Document consist of code and output

//Main.cxx

~/Documents/OS5/OS-threading- main

❯ cat src/main.cxx

#include <iostream>

#include <thread>

#include <mutex>

#include <condition\_variable>

#include <vector>

#include <cstdlib>

#include <ctime>

#include <chrono>

#include <stdexcept>

#define MAX\_WAITING 2 // Maximum number of students waiting

#define HELP\_TIME 5 // Time TA helps a student (in seconds)

#define TA\_GOING\_TIME 10 // Time TA will wait before going to sleep (in seconds)

using namespace std;

mutex mtx; // Mutex for mutual exclusion

condition\_variable cv; // Condition variable for signaling

int waiting\_students = 0; // Tracking number of students

bool ta\_sleeping = true; // TA's state

int ta\_sleeping\_counter = 0; // Counter for TA's sleeping time

void student(int student\_id);

void sleeping\_ta();

int main(int argc, char \*argv[]) {

// Student thread tracker

vector<thread> student\_threads;

srand(static\_cast<unsigned int>(time(0))); // Seed for random number generation

int num\_students;

if (argc < 2) {

cout << "Enter the number of students: ";

cin >> num\_students;

} else {

num\_students = std::stoi(argv[1]);

}

try

{

thread ta\_thread(sleeping\_ta); // Create TA thread

// Create student threads

for (int i = 0; i < num\_students; i++) {

student\_threads.emplace\_back(student, i + 1);

this\_thread::sleep\_for(chrono::seconds(rand() % 2)); // Random wait time before next student arrives

}

// Join all student threads

for (auto& s : student\_threads) {

if (s.joinable()) {

s.detach();

}

}

// Join TA thread

if (ta\_thread.joinable()) {

ta\_thread.join();

}

}

catch(exception &e){

cerr<< "An exception occurred :" << e.what()<<endl;

}

return 0;

}

void sleeping\_ta() {

while (true) {

// Decrease waiting students count

unique\_lock<mutex> lock(mtx);

auto start\_idle\_time = chrono::steady\_clock::now();

cv.wait\_for(lock,10s,[] { return !ta\_sleeping; }); // Wait until TA is woken until some student call in 10 secounds or else bye

// TA is helping a student

if (waiting\_students == 0) {

cout << "[TA THREAD] No students waiting. TA goes back to sleep." << endl;

auto end\_idle\_time = chrono::steady\_clock::now();

auto idle\_duration = chrono::duration\_cast<chrono::seconds>(end\_idle\_time - start\_idle\_time);

//cout<< "count :::" << idle\_duration.count() ;

if (idle\_duration.count() >= 10) {

cout << "[TA THREAD] No students for 10 seconds. TA is exiting." << endl;

return; // Exit the TA thread

}

ta\_sleeping = true; // TA goes back to sleep

}

else{

cout << "[TA THREAD] TA is helping a student..." << endl;

this\_thread::sleep\_for(chrono::seconds(HELP\_TIME)); // Simulate helping time

cout << "[TA THREAD] TA is done helping a student!" << endl;

if (waiting\_students > 0) {

this\_thread::sleep\_for(chrono::seconds(HELP\_TIME)); // Simulate helping time

cout << "[TA THREAD] TA is done helping a student!" << endl;

waiting\_students--;

cout << "[TA THREAD] Waiting students = " << waiting\_students << endl;

}

}

}

}

void student(int student\_id) {

while (true) {

unique\_lock<mutex> lock(mtx);

cout << "[STUDENT THREAD] Student " << student\_id << " is coming!" << endl;

if (ta\_sleeping) {

cout << "[STUDENT THREAD] Student " << student\_id << " wakes up TA!" << endl;

ta\_sleeping = false; // TA is awake

cv.notify\_one(); // Signal the TA to help

cout << "[STUDENT THREAD] student "<< student\_id <<" done with work going bye"<<endl;

return; // Student is helped, exit the function

}

if (waiting\_students < MAX\_WAITING) {

waiting\_students++;

cout << "[STUDENT THREAD] Student " << student\_id << " is seated on a waiting chair. Waiting students = " << waiting\_students << endl;

return; // Student is seated, exit the function

}

else {

cout << "[STUDENT THREAD] Student " << student\_id << " finds no chairs available and will come back later." << endl;

