

程序代写代做 CS编程辅导



**ECS855J/ECS796P**  
**Distributed Systems**  
Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

# What have seen so far



Consensus:

- Allows collection of machines to work as coherent group
- Continuous service, even if some machines fail

WeChat: cstutors  
Assignment Project Exam Help

Paxos:

- Distributed consensus algorithm
- Safety
- Eventual liveness

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

# What the lecture is about



- Raft
- Introduction to cloud computing

WeChat cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导



WeChat: cstutorcs  
Raft  
Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

Many slides from Ion Stoica presentation:

(<https://ucbrise.github.io/cs262a-spring2018/>)

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Introduction



- Raft is a consensus algorithm
  - Primary design goal: understandability (intuition, ease of explanation)
  - Complete enough that can be easily applicable in real implementations

### Assignment Project Exam Help

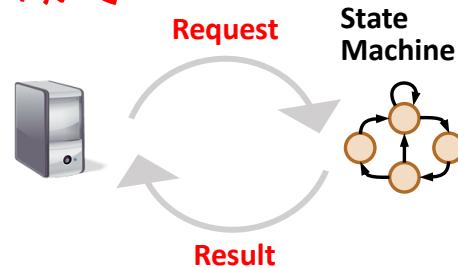
- This results in a different problem decomposition with respect to Paxos!
- WeChat: cstutorcs  
Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Introduction



- Consensus algorithms are used in the context of “replicated state machines”
  - State machine: a program that respond to an external stimuli and manage an internal state
  - Most of today’s services are based on state machines (Memcached, RAMcloud)
- How to build reliable state machines? You replicate them on different servers!

WeChat: cstutorcs

Assignment Project Exam Help

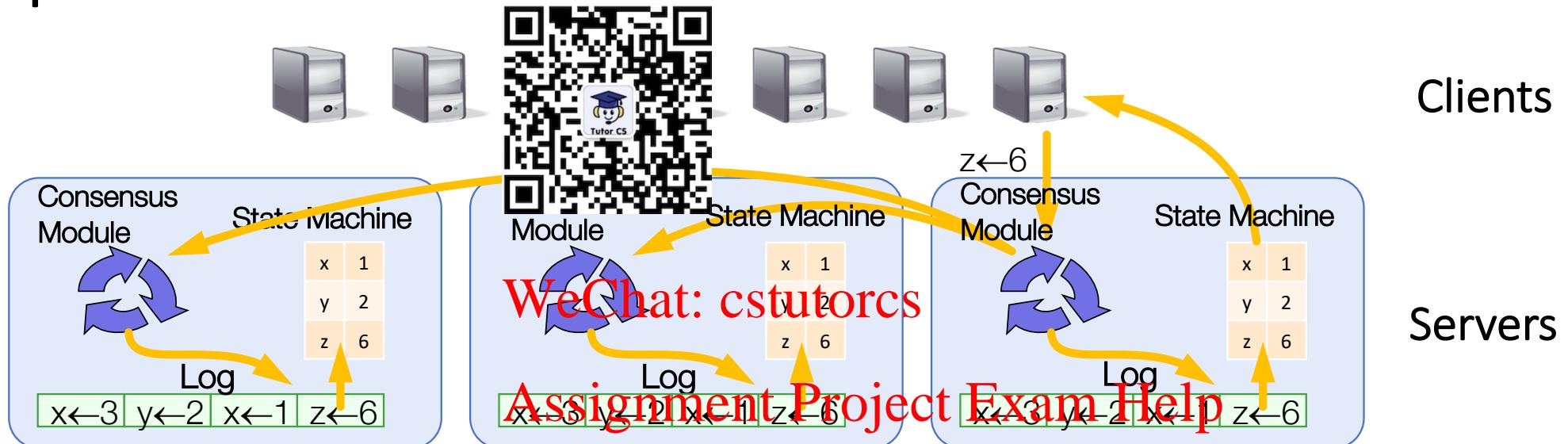
Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

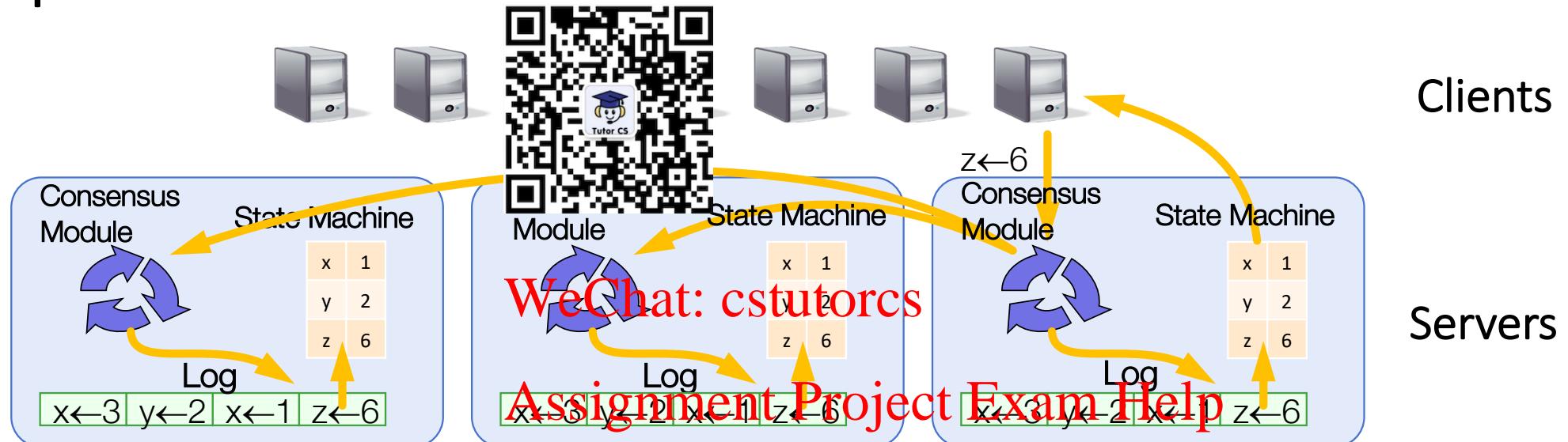
# Replicated State Machines



- The idea: all the machines execute the same set of commands, with the same stimuli in the same order -> all they must produce the same result  
**Email: tutorcs@163.com**
- This shall be so reliable to survive the failure of some machines  
**QQ: 749389476**
- HOW? Keep a replicated log => replicated state machine  
**<https://tutorcs.com>**

程序代写代做 CS编程辅导

# Replicated State Machines



- Consensus module ensures proper log application
- System makes progress provided any majority of servers are up
- Failure model: fail-stop (not Byzantine), delayed/lost messages

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

How to do that?



Get your answer..

1. Proposers: choose unique proposal number (Pn)
2. Acceptors: if  $Pn >$  any previous stored number (Ps), then reply back with Ps and the previously accepted value (V).  
**WeChat: cstutorcs**
3. Proposer: if it gets a majority then select value V, if none choose own value, and send back “accept-request” (Pn,V)  
**Assignment Project Exam Help**
4. Acceptor: is  $Pn > Ps$ ? If so, reply with accept!  
**Email: tutorcs@163.com**

**QQ: 749389476**

**<https://tutorcs.com>**

# 程序代写代做 CS编程辅导

Before moving to



*"There are significant gaps between the description of the Paxos algorithm and the needs of a real-world system...the final system will be based on an unproven WeChat: cstutorcs protocol."*

## Assignment Project Exam Help Google Engineers

### Paxos Made Live - An Engineering Perspective (2006 Invited Talk)

Tushar Chandra, Robert Griesemer, and Joshua Redstone

Google Inc.

#### ABSTRACT

We describe our experience in building a fault-tolerant database using the Paxos consensus algorithm. Despite the existing literature in the field, building such a database proved to be non-trivial. We describe selected algorithmic and engineering problems encountered, and the solutions we found for them. Our measurements indicate that we have built a competitive system.

#### Categories and Subject Descriptors

D.4.5 [Operating systems]: Reliability—*Fault-tolerance*; B.4.5 [Input/output and data communications]: Reliability, Testing, and Fault-Tolerance—*Redundant design*

database is just an example. As a result, the consensus problem has been studied extensively over the past two decades. There are several well-known consensus algorithms that operate within a multitude of settings and which tolerate a variety of failures. The Paxos consensus algorithm [8] has been discussed in the theoretical [16] and applied community [10, 11, 12] for over a decade.

