CS162 Discussion section
Week 4

Overview

- Project 1 submissions
- SVN repository setup
- Synchronization in Java
- Monitors
- Deadlock

Project 1

- Grading
  - Individual portion (40%)
  - Group portion (60%)
- Group portion breakdown
  - First draft [10 points]
  - Design Review [5 points]
  - Final design doc [25 points]
  - Code [60 points]

Design document

- Should include…
  - Introduction to the overall behavior of the system
  - Technical challenges and solutions
    - Solution overview (2-4 lines)
    - Correctness constraints
    - Data structures
    - Design decisions
    - Description of java classes and methods
    - Pseudocode for key algorithms
    - **Test plan and test cases**

Design document (2)

- First draft should be between 1-2k lines
  - Or about 5-10 pages
- Final draft should be 2-4k lines
  - 10-20 pages
- Include diagrams that show interaction between components and examples

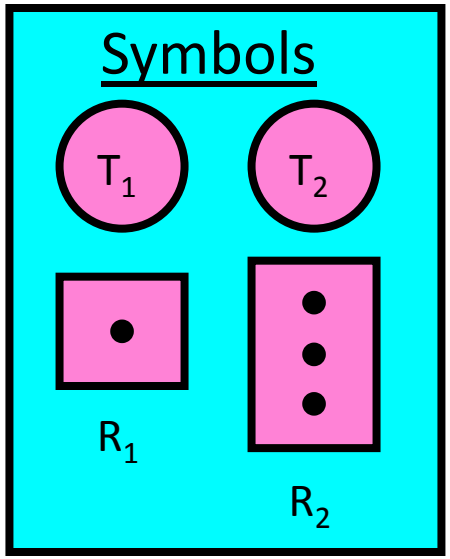
Four requirements for Deadlock

- Mutual exclusion
  - Only one thread at a time can use a resource.
- Hold and wait
  - Thread holding at least one resource is waiting to acquire additional resources held by other threads
- No preemption
  - Resources are released only voluntarily by the thread holding the resource, after thread is finished with it
- Circular wait
  - There exists a set $\{T_1, \ldots, T_n\}$ of waiting threads
    - T_1 is waiting for a resource that is held by T_2
    - T_2 is waiting for a resource that is held by T_3
    - …
    - T_n is waiting for a resource that is held by T_1

Resource-Allocation Graph

- System Model
  - A set of Threads $T_1, T_2, \ldots, T_n$
  - Resource types $R_1, R_2, \ldots, R_m$

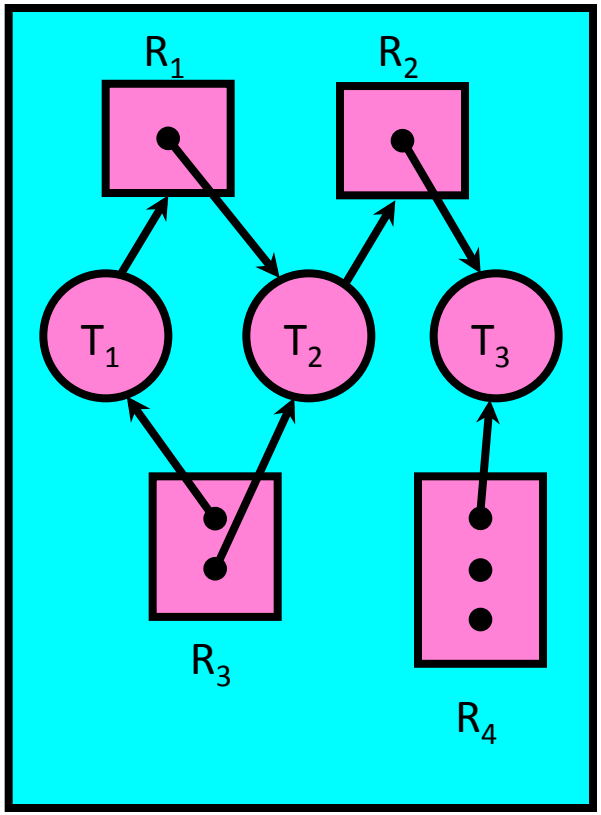
    CPU cycles, memory space, I/O devices
  - Each resource type R_i has W_i instances.
  - Each thread utilizes a resource as follows:
    - `Request() / Use() / Release()`



