BANKER'S ALGORITHM

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DATA STRUCTURES

- Let **'n'** be the number of processes in the system and **'m'** be the number of resources types.
- **Available :**
- It is a 1-d array of size **'m'** indicating the number of available resources of each type.
- Available[j] = k means there are **'k'** instances of resource type $\mathbf{R_j}$
- **Max :**
- It is a 2-d array of size '**n*m'** that defines the maximum demand of each process in a system.
- Max[i, j] = k means process $\mathbf{P_i}$ may request at most **'k'** instances of resource type $\mathbf{R_j}$.

DATA STRUCTURES

- **Allocation :**
- It is a 2-d array of size **'n*m'** that defines the number of resources of each type currently allocated to each process.
- Allocation[i, j] = k means process $\mathbf{P_i}$ is currently allocated **'k'** instances of resource type $\mathbf{R_j}$
- **Need :**
- It is a 2-d array of size **'n*m'** that indicates the remaining resource need of each process.
- Need [i, j] = k means process $\mathbf{P_i}$ currently need **'k'** instances of resource type $\mathbf{R_j}$
- for its execution.
- Need [i, j] = Max [i, j] – Allocation [i, j]

SAFETY ALGORITHM

- *1) Let Work and Finish be vectors of length ‘m’ and ‘n’ respectively.*
  Initialize: Work = Available
  Finish[i] = false; for i=1, 2, 3, 4….n
- *2) Find an i such that both*
  a) Finish[i] = false
  b) $Need_i$ <= Work
  if no i exists go to step (4)
- *3) Work = Work + Allocation[i]*
  Finish[i] = true
  goto step (2)
- *4) if Finish [i] = true for all i*
  then the system is in a safe state

PROGRAM IMPLEMENTATION

First step is to put your resource and process sizes.

```
Enter resource size: 3
Enter process size: 5
```

THERE ARE 2 MODES

Manual mode

Random mode

MANUAL MODE

PRESS M TO SELECT THE MANUAL MODE

```
Press M for manual inout or any to random input: M
Put resource input:
R1 = 10
R2 =
5
R3 = 7
Put allocation input:
0 1 0
2 0 0
3 0 2
2 1 1
0 0 2
Put max input:
7 5 3
3 2 2
9 0 2
2 2 2
4 3 3
```

EXAMPLE

```
  R0 = 10   R1 = 5   R2 = 7
------ALLOCATION-------
     R1   R2   R3
P0   0    1    0
P1   2    0    0
P2   3    0    2
P3   2    1    1
P4   0    0    2

------MAX-------
     R1   R2   R3
P0   7    5    3
P1   3    2    2
P2   9    0    2
P3   2    2    2
P4   4    3    3

------NEED-------
     R1   R2   R3
P0   7    4    3
P1   1    2    2
P2   6    0    0
P3   0    1    1
P4   4    3    1

Available: [3, 3, 2]
```