We used the Paxos algorithm ("Paxos") as the base for a framework that implements a fault-tolerant log. We then relied on that framework to build a fault-tolerant database. Despite the existing literature on the subject, building a production system turned out to be a non-trivial task for a variety of reasons:

- While Paxos can be described with a page of pseudo-

QQ: 749389476

<http://tutorcs.com>

# 程序代写代做 CS编程辅导

Before moving to



*"There are significant gaps in the description of the Paxos algorithm and the needs of a real-world system...the final system will be based on an unproven WeChat: cstutorcs protocol."*

Assignment Project Exam Help Google Engineers

Email: tutorcs@163.com

- Paxos has dominated discussion for 25 years
  - Hard to understand (what does each phase do? what is the purpose of each phase?)
  - Incomplete (only agrees on a value, it does not guarantee that we converge on a value: if it converges, it will be just one value)

# 程序代写代做 CS编程辅导

Before moving to



- Hard to implement reliably (how to choose proposal value?)

WeChat: cstutorcs

Assignment Project Exam Help

Hard to understand + Hard to implement reliably =

Email: tutorcs@163.com

Not a good foundation for practical implementations!

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

## Raft: designing for understandability..



- Main objective of RAFT
  - Which design decision is the easiest to understand?  
**WeChat: cstutorcs**
- Techniques that were used include
  - Dividing problems into smaller problems (that are easier to understand)
  - Reducing the number of system states to consider (removing as much as possible “if statements”)  
**Email: tutorcs@163.com**

**QQ: 749389476**

**<https://tutorcs.com>**

# 程序代写代做 CS编程辅导

## Raft overview



### 1. Leader election

- Select one of the servers to act as cluster leader
- Detect crashes, choose new leader

WeChat: cstutorcs  
Assignment Project Exam Help

### 2. Log replication (normal operation)

- Leader takes commands from clients, appends them to its log
- Leader replicates its log to other servers (overwriting inconsistencies)

Email: tutorcs@163.com  
QQ: 749389476

### 3. Safety

<https://tutorcs.com>

- Only a server with an up-to-date log can become leader

# 程序代写代做 CS编程辅导

## Raft basics: servers



- A Raft cluster consists of servers (remember the replicated state machine)
- Each server can be in one of three states:
  - Follower
  - Candidate
  - Leader

WeChat: cstutorcs

Assignment Project Exam Help

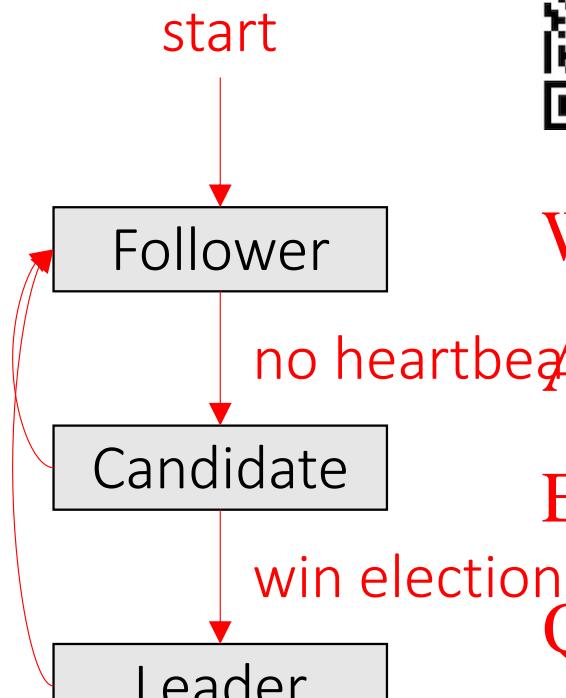
Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Raft basics: serv



power is passive but expect regular heartbeats

WeChat: cstutorcs

Assignment Project Exam Help  
Candidate tries to get elected as leader

Email: tutorcs@163.com

QQ: 749989476  
replicates its log and send regular heartbeats to maintain leadership

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Raft basics: terms



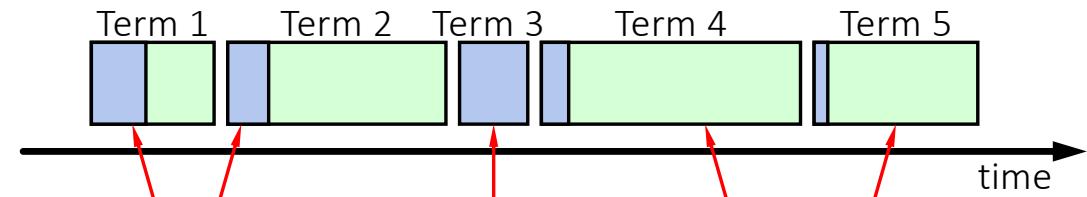
WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

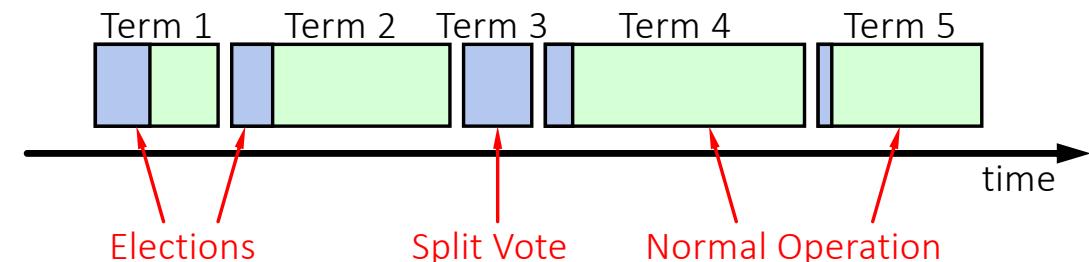
<https://tutorcs.com>



- Terms are epochs of arbitrary duration
  - Start with the election of a leader
  - End when
    - Leader becomes unavailable
    - No leader can be selected (split vote)
- Servers do not have global view of the entire system. Servers do not have global view of terms and might see the progression of terms at different times.  
How to deal with this?

# 程序代写代做 CS编程辅导

## Raft basics: term



- Each server:
  - Keeps what they think the current term is
  - Constantly exchange this information
  - Every Response-Request message include the Term the server thinks we are on
  - If a machine finds out that there is a more updated term, then it has an identity crisis and (1) updates its term and (2) become follower
  - If a machine receives a request with an old term, then it replies saying "dude, you are too old now!"

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Raft basics: RPC



- RPC: Remote Procedure Call request-response protocol used in Raft
- Servers communicate through idempotent RPCs
- RequestVote
  - Initiated by candidates during elections
- AppendEntry
  - Replicate log entries
  - Provide a form of heartbeat
  - Empty AppendEntry( ) calls

Assignment Project Exam Help

Email: [tutorcs@163.com](mailto:tutorcs@163.com)

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Leader election



- Servers start being *followers*
- Remain followers as long as they receive valid RPCs from a leader or candidate
- When a follower receives no communication over a period (the *election timeout*), it starts an election to pick a *new leader*

