok {
182                 return
183             }
184             agent = msg.Agent
185             msg.Rsp <- true
186             printer <- coord
187             if msg.Status == GotDrunk {
188                 // this cell is now permanently occupied by a drunk
189                 isDrunk = true
190                 for isDrunk {
191                     msg, ok := <-in
192                     if !ok {
193                         return
194                     }
195                     msg.Rsp <- false
196                     if msg.Status == GotSober {
197                         isDrunk = false
198                         done = true
199                     }
200                 }
201             }
202         }
203         for !done {
204             select {
205             case <-agentClock:
206                 d := directions(agent.Dirc)
207                 tries := 0
208                 drunk <- DrunkRequest{coord, d[tries], rsp}
209                 if <-rsp {
210                     // Do not go the original direction if a drunk is nearby
211                     // that way. We hate drunkards!
212                     tries++
213                 }
214             }
215             for tries < 3 && !done {
216                 if out[d[tries]] == nil {
217                     // Agent walked off the board
218                     agentDone <- false
219                     oldAgent = false
220                     done = true
221                 } else {
222                     select {

```

```

223         case out[d[tries]] <- Msg{rsp, agent, Regular}:
224             if <-rsp {
225                 oldAgent = false
226                 done = true
227                 agentDone <- true
228             } else {
229                 tries++
230             }
231         case msg := <-in:
232             msg.Rsp <- false
233     }
234 }
235 }
236 if !done {
237     if !oldAgent {
238         oldAgent = true
239     } else {
240         printer <- coord
241     }
242     agentDone <- true
243 }
244 case msg, ok := <-in:
245     if !ok {
246         return
247     }
248     msg.Rsp <- false
249 }
250 }
251 }
252 }
253
254 /**
255  * Controls the drunk (insertion and movement).
256  * Cells query for the position of the drunk.
257  * The process is also in charge of moving the drunk around.
258  */
259 func Drunkard(in chan DrunkRequest, cells [][](chan Msg), ctrl chan Coordinate,
260 printer chan Coordinate, clock chan bool, x int, y int) {
261     rsp := make(chan bool)
262     drunk := Coordinate{-1, -1}
263     for {
264         select {
265             case req := <-in:
266                 req.Rsp <- drunkNearby(drunk, req.ReqCoord, x, y)
267             case coord, ok := <-ctrl:
268                 if !ok {
269                     return
270                 }
271             if !validCoord(drunk, x, y) {
272                 done := false
273                 cellMsg := Msg{rsp, Pedestrian{Up, false}, GotDrunk}
274                 for !done {
275                     select {
276                         case cells[coord.Y][coord.X] <- cellMsg:
277                             done = true
278                         case req := <-in:
279                             req.Rsp <- drunkNearby(drunk, req.ReqCoord, x, y)
280                     }
281                 }
282             if <-rsp {
283                 drunk = coord
284                 printer <- coord
285                 ctrl <- coord
286             } else {
287                 // Indicates that something went wrong
288                 ctrl <- Coordinate{-1, -1}
289             }

```