// this is for degbuging

//cout << "TA :::: "<< ta\_sleeping<< "waiting\_student\_counter :::: " << waiting\_students << endl ;

lock.unlock(); // Unlock the mutex before sleeping

// Wait for a random time before trying again

this\_thread::sleep\_for(chrono::seconds(rand() % 8)); // Random wait between 1 to 3 seconds

// Re-lock the mutex for the next attempt

continue; //will start of the while loop to so it go to if condition

}

}

}

Output :

~/Documents/OS5/OS-threading- main

❯ cat log/pro\_info.log

[STUDENT THREAD] Student 1 is coming!

[STUDENT THREAD] Student 1 wakes up TA!

[STUDENT THREAD] student 1 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 2 is coming!

[STUDENT THREAD] Student 2 wakes up TA!

[STUDENT THREAD] student 2 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 3 is coming!

[STUDENT THREAD] Student 3 wakes up TA!

[STUDENT THREAD] student 3 done with work going bye

[STUDENT THREAD] Student 4 is coming!

[STUDENT THREAD] Student 4 is seated on a waiting chair. Waiting students = 1

[STUDENT THREAD] Student 5 is coming!

[STUDENT THREAD] Student 5 is seated on a waiting chair. Waiting students = 2

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 1

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 0

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 8 is coming!

[STUDENT THREAD] Student 8 wakes up TA!

[STUDENT THREAD] student 8 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 9 is coming!

[STUDENT THREAD] Student 9 wakes up TA!

[STUDENT THREAD] student 9 done with work going bye

[STUDENT THREAD] Student 11 is coming!

[STUDENT THREAD] Student 11 is seated on a waiting chair. Waiting students = 1

[STUDENT THREAD] Student 12 is coming!

[STUDENT THREAD] Student 12 is seated on a waiting chair. Waiting students = 2

[STUDENT THREAD] Student 13 is coming!

[STUDENT THREAD] Student 13 finds no chairs available and will come back later.

[STUDENT THREAD] Student 14 is coming!

[STUDENT THREAD] Student 14 finds no chairs available and will come back later.

[STUDENT THREAD] Student 15 is coming!

[STUDENT THREAD] Student 15 finds no chairs available and will come back later.

[STUDENT THREAD] Student 16 is coming!

[STUDENT THREAD] Student 16 finds no chairs available and will come back later.

[STUDENT THREAD] Student 17 is coming!

[STUDENT THREAD] Student 17 finds no chairs available and will come back later.

[STUDENT THREAD] Student 17 is coming!

[STUDENT THREAD] Student 17 finds no chairs available and will come back later.

[STUDENT THREAD] Student 19 is coming!

[STUDENT THREAD] Student 19 finds no chairs available and will come back later.

[STUDENT THREAD] Student 20 is coming!

[STUDENT THREAD] Student 20 finds no chairs available and will come back later.

[STUDENT THREAD] Student 21 is coming!

[STUDENT THREAD] Student 21 finds no chairs available and will come back later.

[STUDENT THREAD] Student 22 is coming!

[STUDENT THREAD] Student 22 finds no chairs available and will come back later.

[STUDENT THREAD] Student 23 is coming!

[STUDENT THREAD] Student 23 finds no chairs available and will come back later.

[STUDENT THREAD] Student 24 is coming!

[STUDENT THREAD] Student 24 finds no chairs available and will come back later.

[STUDENT THREAD] Student 25 is coming!

[STUDENT THREAD] Student 25 finds no chairs available and will come back later.

[STUDENT THREAD] Student 25 is coming!

