Initial consideration

1. A cop/robber can move in all 8 tiles around it.
2. Both cop/robber are considered vulnerable.
3. A robber will be considered captured if it has more number of cops than the number of robbers around it including itself.
4. Similarly a cop will be considered captured if it has more number of robbers than the number of cops around it including itself.
5. Nobody can skip a chance.
6. If there is no possible move for any of the robber than they are considered caught.

C = 5, R = 4, grid = 3 x 3

```
ccc
c.c
...
```

Cops are placed,

```
ccc
crc
rrr
```

Robbers are placed, robber at (1, 1) is unsafe and hence removed.

```
c.c
ccc
rrr
```

The robbers cannot move, and hence all caught.

How game will be played?

1. Place the cops on the grid such that no cop is vulnerable.
2. Place the robbers such that no robber is vulnerable, if possible.
3. Check for unsafe robbers and remove them.
4. Move cop.
5. Check for unsafe cops and remove them.
6. Move robber.
7. Go to step 3.

Removing the Robber from initial arrangement: C = 7, R = 6, grid = 4 x 4

```
.ccc    rccc
c..     crrr
cc..    ccr.
.c..    .cr.
```

Robber at (1, 1) is unsafe, remove it.

```
rccc
c.rr
ccr.
.cr.
```

Robber at (0, 0) and (1, 2) is now unsafe. Remove them.

```
.ccc
c..r
ccr.
.cr.
```

After removing all the unsafe robbers the cop can move.

Types of situation

1. Deadlock – a state where there is no possible move for ant of the cop.

   C=8, R=7, grid = 4 x 4

   ```
   cc..    ccr.
   c...    crrr
   ..cc    rrcc
   .ccc    rccc
   ```

   No cop can move after the initial placement.

2. Cop Dead – a single loss of cop.

   C = 5, R = 4, grid = 4 x 4

   ```
   ccc.    cccr
   cc..    ccr.
   ....    rr..
   ....    ....
   ```

   Cops at (0, 2) and (1, 1) can move to left down corner at (1, 3) and (2, 2) respectively, and will be unsafe eventually.

3. Caught – when a robber is caught
4. Infinite loop – the state remains unaltered

   C = 7, R = 6, grid = 5 x 5

   ```
   .c...    .cr..
   cc...    ccr..
   c....    c.rr.
   cc...    ccr..
   .c...    .cr..
   ```

   The free robber at (2, 3) can move anywhere in column 3 or 4 to play its chance, and any cop cannot threaten the line of robber at column 2.

Initial findings

The relation between number of Robber and number of Cops is;

$$C = R + 1 \text{ or } C = R + 2$$

R	C_{min} (row x col)	
1	2 (2 x 2)	3 (other)
2		3
3		4
4	5 (3 x 3)	6
5		6
6	7 (4 x 4)	8
7		8
8	9 (5 x 5)	10
9		10

Initial placing of cops affect the game

C = 8, R = 7, grid = 4 x 4

State 1: Cop dead

```
cc..    ccrr
c..c    crrc
..cc    rrcc
.cc.    rcc.
```

Cop at (2, 2) can only move to right down (3, 3), the cop at (1, 3) becomes unsafe.

Or

```
cc..    cc.r
c...    crrr
..cc    rrcc
.ccc    rccc
```

Cop at (0, 1) can move to right (0, 2) and become unsafe.

State 2: Deadlock

```
cc..    ccr.
c...    crrr
..cc    rrcc
.ccc    rccc
```

No cop can move.

State 3: Perfect

```
cccc    cccc
c...    c.rr
cc..    ccrr
c...    crrr
```

Or

```
cccc    cccc
c...    c.rr
c...    crrr
cc..    ccrr
```

In both the case the cop at (0, 0) move to right down (1, 1) and makes a robber unsafe.

Grid Size

State 1: Minimum grid size

C = 7, R = 6, grid = 4 x 4

```
.ccc    .ccc
c...    c.rr
cc..    ccrr
.c..    .crr
```

State 2: More

More cops required for same number of robbers.

C = 8, R = 6, grid = 5 x 5

```
cc...    cc...
c....    c...r
....c    ...rc
...cc    r.rcc
..cc.    rrcc.
```

Conclusion

The game depends on:

1. Initial position of the cops.
2. Size of the grid.
3. Strategy of the cops to catch the robbers.