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导



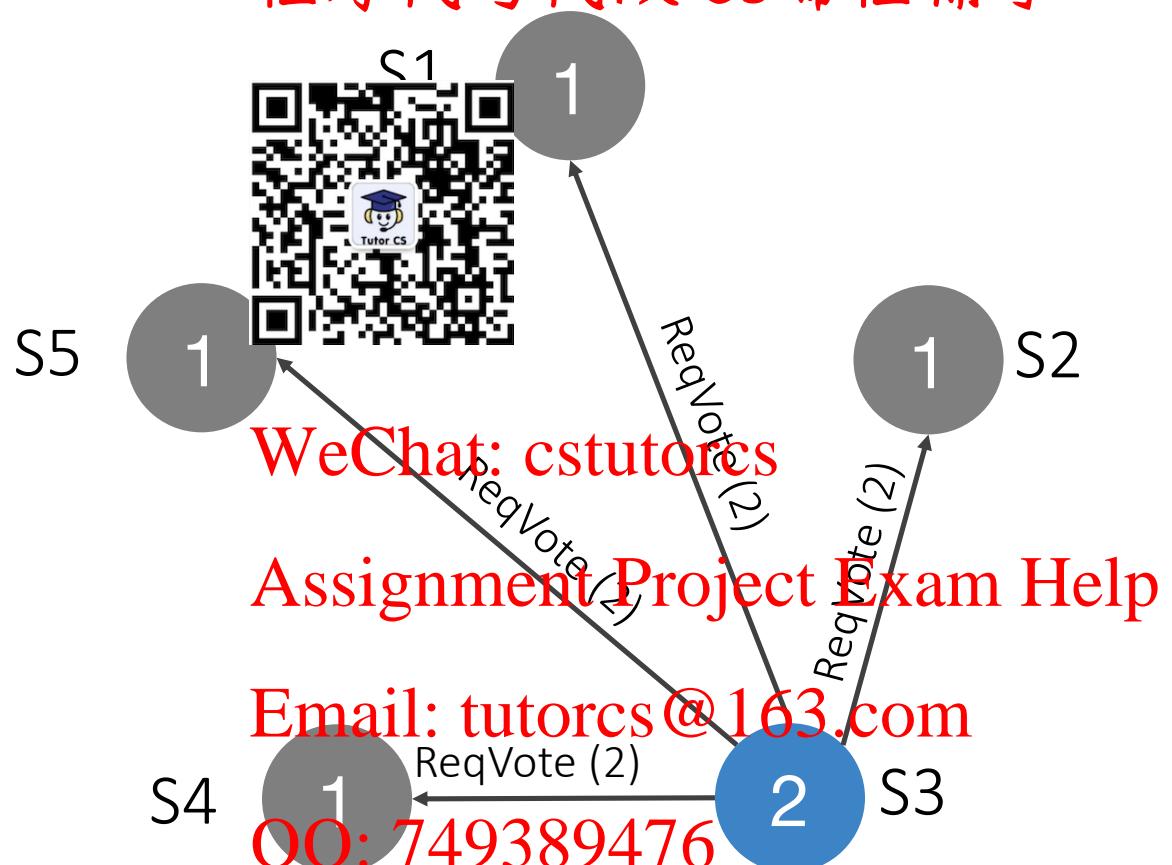
- Follower
- Candidate
- Leader

Assignment Project Exam Help

Email: tutorcs@163.com  
QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导



- Follower
- Candidate
- Leader

S3 timeouts, switch to candidate state,  
increment term, vote itself as a leader and ask everyone else to confirm

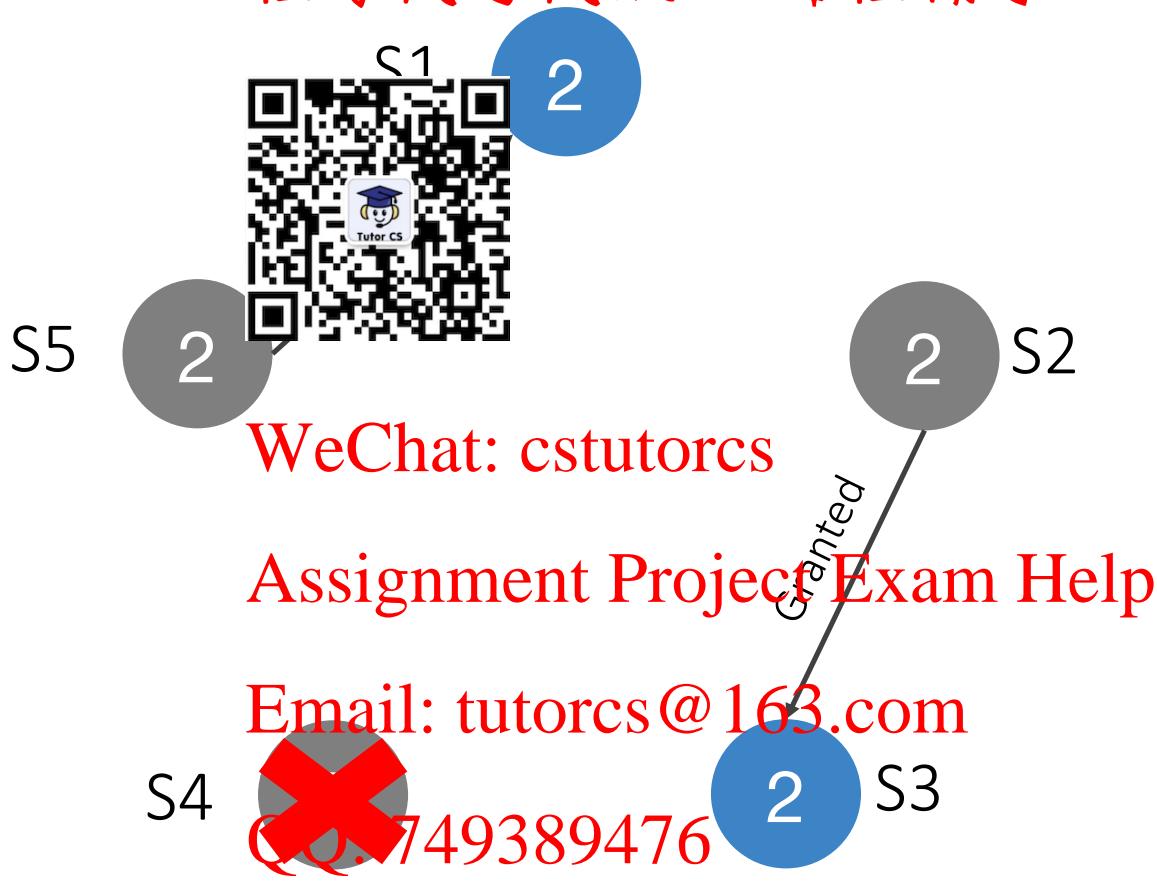
# 程序代写代做 CS编程辅导



Concurrently S1 timeouts, switch to candidate state,  
increment term, vote itself as a leader and ask everyone else to confirm