[STUDENT THREAD] Student 25 finds no chairs available and will come back later.

[STUDENT THREAD] Student 26 is coming!

[STUDENT THREAD] Student 26 finds no chairs available and will come back later.

[STUDENT THREAD] Student 27 is coming!

[STUDENT THREAD] Student 27 finds no chairs available and will come back later.

[STUDENT THREAD] Student 28 is coming!

[STUDENT THREAD] Student 28 finds no chairs available and will come back later.

[STUDENT THREAD] Student 29 is coming!

[STUDENT THREAD] Student 29 finds no chairs available and will come back later.

[STUDENT THREAD] Student 30 is coming!

[STUDENT THREAD] Student 30 finds no chairs available and will come back later.

[STUDENT THREAD] Student 31 is coming!

[STUDENT THREAD] Student 31 finds no chairs available and will come back later.

[STUDENT THREAD] Student 32 is coming!

[STUDENT THREAD] Student 32 finds no chairs available and will come back later.

[STUDENT THREAD] Student 32 is coming!

[STUDENT THREAD] Student 32 finds no chairs available and will come back later.

[STUDENT THREAD] Student 33 is coming!

[STUDENT THREAD] Student 33 finds no chairs available and will come back later.

[STUDENT THREAD] Student 34 is coming!

[STUDENT THREAD] Student 34 finds no chairs available and will come back later.

[STUDENT THREAD] Student 35 is coming!

[STUDENT THREAD] Student 35 finds no chairs available and will come back later.

[STUDENT THREAD] Student 7 is coming!

[STUDENT THREAD] Student 7 finds no chairs available and will come back later.

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 1

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 0

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 18 is coming!

[STUDENT THREAD] Student 18 wakes up TA!

[STUDENT THREAD] student 18 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 6 is coming!

[STUDENT THREAD] Student 6 wakes up TA!

[STUDENT THREAD] student 6 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 7 is coming!

[STUDENT THREAD] Student 7 wakes up TA!

[STUDENT THREAD] student 7 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 20 is coming!

[STUDENT THREAD] Student 20 wakes up TA!

[STUDENT THREAD] student 20 done with work going bye

[STUDENT THREAD] Student 15 is coming!

[STUDENT THREAD] Student 15 is seated on a waiting chair. Waiting students = 1

[STUDENT THREAD] Student 14 is coming!

[STUDENT THREAD] Student 14 is seated on a waiting chair. Waiting students = 2

[STUDENT THREAD] Student 13 is coming!

[STUDENT THREAD] Student 13 finds no chairs available and will come back later.

[STUDENT THREAD] Student 17 is coming!

[STUDENT THREAD] Student 17 finds no chairs available and will come back later.

[STUDENT THREAD] Student 22 is coming!

[STUDENT THREAD] Student 22 finds no chairs available and will come back later.

[STUDENT THREAD] Student 25 is coming!

[STUDENT THREAD] Student 25 finds no chairs available and will come back later.

[STUDENT THREAD] Student 19 is coming!

[STUDENT THREAD] Student 19 finds no chairs available and will come back later.

[STUDENT THREAD] Student 30 is coming!

[STUDENT THREAD] Student 30 finds no chairs available and will come back later.

[STUDENT THREAD] Student 30 is coming!

[STUDENT THREAD] Student 30 finds no chairs available and will come back later.

[STUDENT THREAD] Student 35 is coming!

[STUDENT THREAD] Student 35 finds no chairs available and will come back later.

[STUDENT THREAD] Student 24 is coming!

[STUDENT THREAD] Student 24 finds no chairs available and will come back later.

[STUDENT THREAD] Student 28 is coming!

[STUDENT THREAD] Student 28 finds no chairs available and will come back later.

[STUDENT THREAD] Student 29 is coming!

[STUDENT THREAD] Student 29 finds no chairs available and will come back later.

[STUDENT THREAD] Student 33 is coming!