```

290         } else {
291             ctrl <- Coordinate{-1, -1}
292         }
293     case <-clock:
294         if validCoord(drunk, x, y) {
295             randomCoord := randomDirc(drunk, x, y)
296             if validCoord(randomCoord, x, y) {
297                 done := false
298                 cellMsg := Msg{rsp, Pedestrian{Up, false}, GotDrunk}
299                 for !done {
300                     select {
301                         case cells[randomCoord.Y][randomCoord.X] <- cellMsg:
302                             done = true
303                         case req := <-in:
304                             req.Rsp <- drunkNearby(drunk, req.ReqCoord, x, y)
305                     }
306                 }
307                 if <-rsp {
308                     cellMsg := Msg{rsp, Pedestrian{Up, false}, GotSober}
309                     done = false
310                     for !done {
311                         select {
312                             case cells[drunk.Y][drunk.X] <- cellMsg:
313                                 <-rsp
314                                 done = true
315                             case req := <-in:
316                                 req.Rsp <- drunkNearby(drunk, req.ReqCoord, x, y)
317                         }
318                     }
319                     drunk = randomCoord
320                     printer <- randomCoord
321                 }
322             } else {
323                 cellMsg := Msg{rsp, Pedestrian{Up, false}, GotSober}
324                 cells[drunk.Y][drunk.X] <- cellMsg
325                 <-rsp
326                 drunk = Coordinate{-1, -1}
327                 printer <- drunk
328             }
329         }
330     }
331 }
332 }
333
334 /**
335  * Creates a rectangular sidewalk with the given dimensions, the simulation
336  * runs the specified number of steps. The injectors are added at the given
337  * coordinates, and with the given directions.
338  */
339 func Sidewalk(x int, y int, injs []Coordinate, ds []Direction, steps int) {
340     agentClock := make(chan bool)
341     agentDone := make(chan bool)
342     cells := makeMsgChs(x, y)
343     clockCtrl := make(chan ClockRequest)
344     clockIn := make(chan Pedestrian)
345     drunkClock := make(chan bool)
346     drunkCtrl := make(chan Coordinate)
347     drunkPrinter := make(chan Coordinate)
348     drunkReq := make(chan DrunkRequest)
349     injChs := make([]chan bool, len(injs))
350     injCtrl := make([]chan int, len(injs))
351     printer := make(chan Coordinate)
352     printerClock := make(chan bool)
353     for i := 0; i < y; i++ {
354         for j := 0; j < x; j++ {
355             out := getOutChs(j, i, x, y, cells)
356             go Cell(cells[i][j], out, printer, Coordinate{j, i}, agentClock,

```

```

357         agentDone, drunkReq)
358     }
359 }
360 for i, _ := range injs {
361     injChs[i] = make(chan bool)
362     injCtrl[i] = make(chan int)
363     injx := injs[i].X
364     injy := injs[i].Y
365     go Injector(injChs[i], cells[injy][injx], clockIn, ds[i], injCtrl[i])
366 }
367 go Printer(printer, drunkPrinter, printerClock, x, y)
368 go Drunkard(drunkReq, cells, drunkCtrl, drunkPrinter, drunkClock, x, y)
369 go Clock(clockIn, agentClock, agentDone, injChs, printerClock,
370     steps, clockCtrl, drunkClock)
371 Controller(clockCtrl, injCtrl, drunkCtrl, printer, cells, x, y)
372 }

```

```

1  package sidewalk
2
3  import (
4      "bufio"
5      "os"
6      "strconv"
7      "strings"
8  )
9
10 /**
11  * The shell used for interaction with the player. The shell expects ANSI
12  * escape characters to work in the terminal, as these are used to overwrite
13  * old output.
14  */
15 func Controller(clockCtrl chan ClockRequest, injCtrl [](chan int),
16     drunkCtrl chan Coordinate, printer chan Coordinate, cells [][](chan Msg),
17     x int, y int) {
18     os.Stdout.WriteString("\033[0;0H\033[J\033[" + strconv.Itoa(y+6) + ";0H")
19     clockCtrl <- ClockRequest{CmdResume, nil}
20     play := true
21     exit := false
22     os.Stdout.WriteString("\r\n" + HelpText + "\033[F")
23     for !exit {
24         os.Stdout.WriteString("\033[Kcmd> ")
25         stdin := bufio.NewReader(os.Stdin)
26         input, _ := stdin.ReadString('\n')
27         cmd := strings.Split(strings.ToLower(strings.TrimSpace(input)), " ")
28         os.Stdout.WriteString("\033[J")
29         switch cmd[0] {
30             case "pause":
31                 if play {
32                     clockCtrl <- ClockRequest{CmdPause, nil}
33                     os.Stdout.WriteString("Simulation paused")
34                     play = !play
35                 } else {
36                     os.Stdout.WriteString("Simulation already paused")
37                 }
38             case "resume":
39                 if !play {
40                     clockCtrl <- ClockRequest{CmdResume, nil}
41                     os.Stdout.WriteString("Simulation resumed")
42                     play = !play
43                 } else {
44                     os.Stdout.WriteString("Simulation already running")
45                 }
46             case "rate":
47                 i, _ := strconv.Atoi(cmd[1])
48                 if i > 0 && i < 11 {
49                     for _, inj := range injCtrl {

```