- Follower
- Candidate
- Leader

# 程序代写代做 CS编程辅导

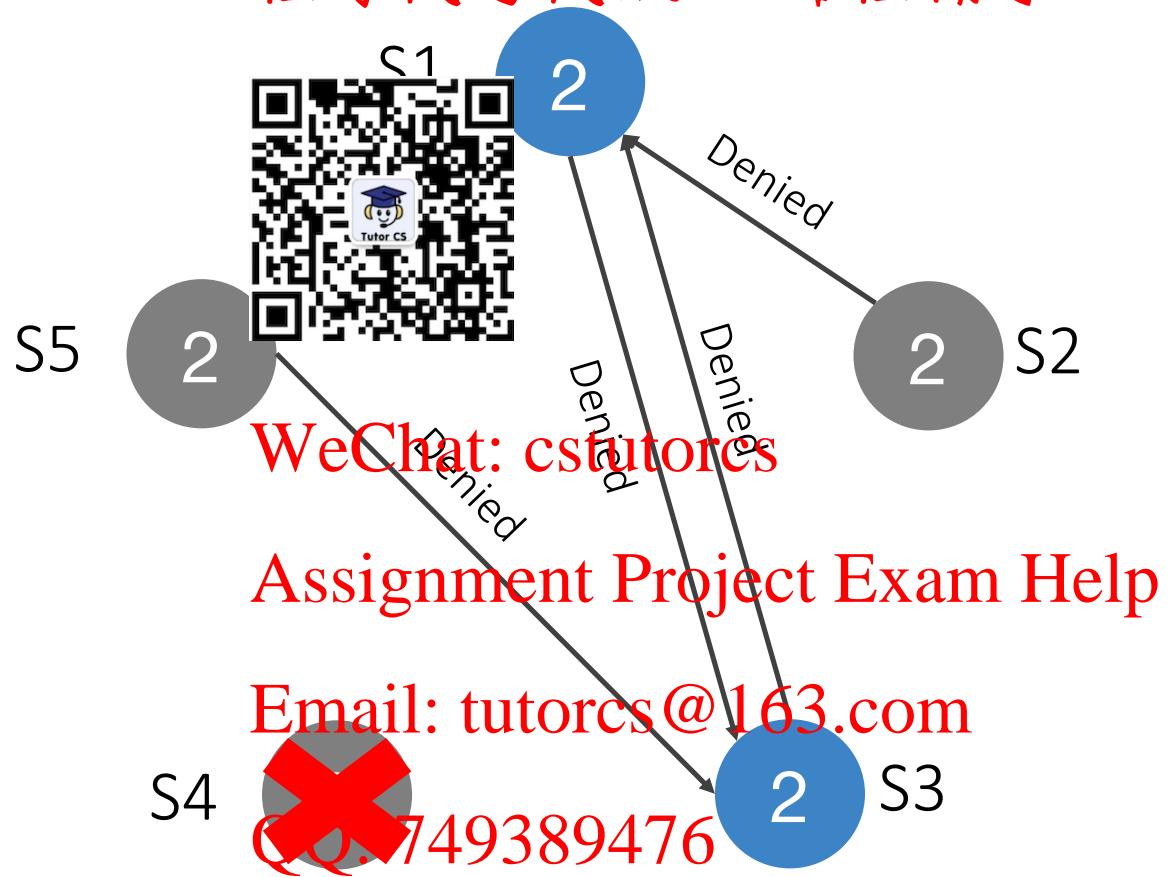


Let's assume that S4 crashes at S5 grant vote to S1, while S2 grants vote to S3

# 程序代写代做 CS编程辅导



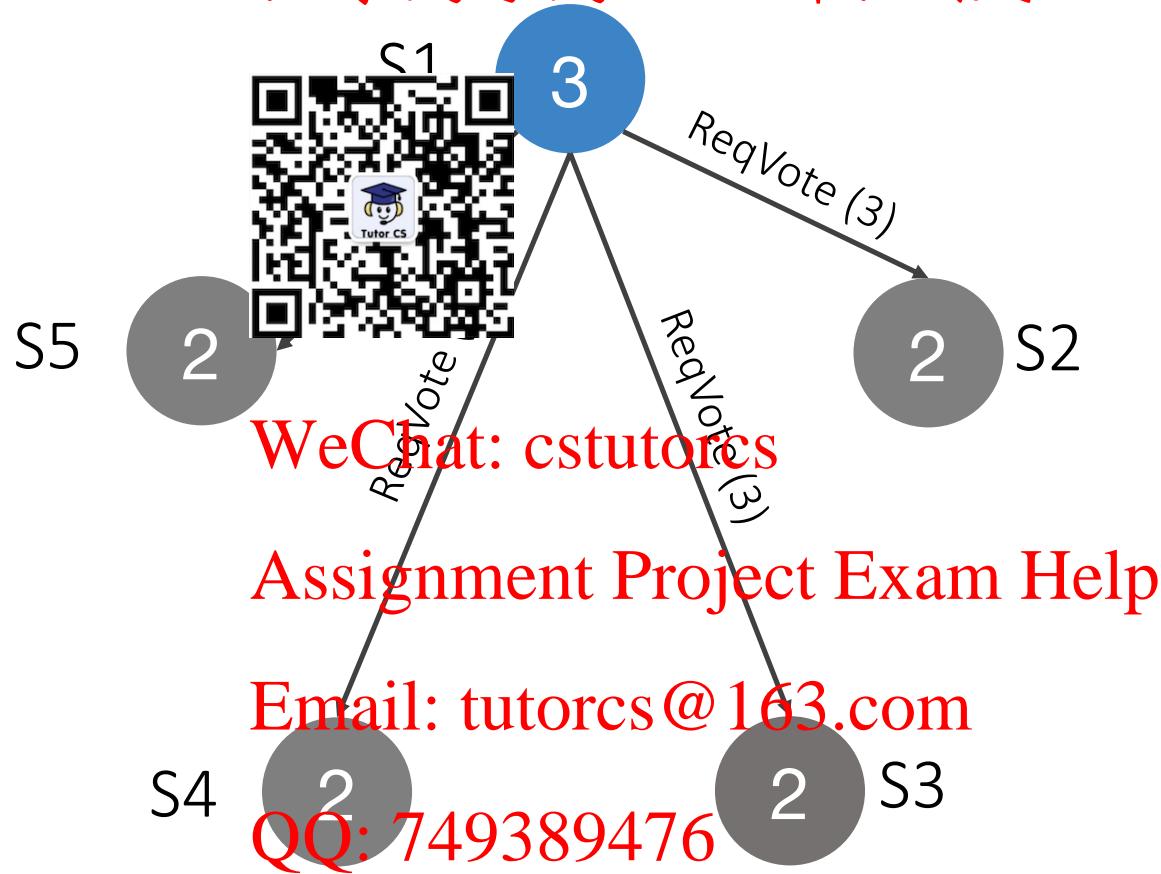
# 程序代写代做 CS编程辅导



- Follower
- Candidate
- Leader

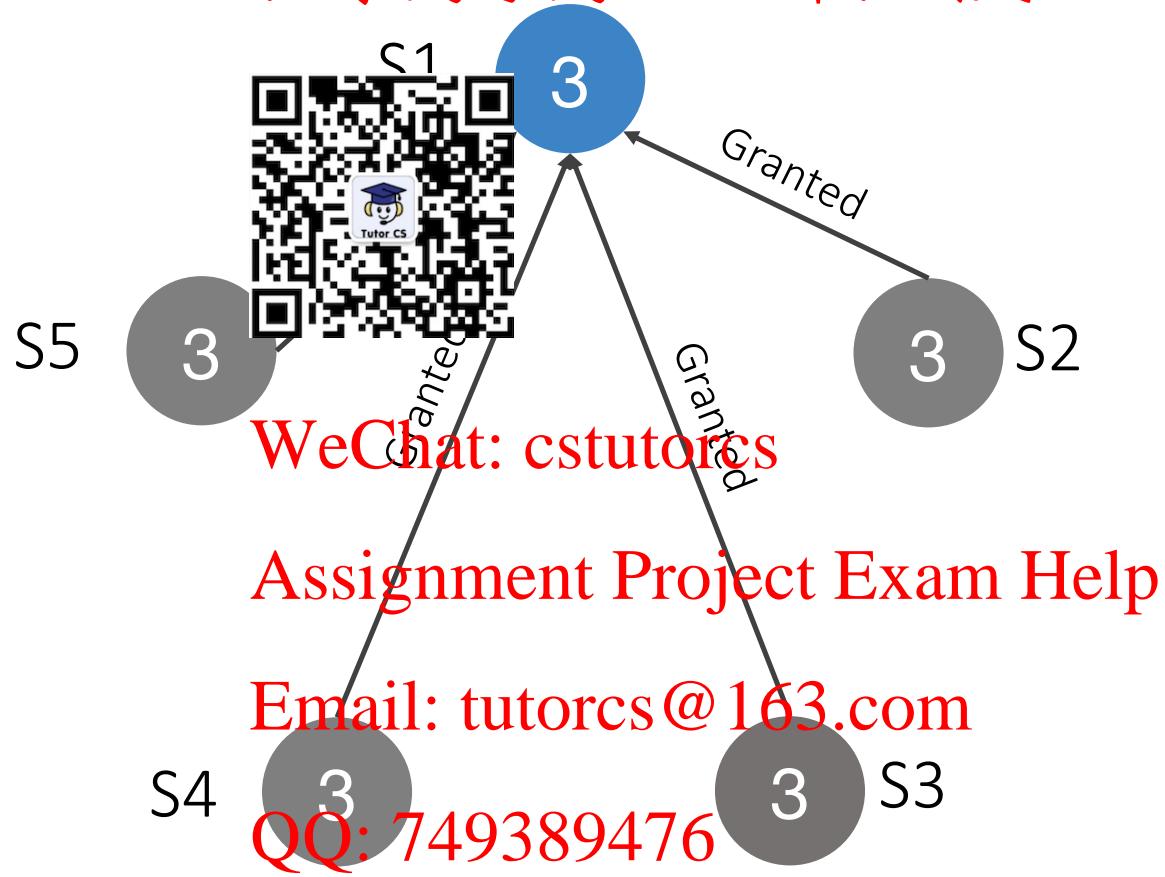
Neither candidate gets majority. After a random delay between 150-300ms try again.

# 程序代写代做 CS编程辅导



S1 initiates another election for term 3 <https://tutorcs.com>

# 程序代写代做 CS编程辅导



Everyone grants the vote to <https://tutorcs.com>

- Follower
- Candidate
- Leader

# 程序代写代做 CS编程辅导



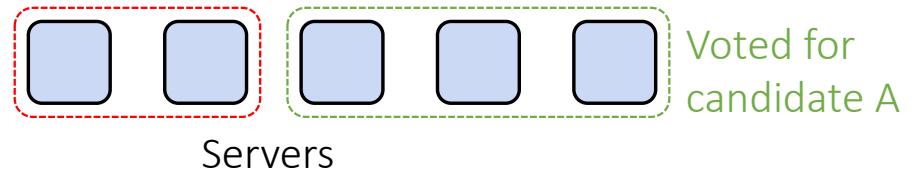
- Follower
- Candidate
- Leader

# 程序代写代做 CS编程辅导

## Election correct



can't also  
majority



- Safety (nothing bad happens): We allow at most one winner per term
  - Each server gives only one vote per term
  - Majority required to win election

Email: tutorcs@163.com

- Liveness (something good happens): some candidate must eventually win
  - Choose election timeouts randomly in  $[T, 2T]$  (e.g., 150-300ms)
  - One sever usually times out and wins election before others time out
  - Works well if  $T \gg$  broadcast time

# 程序代写代做 CS编程辅导



WeChat: cstutorcs  
So, what does a leader do?  
Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Leader



- Accept client command

WeChat: cstutorcs

- Append them to their log (new entry)

Assignment Project Exam Help

- Issue AppendEntry RPCs in parallel to all followers

Email: tutorcs@163.com

- Apply the entry to their state machine once it has been safely replicated

QQ: 749389476  
<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Leader



- Apply the entry to their state machine once it has been safely replicated. What does this mean?

