

BATMAN

Name: Mohamed Hesham Ibrahim Alkhaligy

ID: 47

Goals

1. Introducing threads synchronization and mutual exclusion.
1. Familiarizing with monitors, mutexes and condition variables.

Code Organization:

The project consists of two classes; "BATMAN" and "main". The "BATMAN" class implements synchronization solution of BATs problem. While the "main" class is only to initialize the BATMAN classes.

Major Functions:

Class: "BATMAN"

- **"initialize"**: Initializes the BATs' threads in which the characters of the given string represents the BATs. A thread is created for each BAT.
- **"BAT_thread"**: BAT_thread is the created thread of the BAT which goes through BAT's life cycle; arriving, crossing and finally leaving the crossroad.
- **"initialize_BAT_number"**: Initializes the BAT's number in which a global variable keeps track of initialized BATs' numbers.
- **"check"**: Checks for deadlock and solve it if exists by signaling the north BAT.
- **"deadlock_checker"**: The thread which is responsible for calling check function every pre-specified seconds.
- **"direction_enum_to_string"**: Changes a direction enum to a string to be printed.
- **"arrive"**: Handles the BATs arriving at the crossroad.
- **"cross"**: Handles the BATs crossing the crossroad.
- **"leave"**: Handles the BATs leaving the crossroad..

Problems Encountered & their solutions:

- Racing of BATs threads in a given direction to arrive, solved by creating a mutex for every direction track so that only one BAT thread can arrive at a time while the others would be in waiting queue till the later BAT finishes.
- Frequency of deadlock checker in which it has to check for deadlocks continuously & frequently, solved by making the individual thread responsible for it sleep for a pre-specified amount of seconds so that deadlock wouldn't be checked as frequently as it was.

Tracking

Actions	N	E	S	W
N+	1	0	0	0
N-	0	0	0	0
S+	0	0	1	0
E+	0	1	1	0
E-	0	0	1	0
S-	0	0	0	0
E+	0	1	0	0
E-	0	0	0	0

Actions	N	E	S	W
N+	1	0	0	0
N-	0	0	0	0
E+	0	1	0	0
E-	0	0	0	0
N+, E+, S+ & W+: Deadlock	1	1	1	1
N-	0	1	1	1
E- & E+	0	1	1	1
S-, S+, N+ & N+	2	1	1	1
W- & N-	1	1	1	0
W x6 & E-	1	0	1	6
S-, W- x2 & N-	0	0	0	4
W- x4	0	0	0	0


```
nsewwewnnsewwewnnsew
BAT 1 from North arrives at crossing
BAT 1 from North crossing
BAT 2 from South arrives at crossing
BAT 1 from North leaving crossing
BAT 3 from East arrives at crossing
BAT 3 from East crossing
BAT 3 from East leaving crossing
BAT 2 from South crossing
BAT 2 from South leaving crossing
BAT 4 from East arrives at crossing
BAT 4 from East crossing
BAT 4 from East leaving crossing
BAT 5 from North arrives at crossing I
BAT 5 from North crossing
BAT 5 from North leaving crossing
BAT 7 from East arrives at crossing
BAT 7 from East crossing
BAT 6 from South arrives at crossing
BAT 7 from East leaving crossing
BAT 11 from North arrives at crossing
BAT 14 from East arrives at crossing
BAT 8 from West arrives at crossing
DEADLOCK: BAT jam detected, signalling North to go
```

```
BAT 11 from North crossing
BAT 12 from North arrives at crossing
BAT 19 from North arrives at crossing
BAT 11 from North leaving crossing
BAT 14 from East crossing
BAT 9 from East arrives at crossing
BAT 14 from East leaving crossing
BAT 6 from South crossing
BAT 13 from South arrives at crossing
BAT 6 from South leaving crossing
BAT 8 from West crossing
BAT 10 from West arrives at crossing
BAT 16 from West arrives at crossing
BAT 15 from West arrives at crossing
BAT 17 from West arrives at crossing
BAT 18 from West arrives at crossing
BAT 20 from West arrives at crossing
BAT 8 from West leaving crossing
BAT 12 from North crossing
BAT 12 from North leaving crossing
BAT 9 from East crossing
BAT 9 from East leaving crossing
BAT 13 from South crossing
BAT 13 from South leaving crossing
```

```
BAT 10 from West crossing
BAT 10 from West leaving crossing
BAT 16 from West crossing
BAT 16 from West leaving crossing
BAT 19 from North crossing
BAT 19 from North leaving crossing
BAT 15 from West crossing
BAT 15 from West leaving crossing
BAT 17 from West crossing
BAT 17 from West leaving crossing
BAT 18 from West crossing
BAT 18 from West leaving crossing
BAT 20 from West crossing
BAT 20 from West leaving crossing
All BATs Leaved, no more BATs.
```

Sample Runs:

```
nswe
BAT 1 from North arrives at crossing
BAT 4 from East arrives at crossing
BAT 3 from West arrives at crossing
BAT 2 from South arrives at crossing
DEADLOCK: BAT jam detected, signalling North to go
BAT 1 from North crossing
BAT 1 from North leaving crossing
BAT 4 from East crossing
BAT 4 from East leaving crossing
BAT 2 from South crossing
BAT 2 from South leaving crossing
BAT 3 from West crossing
BAT 3 from West leaving crossing
All BATs Leaved, no more BATs.
```

```
sen
BAT 1 from South arrives at crossing
BAT 2 from East arrives at crossing
BAT 3 from North arrives at crossing
BAT 3 from North crossing
BAT 3 from North leaving crossing
BAT 2 from East crossing
BAT 2 from East leaving crossing
BAT 1 from South crossing
BAT 1 from South leaving crossing
All BATs Leaved, no more BATs.
```

```
nsewwewn
BAT 1 from North arrives at crossing
BAT 1 from North crossing
BAT 3 from East arrives at crossing
BAT 2 from South arrives at crossing
BAT 1 from North leaving crossing
BAT 4 from West arrives at crossing
BAT 3 from East crossing
BAT 3 from East leaving crossing
BAT 2 from South crossing
BAT 2 from South leaving crossing
BAT 7 from North arrives at crossing
BAT 4 from West crossing
BAT 5 from West arrives at crossing
BAT 6 from West arrives at crossing
BAT 4 from West leaving crossing
BAT 8 from East arrives at crossing
BAT 5 from West crossing
BAT 5 from West leaving crossing
BAT 6 from West crossing
BAT 6 from West leaving crossing
BAT 7 from North crossing
BAT 7 from North leaving crossing
BAT 8 from East crossing
BAT 8 from East leaving crossing
All BATs Leaved, no more BATs.
```

I