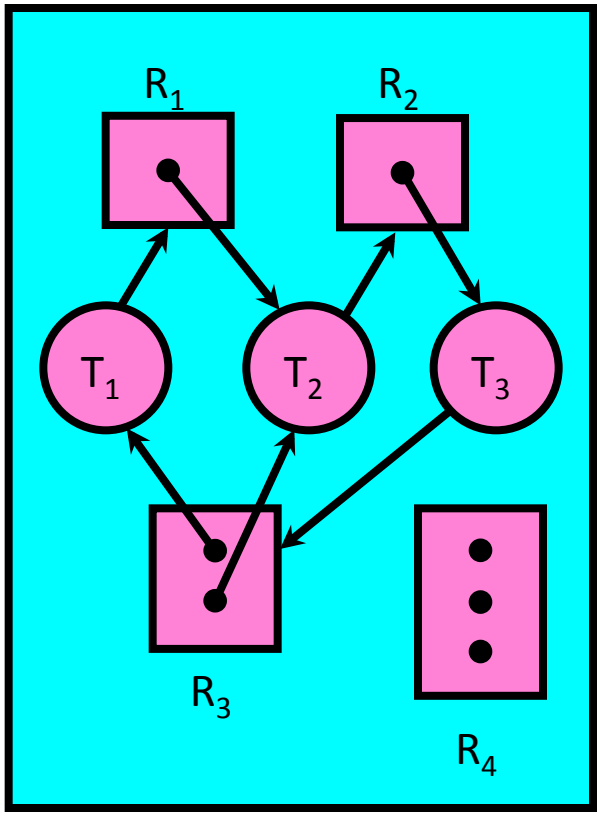
- Resource-Allocation Graph:
  - V is partitioned into two types:
    - $T = \{T_1, T_2, \ldots, T_n\}$, the set threads in the system.
    - $R = \{R_1, R_2, \ldots, R_m\}$, the set of resource types in system
  - request edge – directed edge $T_1 \rightarrow R_j$
  - assignment edge – directed edge $R_j \rightarrow T_i$

Resource Allocation Graph Examples

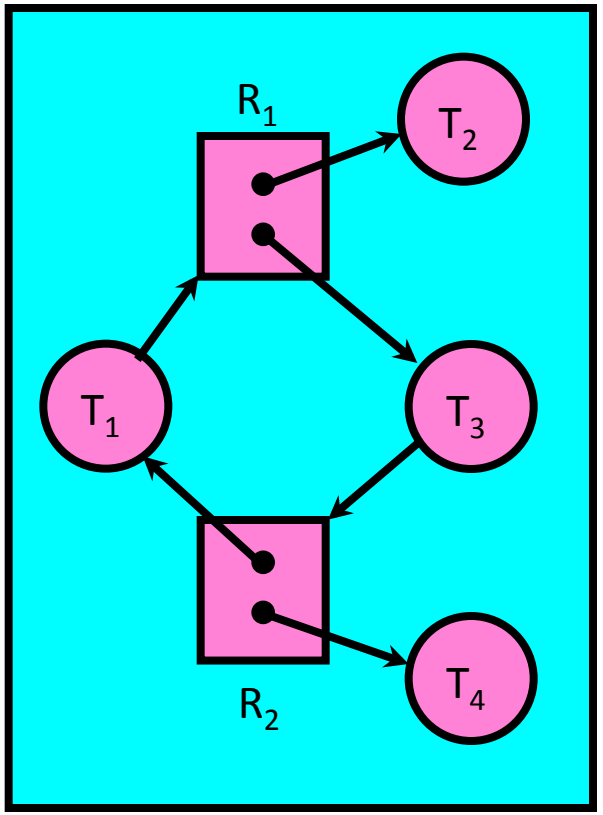
- Recall:
  - request edge – directed edge $T_1 \rightarrow R_j$
  - assignment edge – directed edge $R_j \rightarrow T_i$



Simple Resource Allocation Graph



Allocation Graph With Deadlock



Allocation Graph With Cycle, but No Deadlock

Banker's algorithm(1)

Name	Size	What it stores
avail	num resources x 1	avail[i] is the number of available and indistinguishable instances of the resource
Max	num threads x num resources	max[i][j] is the maximum number of instances of resource j that thread i will request
Allocation	num threads x num resources	allocation[i][j] is the number of instances of resource j that have been allocated to thread i
Need	num threads x num resources	need[i][j] is the max number of instances of resource j that thread i still needs to complete its task notice that need[i][:] = max[i][:]-allocation[i][:] when we don't overestimate the amount of resources we need

Banker's algorithm(2)
Safety Check

Algorithm 1 Algorithm for finding out if a system is in a safe

state let work = an array of length num resources
let finish = an array of length num threads
work = avail
for each thread i set finish[i] to false
while there exists a thread i such that $finish[i] == false$ and $need[i][:] \leq work$ **do**
  work = work + allocation[i][:]
  finish[i] = true
end while
if $finish[i] == true \ \forall i$ **then**
  system is safe
else
  deadlock is possible

end if

Banker's algorithm(3)
Request Granting

Algorithm 2 algorithm for requesting a resource

```
allocation let request[i][:] be the request vector for thread i
    if request[i][:] ≤ need[i][:] then
      if request[i][:] ≤ avail[i][:] then
        wait because there aren't enough free resources
      else
        pretend to modify the system
        avail = avail − request[i][:]
        allocation[i][:] = allocation[i][:] + request[i]
        need[i][:] = need[i][:] − request[i][:]
        if safety check algorithm says system is safe then
          allocate resources and complete transaction
        else
          undo the changes to avail, allocation, and
          need wait since allocation could cause
          deadlock and
          try the request later once resources have cleared up
        en
      d if
      end
      if
    else
      signal an error because we have requesting more than our max possible requests

    end if
```