WeChat: cstutorcs

- Once new entry committed (safely replicated)

**Assignment Project Exam Help**

- Leader executes command in its state machine, returns result to client
- Leader notifies followers of committed entries in subsequent AppendEntries RPCs
- Followers execute committed commands in their state machines

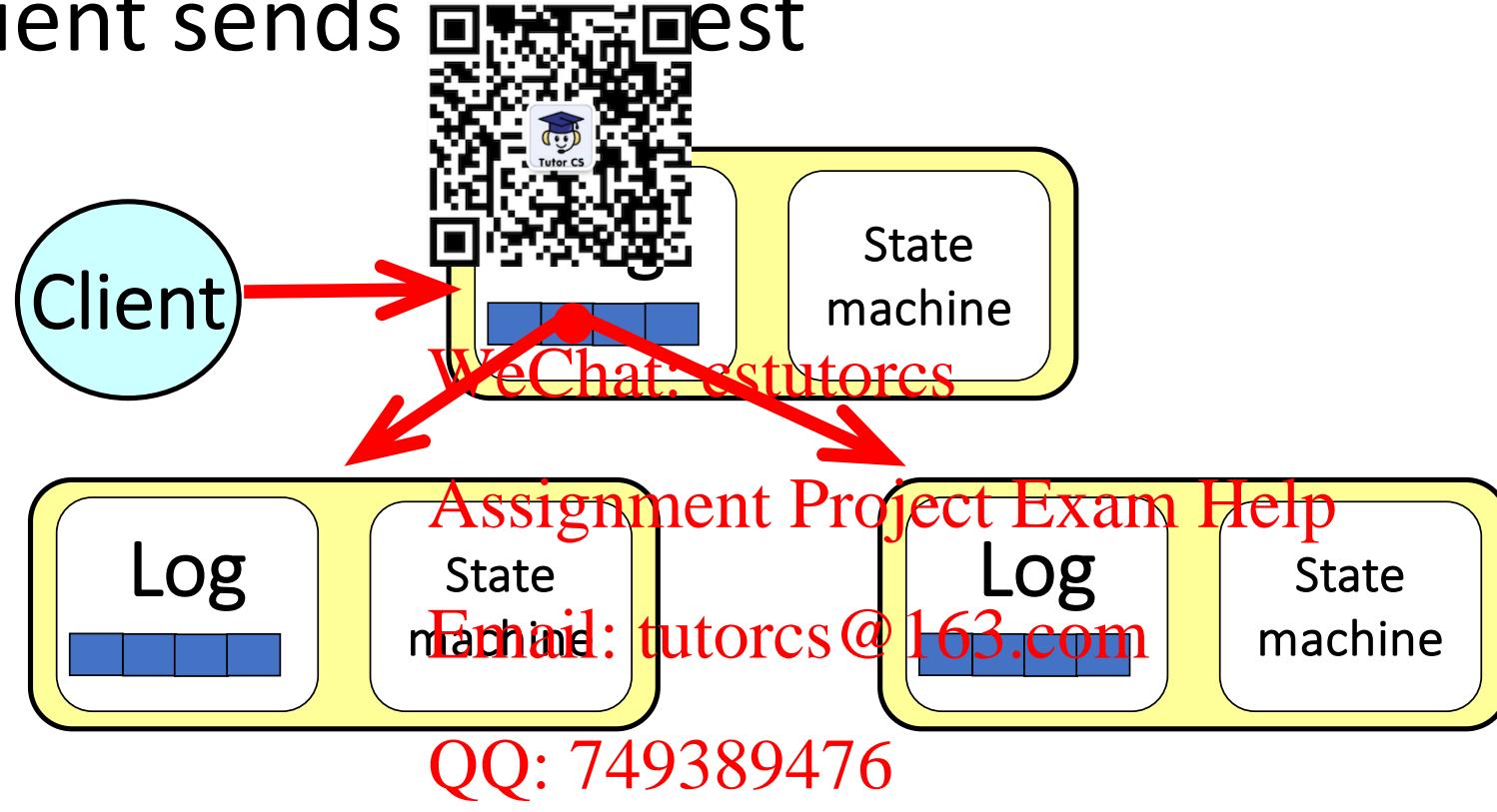
Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

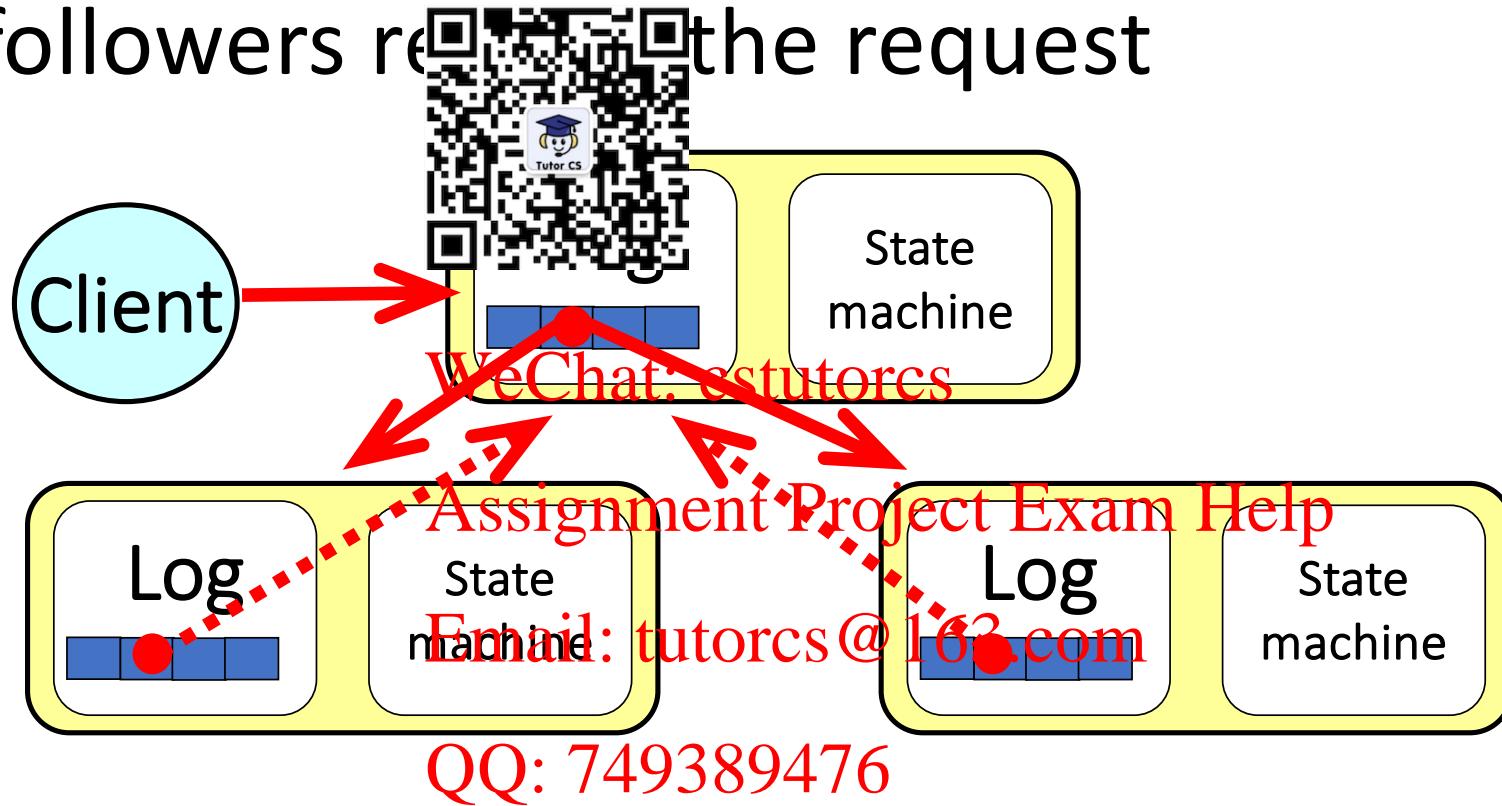
A client sends request



Leader stores request on its log and forwards it to its followers  
<https://tutorcs.com>