[STUDENT THREAD] Student 33 finds no chairs available and will come back later.

[STUDENT THREAD] Student 26 is coming!

[STUDENT THREAD] Student 26 finds no chairs available and will come back later.

[STUDENT THREAD] Student 21 is coming!

[STUDENT THREAD] Student 21 finds no chairs available and will come back later.

[STUDENT THREAD] Student 27 is coming!

[STUDENT THREAD] Student 27 finds no chairs available and will come back later.

[STUDENT THREAD] Student 31 is coming!

[STUDENT THREAD] Student 31 finds no chairs available and will come back later.

[STUDENT THREAD] Student 10 is coming!

[STUDENT THREAD] Student 10 finds no chairs available and will come back later.

[STUDENT THREAD] Student 16 is coming!

[STUDENT THREAD] Student 16 finds no chairs available and will come back later.

[STUDENT THREAD] Student 32 is coming!

[STUDENT THREAD] Student 32 finds no chairs available and will come back later.

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 1

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 0

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 34 is coming!

[STUDENT THREAD] Student 34 wakes up TA!

[STUDENT THREAD] student 34 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 24 is coming!

[STUDENT THREAD] Student 24 wakes up TA!

[STUDENT THREAD] student 24 done with work going bye

[STUDENT THREAD] Student 19 is coming!

[STUDENT THREAD] Student 19 is seated on a waiting chair. Waiting students = 1

[STUDENT THREAD] Student 21 is coming!

[STUDENT THREAD] Student 21 is seated on a waiting chair. Waiting students = 2

[STUDENT THREAD] Student 10 is coming!

[STUDENT THREAD] Student 10 finds no chairs available and will come back later.

[STUDENT THREAD] Student 22 is coming!

[STUDENT THREAD] Student 22 finds no chairs available and will come back later.

[STUDENT THREAD] Student 28 is coming!

[STUDENT THREAD] Student 28 finds no chairs available and will come back later.

[STUDENT THREAD] Student 29 is coming!

[STUDENT THREAD] Student 29 finds no chairs available and will come back later.

[STUDENT THREAD] Student 27 is coming!

[STUDENT THREAD] Student 27 finds no chairs available and will come back later.

[STUDENT THREAD] Student 32 is coming!

[STUDENT THREAD] Student 32 finds no chairs available and will come back later.

[STUDENT THREAD] Student 35 is coming!

[STUDENT THREAD] Student 35 finds no chairs available and will come back later.

[STUDENT THREAD] Student 26 is coming!

[STUDENT THREAD] Student 26 finds no chairs available and will come back later.

[STUDENT THREAD] Student 16 is coming!

[STUDENT THREAD] Student 16 finds no chairs available and will come back later.

[STUDENT THREAD] Student 13 is coming!

[STUDENT THREAD] Student 13 finds no chairs available and will come back later.

[STUDENT THREAD] Student 25 is coming!

[STUDENT THREAD] Student 25 finds no chairs available and will come back later.

[STUDENT THREAD] Student 25 is coming!

[STUDENT THREAD] Student 25 finds no chairs available and will come back later.

[STUDENT THREAD] Student 17 is coming!

[STUDENT THREAD] Student 17 finds no chairs available and will come back later.

[STUDENT THREAD] Student 33 is coming!

[STUDENT THREAD] Student 33 finds no chairs available and will come back later.

[STUDENT THREAD] Student 31 is coming!

[STUDENT THREAD] Student 31 finds no chairs available and will come back later.

[STUDENT THREAD] Student 23 is coming!

[STUDENT THREAD] Student 23 finds no chairs available and will come back later.

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 1

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 0

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 27 is coming!

[STUDENT THREAD] Student 27 wakes up TA!

[STUDENT THREAD] student 27 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 32 is coming!

[STUDENT THREAD] Student 32 wakes up TA!

[STUDENT THREAD] student 32 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 17 is coming!

