Consider the following snapshot of a system:

|  |  |  |
| --- | --- | --- |
| Processes | Allocation | Max |
| *A B C D* | *A B C D* |
| P0 | 3 0 1 4 | 5 1 1 7 |
| P1 | 2 2 1 0 | 3 2 1 0 |
| P2 | 3 1 2 1 | 3 3 2 1 |
| P3 | 0 5 1 0 | 4 5 1 2 |
| P4 | 4 2 1 1 | 6 3 2 5 |

Using the banker’s algorithm, determine whether or not each of the following states is unsafe. If the state is safe, illustrate the order in which the processes may complete. Otherwise, illustrate why the state is unsafe.

1. ***Available*** = (0, 3, 0, 1)
2. ***Available*** = (1, 0, 0, 2)

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 0 | 3 | 0 | 1 |
| P1 | 2 | 2 | 1 | 0 | 3 | 2 | 1 | 0 | 1 | 0 | 0 | 0 |  |  |  |  |
| P2 | 3 | 1 | 2 | 1 | 3 | 3 | 2 | 1 | 0 | 2 | 0 | 0 |  |  |  |  |
| P3 | 0 | 5 | 1 | 0 | 4 | 5 | 1 | 2 | 4 | 0 | 0 | 2 |  |  |  |  |
| P4 | 4 | 2 | 1 | 1 | 6 | 3 | 2 | 5 | 2 | 1 | 1 | 4 |  |  |  |  |

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 3 | 4 | 2 | 2 |
| P1 | 2 | 2 | 1 | 0 | 3 | 2 | 1 | 0 | 1 | 0 | 0 | 0 |  |  |  |  |
| P3 | 0 | 5 | 1 | 0 | 4 | 5 | 1 | 2 | 4 | 0 | 0 | 2 |  |  |  |  |
| P4 | 4 | 2 | 1 | 1 | 6 | 3 | 2 | 5 | 2 | 1 | 1 | 4 |  |  |  |  |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P2

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 5 | 6 | 3 | 2 |
| P3 | 0 | 5 | 1 | 0 | 4 | 5 | 1 | 2 | 4 | 0 | 0 | 2 |  |  |  |  |
| P4 | 4 | 2 | 1 | 1 | 6 | 3 | 2 | 5 | 2 | 1 | 1 | 4 |  |  |  |  |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P2,P1

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 5 | 11 | 4 | 2 |
| P4 | 4 | 2 | 1 | 1 | 6 | 3 | 2 | 5 | 2 | 1 | 1 | 4 |  |  |  |  |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P2 ,P1,P3

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 9 | 13 | 5 | 3 |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P2 ,P1,P3,P4

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
|  |  |  |  |  |  |  |  |  |  |  |  |  | 12 | 13 | 6 | 7 |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P2 ,P1,P3,P4

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P2, P1, P3, P4, P0 hệ thống không có deadlock. Kết thúc thuật toán.

b. Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 1 | 0 | 0 | 2 |
| P1 | 2 | 2 | 1 | 0 | 3 | 2 | 1 | 0 | 1 | 0 | 0 | 0 |  |  |  |  |
| P2 | 3 | 1 | 2 | 1 | 3 | 3 | 2 | 1 | 0 | 2 | 0 | 0 |  |  |  |  |
| P3 | 0 | 5 | 1 | 0 | 4 | 5 | 1 | 2 | 4 | 0 | 0 | 2 |  |  |  |  |
| P4 | 4 | 2 | 1 | 1 | 6 | 3 | 2 | 5 | 2 | 1 | 1 | 4 |  |  |  |  |

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 3 | 2 | 1 | 2 |
| P2 | 3 | 1 | 2 | 1 | 3 | 3 | 2 | 1 | 0 | 2 | 0 | 0 |  |  |  |  |
| P3 | 0 | 5 | 1 | 0 | 4 | 5 | 1 | 2 | 4 | 0 | 0 | 2 |  |  |  |  |
| P4 | 4 | 2 | 1 | 1 | 6 | 3 | 2 | 5 | 2 | 1 | 1 | 4 |  |  |  |  |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P1

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 6 | 3 | 3 | 3 |
| P3 | 0 | 5 | 1 | 0 | 4 | 5 | 1 | 2 | 4 | 0 | 0 | 2 |  |  |  |  |
| P4 | 4 | 2 | 1 | 1 | 6 | 3 | 2 | 5 | 2 | 1 | 1 | 4 |  |  |  |  |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P1,P2

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 6 | 8 | 4 | 3 |
| P4 | 4 | 2 | 1 | 1 | 6 | 3 | 2 | 5 | 2 | 1 | 1 | 4 |  |  |  |  |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P1 ,P,P3

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| P0 | 3 | 0 | 1 | 4 | 5 | 1 | 1 | 7 | 2 | 1 | 0 | 3 | 10 | 5 | 5 | 4 |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P2 ,P1,P3,P4

Tại :

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tiến Trình | Allocation | | | | Max | | | | Need | | | | Available | | | |
| A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
|  |  |  |  |  |  |  |  |  |  |  |  |  | 13 | 10 | 6 | 9 |

Chạy thuật giải tồn tại chuỗi trạng thái an toàn: P1 ,P2,P3,P4,P0 hệ thống không có deadlock. Kết thúc thuật toán.