# 程序代写代做 CS编程辅导

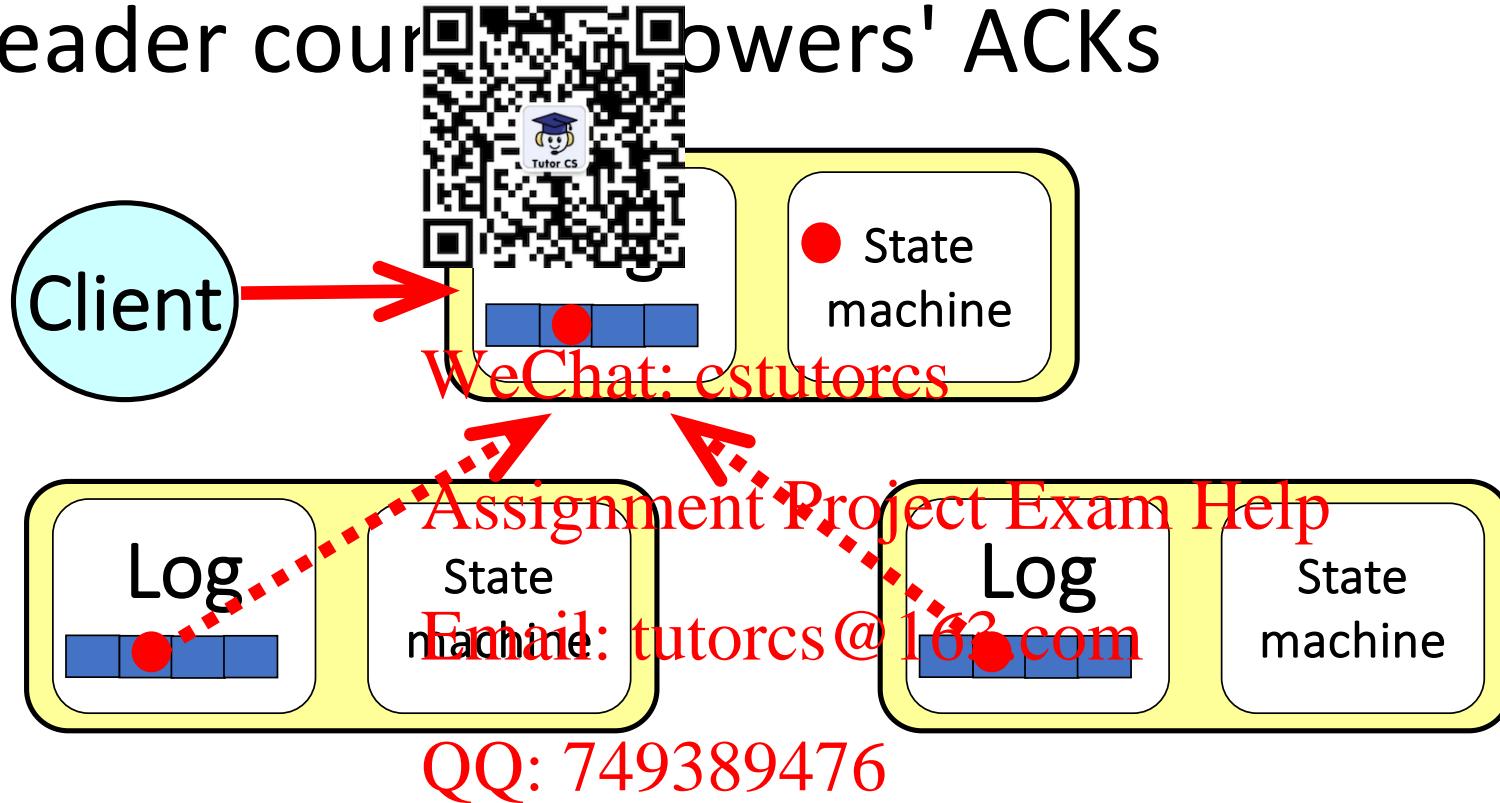
The followers receive the request



Followers store the request on their logs and acknowledge its receipt  
<https://tutorcs.com>

# 程序代写代做 CS编程辅导

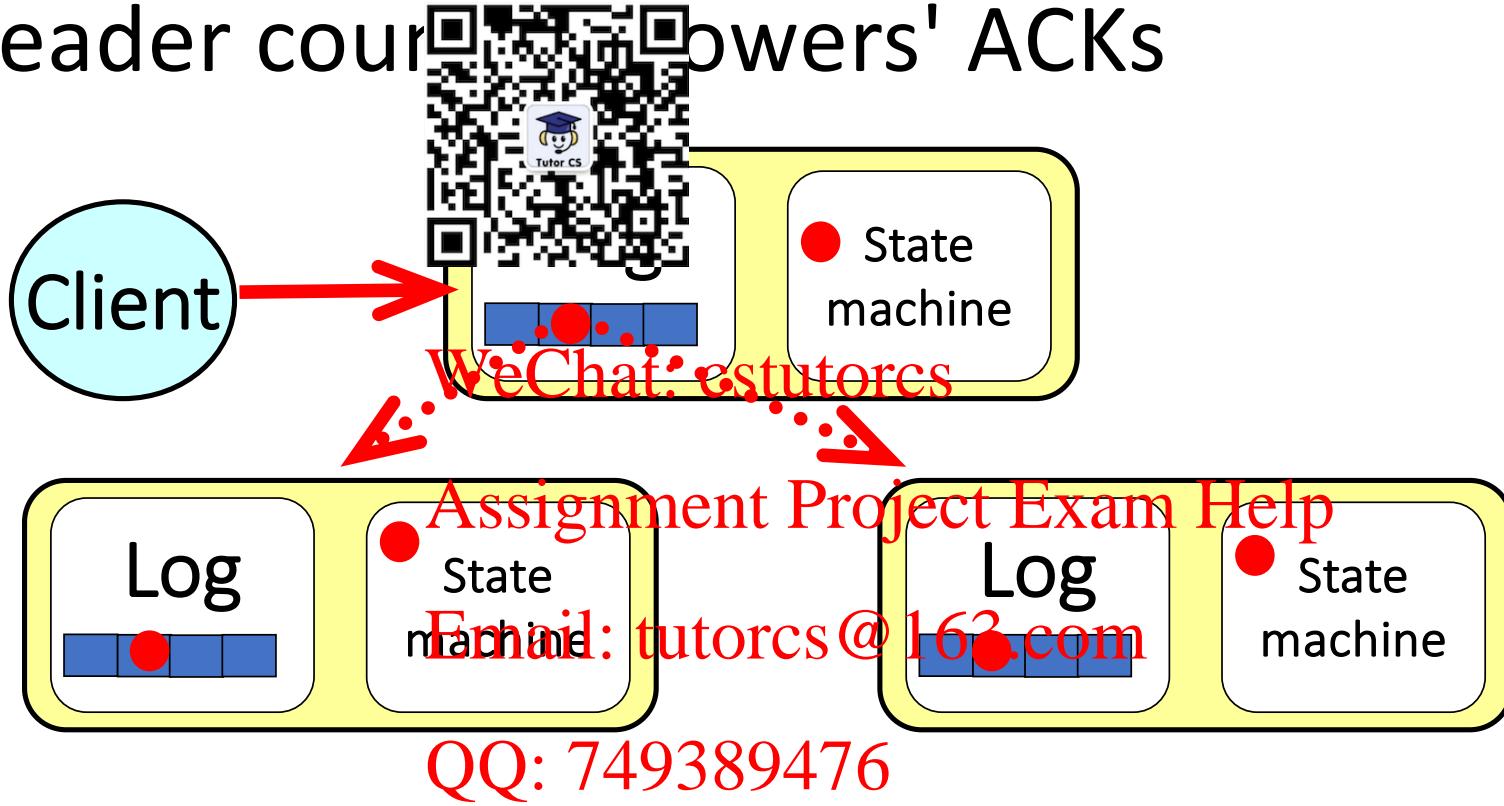
The leader coordinates followers' ACKs



Once it ascertains the request has been processed by a majority of the servers, it consider the entry committed (replicated in enough logs). So, it execute the command in the state machine