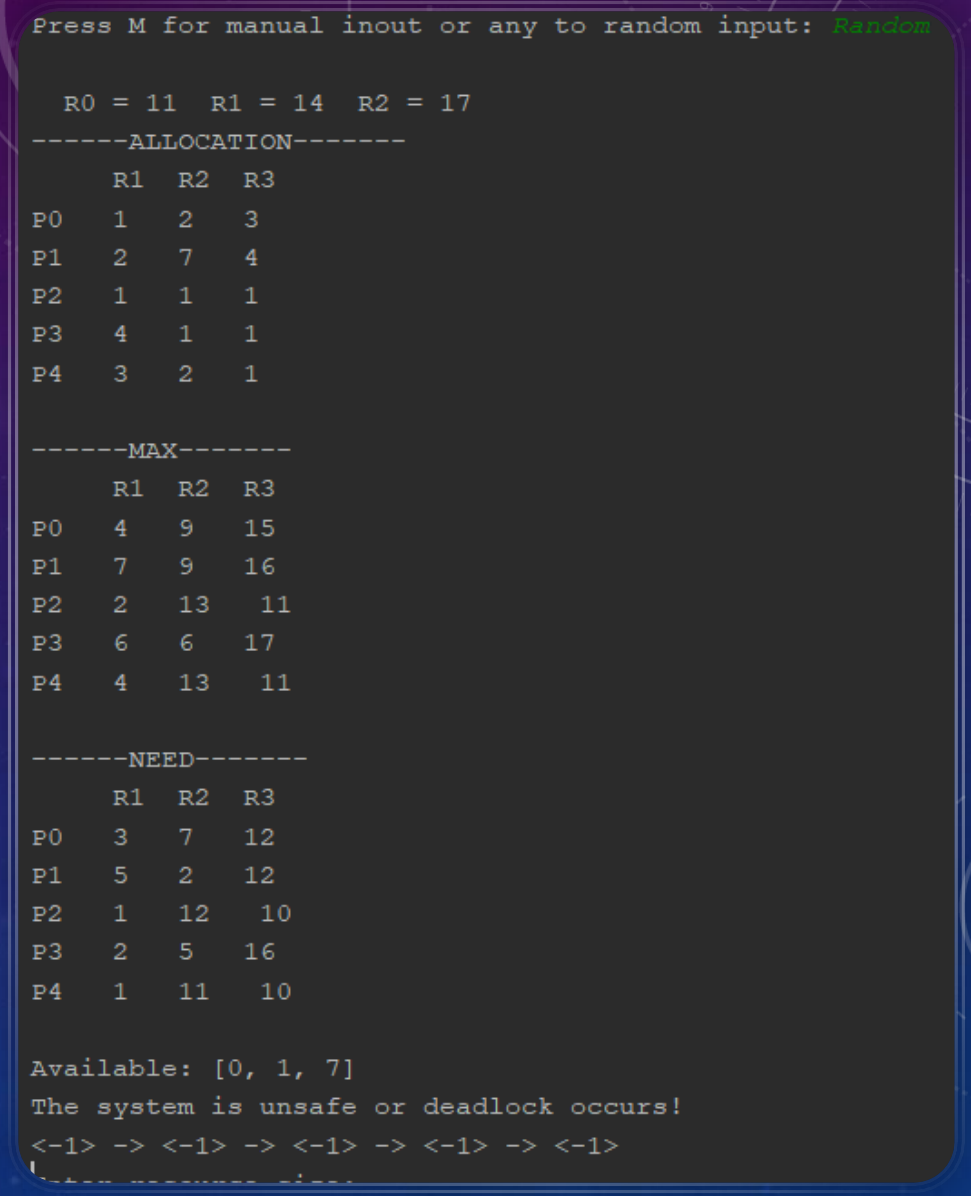
```
------ALLOCATION-------
     R1   R2   R3
P0   0    1    0
P1   0    0    0
P2   3    0    2
P3   2    1    1
P4   0    0    2

------NEED-------
     R1   R2   R3
P0   7    4    3
P1   0    0    0
P2   6    0    0
P3   0    1    1
P4   4    3    1

Available:[5, 3, 2]

------ALLOCATION-------
     R1   R2   R3
P0   0    1    0
P1   0    0    0
P2   3    0    2
P3   0    0    0
P4   0    0    2

------NEED-------
     R1   R2   R3
P0   7    4    3
P1   0    0    0
P2   6    0    0
P3   0    0    0
P4   4    3    1

Available:[7, 4, 3]
```

```
------ALLOCATION-------
     R1   R2   R3
P0   0    1    0
P1   0    0    0
P2   3    0    2
P3   0    0    0
P4   0    0    0

------NEED-------
     R1   R2   R3
P0   7    4    3
P1   0    0    0
P2   6    0    0
P3   0    0    0
P4   0    0    0

Available:[7, 4, 5]

------ALLOCATION-------
     R1   R2   R3
P0   0    0    0
P1   0    0    0
P2   3    0    2
P3   0    0    0
P4   0    0    0

------NEED-------
     R1   R2   R3
P0   0    0    0
P1   0    0    0
P2   6    0    0
P3   0    0    0
P4   0    0    0
```

```
------ALLOCATION-------
     R1   R2   R3
P0   0    0    0
P1   0    0    0
P2   0    0    0
P3   0    0    0
P4   0    0    0

------NEED-------
     R1   R2   R3
P0   0    0    0
P1   0    0    0
P2   0    0    0
P3   0    0    0
P4   0    0    0

Available:[10, 5, 7]

Available vector:   R0 = 10    R1 = 5    R2 = 7
The safe-state order: <1>, <3>, <4>, <0>, <2>
```

RAMDOM MODE

PRESS ANY KEYS TO SELECT THE MANUAL MODE



SAFE ALGORITHM

```
fun isSafe(): Boolean {
    var isVisited = Array(processSize) { false }
    var count = 0
    var work = createAvailable()

    while (count < processSize) {
        var flag = false
        for (i in 0 until processSize) {
            if (!isVisited[i]) {
                var jTemp = 0
                for (j in 0 until resourceSize) {
                    jTemp = j
                    if (need[i][jTemp] > work[jTemp]) break
                }
                if (jTemp == resourceSize-1) {
                    isVisited[i] = true
                    flag = true
                    resultSequence[count] = i
                    count++
                    for (j in 0 until resourceSize) {
                        work[j] += allocation[i][j]
                        allocation[i][j] = 0
                        need[i][j] = 0
                    }
                    showMatrix("Allocation")
                    showMatrix("Need")
                    println("\nAvailable:" + work.toList())
                }
            }
        }
        if (!flag) {
            break
        }
    }
    if (count == processSize) {
        print("\nAvailable vector: ")
        for (i in 0 until resourceNum.size) {
            print("  R$i = ${resourceNum[i]}  ")
        }
        print("\nThe safe-state order: ")
        var result = "<${resultSequence[0]}>"
        for (i in 1 until resultSequence.size) {
            result += ", <${resultSequence[i]}>"
        }
        print(result)
        return true
    } else {
        println("The system is unsafe or deadlock occurs!")
        var result = "<${resultSequence[0]}>"
        for (i in 1 until resultSequence.size) {
            result += " -> <${resultSequence[i]}>"
        }
        println(result)
        return false
    }
}
```

RANDOM INOUT

```
fun generateMax() { // Each value less than or equal Ri

    for (column in 0 until resourceSize) {
        for (row in 0 until processSize) {
            try {
                max[row][column] = random.nextInt(resourceNum[column]) + 1
            } catch (e: Exception) {
                print(e)
            }
        }
    }
}
```

```
fun generateAllocation() { // Sum of each resource in all process
    var maxInColumn = 0

    for (column in 0 until resourceSize) {
        for (row in 0 until processSize) {
            maxInColumn += max[row][column]
        }
        while (true) {
            var arrayEachResource = Array(processSize) {
                random.nextInt(max[it][column]) + 1
            }
            if (arrayEachResource.sum() <= resourceNum[column]) {
                putArrayInEachResource(arrayEachResource, column)
                break
            }
        }
    }
}
```

RANDOM INPUT

```
fun calculateNeed() {
    for (row in 0 until processSize) {
        for (column in 0 until resourceSize) {
            var needValue = max[row][column] - allocation[row][column]
            if (needValue < 0) {
                needValue = 0
            }
            need[row][column] = needValue
        }
    }
}
```

THANK YOU