```

50         inj <- i
51     }
52     os.Stdout.WriteString("Rate changed to " + cmd[1])
53 } else {
54     os.Stdout.WriteString("Rate but be between 1 and 10")
55 }
56 case "drunk":
57     drunkX, _ := strconv.Atoi(cmd[1])
58     drunkY, _ := strconv.Atoi(cmd[2])
59     if drunkX >= 0 && drunkX < x && drunkY >= 0 && drunkY < y {
60         drunkCtrl <- Coordinate{drunkX, drunkY}
61         msg := <-drunkCtrl
62         if msg.X == drunkX && msg.Y == drunkY {
63             os.Stdout.WriteString("Drunk placed at (" + cmd[1] + "," +
64                 cmd[2] + ")")
65         } else {
66             os.Stdout.WriteString("Drunk not placed, coordinates are" +
67                 " occupied or drunk already exists on board")
68         }
69     } else {
70         os.Stdout.WriteString("Drunk not placed, coordinates are invalid")
71     }
72 case "timestep":
73     wait, _ := strconv.Atoi(cmd[1])
74     if wait >= 0 {
75         clockCtrl <- ClockRequest{CmdTime, []int{wait}}
76         os.Stdout.WriteString("Time between steps changed")
77     } else {
78         os.Stdout.WriteString("Time between steps cannot be negative")
79     }
80 case "help":
81     os.Stdout.WriteString(HelpText)
82 case "exit":
83     clockCtrl <- ClockRequest{CmdExit, nil}
84     for _, i := range cells {
85         for _, j := range i {
86             close(j)
87         }
88     }
89     for _, i := range injCtrl {
90         close(i)
91     }
92     close(drunkCtrl)
93     close(printer)
94     close(clockCtrl)
95     return
96 default:
97     os.Stdout.WriteString("Unknown command")
98 }
99 os.Stdout.WriteString("\033[F")
100 }
101 }
102
103 const HelpText = "The following commands can be called\r\n" +
104     "pause\033[25Gpauses the simulation after the current step has executed\r\n" +
105     "resume\033[25Gresumes the simulation if it has been paused\r\n" +
106     "rate [ARG]\033[25Gsets the number of steps between injections of pedestrians\r\n" +
107     "drunk [ARG_X] [ARG_Y]\033[25Ginsert a drunk at the given position\r\n" +
108     "timestep [ARG]\033[25Gchanges the time (in milliseconds) " +
109     "simulation waits between step\r\n" +
110     "help\033[25Gshows this text\r\n" +
111     "exit\033[25Gexits the simulation\033[7F"

```

```

1 package sidewalk
2
3 import (

```

```

4      "math"
5      "math/rand"
6  )
7
8  /**
9   * Creates a list of the given direction and its two orthogonal directions
10  * the orthogonals order are randomized.
11  */
12  func directions(d Direction) (l []Direction) {
13      r := rand.Intn(2)
14      switch d {
15      case Up:
16          if r > 0 {
17              l = []Direction{Up, Left, Right}
18          } else {
19              l = []Direction{Up, Right, Left}
20          }
21      case Down:
22          if r > 0 {
23              l = []Direction{Down, Right, Left}
24          } else {
25              l = []Direction{Down, Right, Left}
26          }
27      case Left:
28          if r > 0 {
29              l = []Direction{Left, Down, Up}
30          } else {
31              l = []Direction{Left, Up, Down}
32          }
33      case Right:
34          if r > 0 {
35              l = []Direction{Right, Down, Up}
36          } else {
37              l = []Direction{Right, Up, Down}
38          }
39      }
40      return
41  }
42
43  /**
44   * Creates a slice of slices containing bools.
45   */
46  func makeCoords(x int, y int) [][]bool {
47      coords := make([][]bool, y)
48      for i, _ := range coords {
49          coords[i] = make([]bool, x)
50          for j, _ := range coords[i] {
51              coords[i][j] = false
52          }
53      }
54      return coords
55  }
56
57  /**
58   * Sets all values in the slice of slices to the specified value.
59   */
60  func setCoords(val bool, coords [][]bool) {
61      for i, _ := range *coords {
62          for j, _ := range (*coords)[i] {
63              (*coords)[i][j] = val
64          }
65      }
66  }
67
68  /**
69   * Creates a slice of slices containing message channels used by cells.
70   */

```