程序代写代做 CS编程辅导

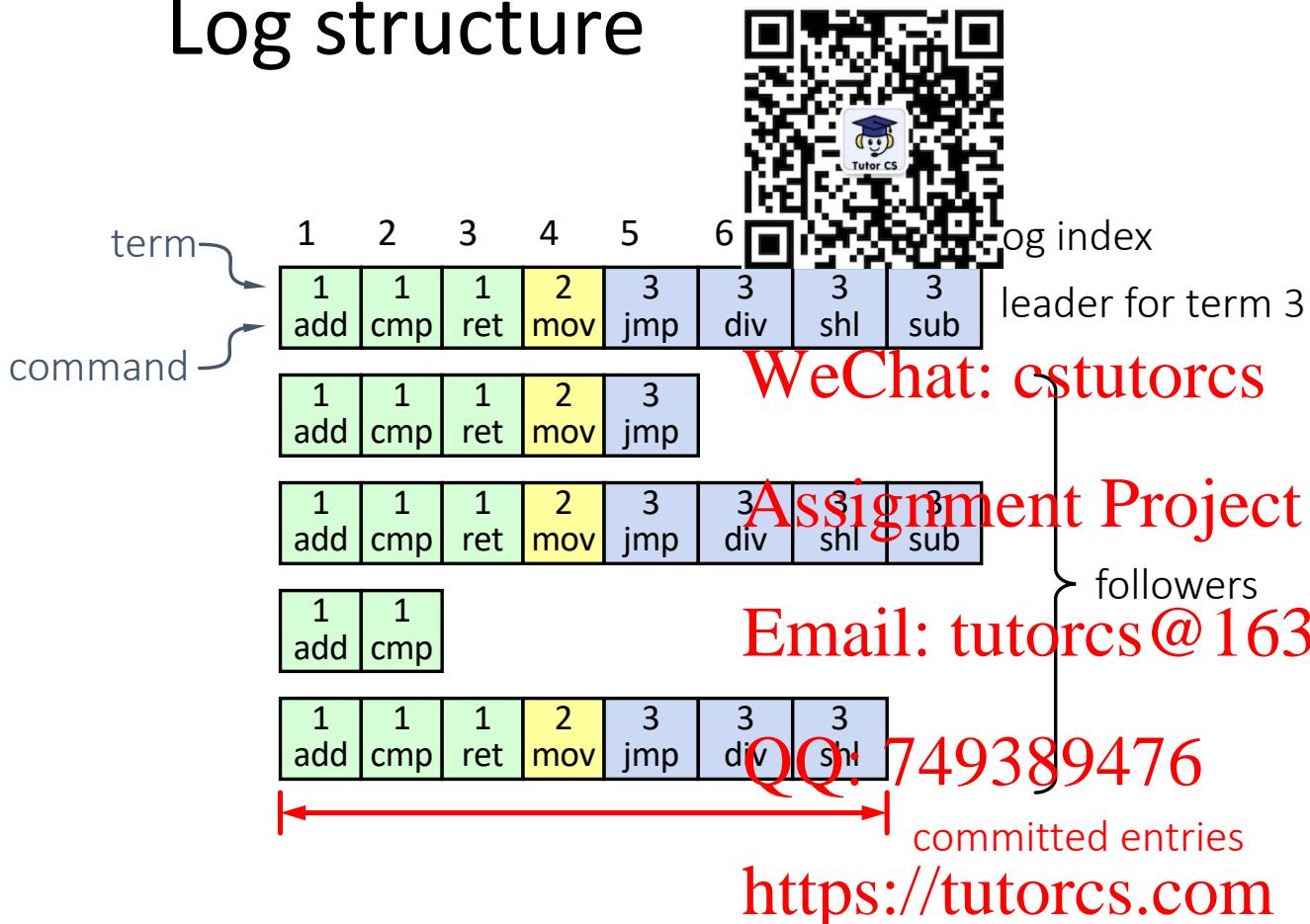
## The leader controls followers' ACKs



Leader's heartbeats convey the news to its followers: they update their state machines  
<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Log structure

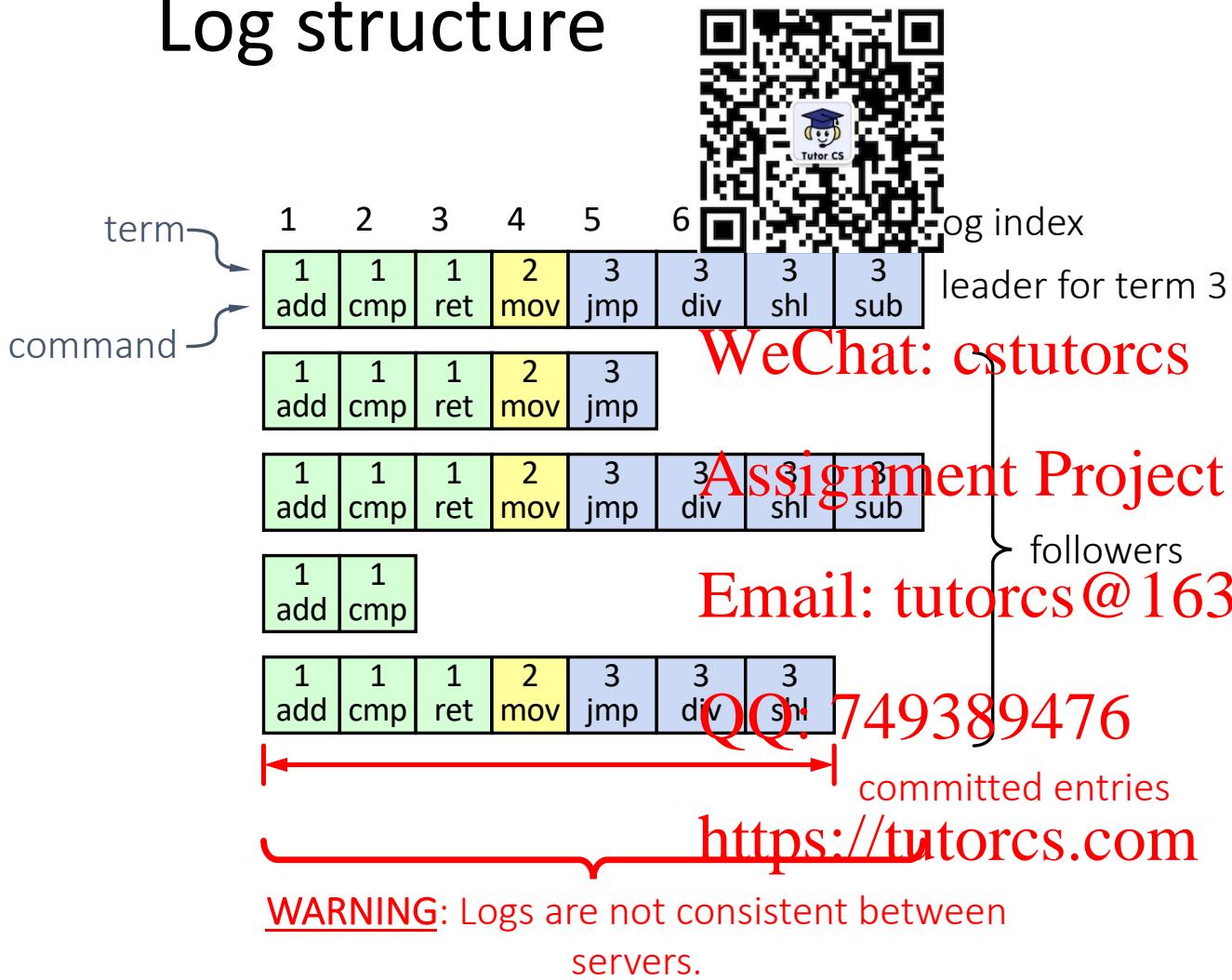


- Entry is committed only if it is stored in the majority of the servers (i.e., in this case index = 7)

- This is to guarantee that operations are executed in strictly the same sequential order

# 程序代写代做 CS编程辅导

## Log structure



- Entry is committed only if it is stored in the majority of the servers (i.e., in this case index = 7)

- This is to guarantee that operations are executed in strictly the same sequential order

# 程序代写代做 CS编程辅导

## Log matching pr



- The goal: high level of consistency between logs

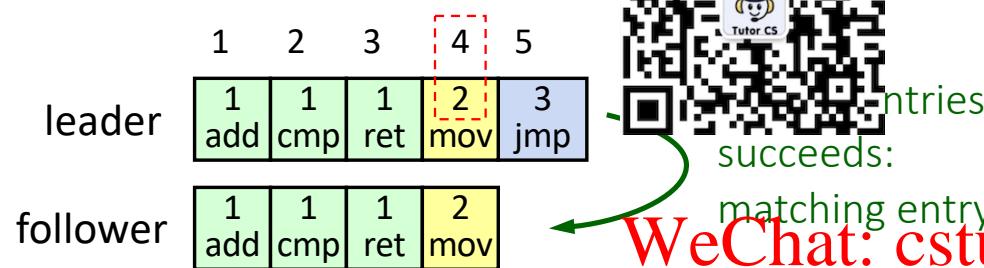
WeChat: cstutorcs

1. If log entries on different servers have the same index and term
  - They store the same command
  - The logs are identical in all the preceding entries (they are committed)
2. If a given entry is committed, all preceding entries are also committed