[STUDENT THREAD] Student 17 wakes up TA!

[STUDENT THREAD] student 17 done with work going bye

[STUDENT THREAD] Student 26 is coming!

[STUDENT THREAD] Student 26 is seated on a waiting chair. Waiting students = 1

[STUDENT THREAD] Student 28 is coming!

[STUDENT THREAD] Student 28 is seated on a waiting chair. Waiting students = 2

[STUDENT THREAD] Student 22 is coming!

[STUDENT THREAD] Student 22 finds no chairs available and will come back later.

[STUDENT THREAD] Student 13 is coming!

[STUDENT THREAD] Student 13 finds no chairs available and will come back later.

[STUDENT THREAD] Student 29 is coming!

[STUDENT THREAD] Student 29 finds no chairs available and will come back later.

[STUDENT THREAD] Student 35 is coming!

[STUDENT THREAD] Student 35 finds no chairs available and will come back later.

[STUDENT THREAD] Student 10 is coming!

[STUDENT THREAD] Student 10 finds no chairs available and will come back later.

[STUDENT THREAD] Student 16 is coming!

[STUDENT THREAD] Student 16 finds no chairs available and will come back later.

[STUDENT THREAD] Student 33 is coming!

[STUDENT THREAD] Student 33 finds no chairs available and will come back later.

[STUDENT THREAD] Student 23 is coming!

[STUDENT THREAD] Student 23 finds no chairs available and will come back later.

[STUDENT THREAD] Student 30 is coming!

[STUDENT THREAD] Student 30 finds no chairs available and will come back later.

[STUDENT THREAD] Student 25 is coming!

[STUDENT THREAD] Student 25 finds no chairs available and will come back later.

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 1

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 0

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 22 is coming!

[STUDENT THREAD] Student 22 wakes up TA!

[STUDENT THREAD] student 22 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 30 is coming!

[STUDENT THREAD] Student 30 wakes up TA!

[STUDENT THREAD] student 30 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 33 is coming!

[STUDENT THREAD] Student 33 wakes up TA!

[STUDENT THREAD] student 33 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 13 is coming!

[STUDENT THREAD] Student 13 wakes up TA!

[STUDENT THREAD] student 13 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 23 is coming!

[STUDENT THREAD] Student 23 wakes up TA!

[STUDENT THREAD] student 23 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 35 is coming!

[STUDENT THREAD] Student 35 wakes up TA!

[STUDENT THREAD] student 35 done with work going bye

[STUDENT THREAD] Student 29 is coming!

[STUDENT THREAD] Student 29 is seated on a waiting chair. Waiting students = 1

[STUDENT THREAD] Student 25 is coming!

[STUDENT THREAD] Student 25 is seated on a waiting chair. Waiting students = 2

[STUDENT THREAD] Student 16 is coming!

[STUDENT THREAD] Student 16 finds no chairs available and will come back later.

[STUDENT THREAD] Student 10 is coming!

[STUDENT THREAD] Student 10 finds no chairs available and will come back later.

[STUDENT THREAD] Student 31 is coming!

[STUDENT THREAD] Student 31 finds no chairs available and will come back later.

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 1

[TA THREAD] TA is helping a student...

[TA THREAD] TA is done helping a student!

[TA THREAD] TA is done helping a student!

[TA THREAD] Waiting students = 0

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 16 is coming!

[STUDENT THREAD] Student 16 wakes up TA!

[STUDENT THREAD] student 16 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 31 is coming!

[STUDENT THREAD] Student 31 wakes up TA!

[STUDENT THREAD] student 31 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[STUDENT THREAD] Student 10 is coming!

[STUDENT THREAD] Student 10 wakes up TA!

[STUDENT THREAD] student 10 done with work going bye

[TA THREAD] No students waiting. TA goes back to sleep.

[TA THREAD] No students waiting. TA goes back to sleep.

[TA THREAD] No students for 10 seconds. TA is exiting.