```

71 func makeMsgChs(x int, y int) [][](chan Msg) {
72     chs := make([][](chan Msg), y)
73     for i, _ := range chs {
74         chs[i] = make([](chan Msg), x)
75         for j, _ := range chs[i] {
76             chs[i][j] = make(chan Msg)
77         }
78     }
79     return chs
80 }
81
82 /**
83  * Returns a list of the four channels corresponding to cells adjacent to
84  * the cell at the position (j,i). If no cell is adjacent in a direction the
85  * channel is nil.
86  */
87 func getOutChs(j int, i int, x int, y int, chs [][](chan Msg)) [] (chan Msg) {
88     var left, right, up, down chan Msg = nil, nil, nil, nil
89     if j == 0 {
90         right = chs[i][j+1]
91     } else if j == x-1 {
92         left = chs[i][j-1]
93     } else {
94         left = chs[i][j-1]
95         right = chs[i][j+1]
96     }
97     if i == 0 {
98         up = chs[i+1][j]
99     } else if i == y-1 {
100         down = chs[i-1][j]
101     } else {
102         down = chs[i-1][j]
103         up = chs[i+1][j]
104     }
105     return [] (chan Msg){up, right, down, left}
106 }
107
108 /**
109  * Checks whether a coordinate is valid (non-negative) and
110  * within the specified bounds.
111  */
112 func validCoord(coord Coordinate, x int, y int) bool {
113     return coord.X >= 0 && coord.Y >= 0 && coord.X < x && coord.Y < y
114 }
115
116 func randomDirc(coord Coordinate, x int, y int) Coordinate {
117     randomCoord := Coordinate{-1, -1}
118     switch Direction(rand.Intn(4)) {
119     case Up:
120         if coord.Y < y-1 {
121             randomCoord = Coordinate{coord.X, coord.Y + 1}
122         }
123     case Down:
124         if coord.Y > 0 {
125             randomCoord = Coordinate{coord.X, coord.Y - 1}
126         }
127     case Left:
128         if coord.X > 0 {
129             randomCoord = Coordinate{coord.X - 1, coord.Y}
130         }
131     case Right:
132         if coord.X < x-1 {
133             randomCoord = Coordinate{coord.X + 1, coord.Y}
134         }
135     }
136     return randomCoord
137 }

```

```

138
139 /**
140  * Calculates whether a given drunk coordinate is within 3 cells.
141  * The calculation is the euclidian distance formula in two dimensions.
142  */
143 func drunkNearby(drunk Coordinate, reqCoord Coordinate, x int, y int) bool {
144     if validCoord(drunk, x, y) {
145         x := float64(drunk.X - reqCoord.X)
146         y := float64(drunk.Y - reqCoord.Y)
147         dist := math.Sqrt(math.Pow(x, 2) + math.Pow(y, 2))
148         return dist <= 3
149     } else {
150         return false
151     }
152 }

```

```

1 package sidewalk
2
3 type Direction int
4 type State int
5 type CmdWord int
6
7 const (
8     Up Direction = iota
9     Right
10    Down
11    Left
12 )
13
14 const (
15     GotDrunk State = iota
16     GotSober
17     Regular
18 )
19
20 const (
21     CmdResume CmdWord = iota
22     CmdPause
23     CmdTime
24     CmdExit
25 )
26
27 type Msg struct {
28     Rsp chan bool
29     Agent Pedestrian
30     Status State
31 }
32
33 type Pedestrian struct {
34     Dir Direction
35     Ok bool
36 }
37
38 type Coordinate struct {
39     X int
40     Y int
41 }
42
43 type DrunkRequest struct {
44     ReqCoord Coordinate
45     DrunkDir Direction
46     Rsp chan bool
47 }
48
49 type ClockRequest struct {
50     Cmd CmdWord

```

```
51     Arg []int
52 }
```