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Consistency check



- AppendEntries RPCs include <index, term> of entry preceding new one(s)

- Follower must contain matching entry;

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Consistency check

|          | 1        | 2        | 3        | 4        | 5        |
|----------|----------|----------|----------|----------|----------|
| leader   | 1<br>add | 1<br>cmp | 1<br>ret | 2<br>mov | 3<br>jmp |
| follower | 1<br>add | 1<br>cmp | 1<br>ret | 2<br>mov |          |



entries  
succeeds:  
matching entry

WeChat: cstutorcs

|          | 1        | 1        | 1        | 2        | 3        |
|----------|----------|----------|----------|----------|----------|
| leader   | 1<br>add | 1<br>cmp | 1<br>ret | 2<br>mov | 3<br>jmp |
| follower | 1<br>add | 1<br>cmp | 1<br>ret | 1<br>shl |          |

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

- AppendEntries RPCs include <index, term> of entry preceding new one(s)

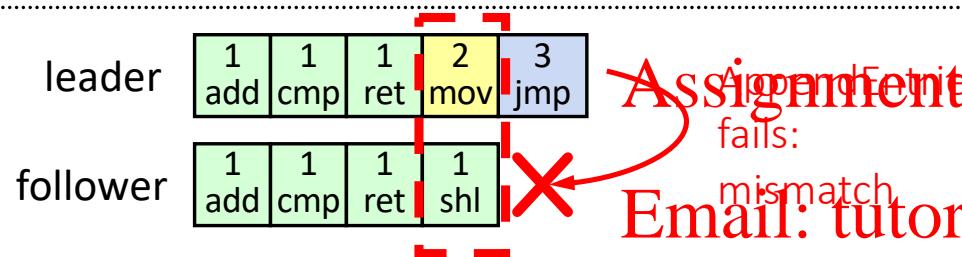
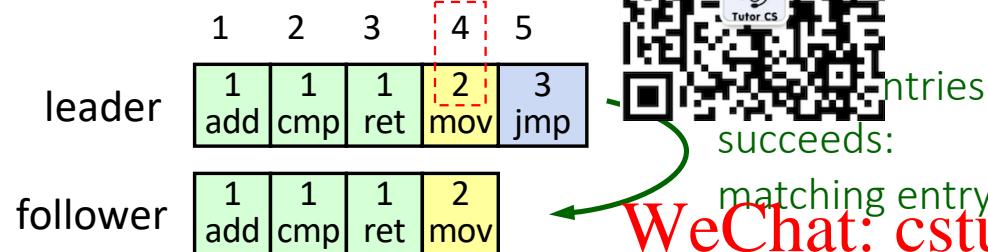
- Follower must contain matching entry; otherwise, it rejects the request

- Leader retries with lower log index

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Consistency check



The leader cannot commit <5,3> because index 4 is different

QQ: 749389476

<https://tutorcs.com>

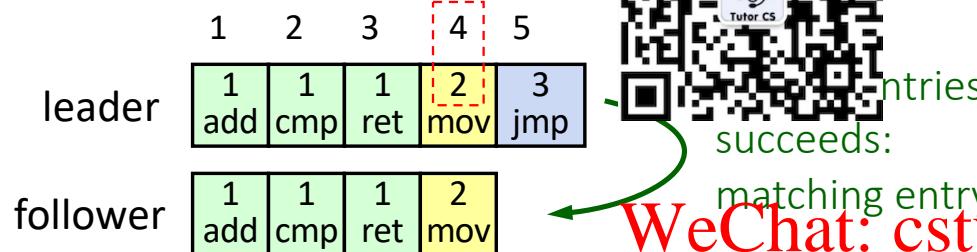
- AppendEntries RPCs include <index, term> of entry preceding new one(s)

- Follower must contain matching entry; otherwise, it rejects the request

- Leader retries with lower log index

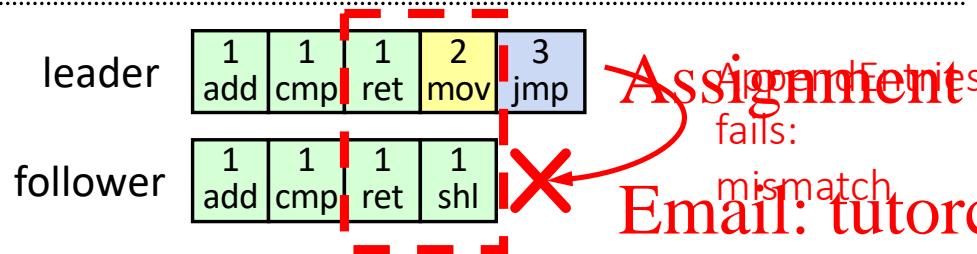
# 程序代写代做 CS编程辅导

## Consistency check



entries  
succeeds:  
matching entry

WeChat: cstutorcs



Assignment Project Exam Help

Email: tutorcs@163.com

The leader retries with  
Lower log index and to  
Index 3 the logs match!

QQ: 749389476

<https://tutorcs.com>

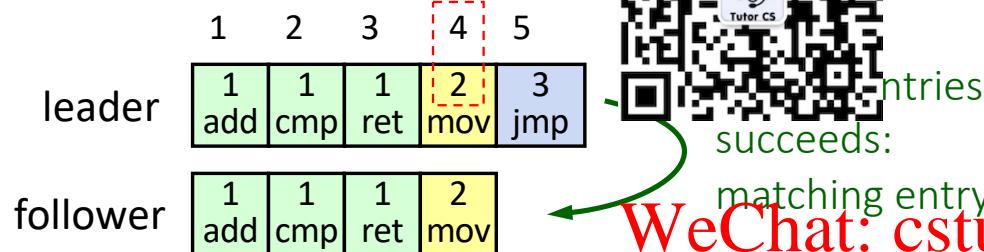
- AppendEntries RPCs include <index, term> of entry preceding new one(s)

- Follower must contain matching entry; otherwise, it rejects the request

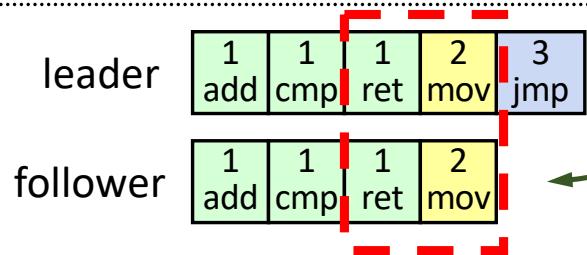
- Leader retries with lower log index

# 程序代写代做 CS编程辅导

## Consistency check



- AppendEntries RPCs include <index, term> of entry preceding new one(s)



- Follower must contain matching entry; otherwise, it rejects the request

The follower now can synchronize with the leader  
QQ: 749389476

- Leader retries with lower log index

<https://tutorcs.com>



WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

# 程序代写代做 CS编程辅导

## Safety: leader consistency



- This assumes that the leader says right! (it has all the entry committed)

WeChat: cstutorcs

- Once log entry committed, all future leaders must store that entry

Assignment Project Exam Help

- Servers with incomplete logs must not get elected

Email: [tutorcs@163.com](mailto:tutorcs@163.com)

- Candidates include index and term of last log entry in RequestVote
- Voting servers denies vote if its log is more up-to-date
- Logs ranked by <lastTerm, lastIndex>

<https://tutorcs.com>

## 程序代写代做 CS编程辅导

### Eventual liveness



- Theoretically, competing servers could cause repeated split votes

WeChat: cstutorcs

- Raft mitigates this by having each participating server individually choose a new random timeout within each given interval.

Assignment Project Exam Help

Email: tutorcs@163.com

- This will lead to a situation, where usually there is only one server awake, which can then win the election while every other server is still asleep.

QQ: 749389476

<https://tutorcs.com>

- This works best if the lower bound of the chosen interval is considerably larger than the broadcast time

程序代写代做 CS编程辅导

## Summary



- Consensus key building blocks of distributed systems
- Raft “similar to” Paxos
- Raft arguably easier to understand than Paxos
  - It separates stages which reduces the algorithm state space
  - Provides a more detailed implementation

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导



WeChat: cstutorcs  
Introduction to Cloud Computing  
Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>



# 程序代写代做 CS编程辅导

## Disclaimer



# 程序代写代做 CS编程辅导

So, what is it?



- **Cloud Computing** is a general term used to describe a class of network-based computing that takes place over the Internet

WeChat: cstutorcs

- Simply the renting of servers and/or storage as well as access to these resources via a network

Email: tutorcs@163.com

- This an oversimplification but a good starting point

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

So, what is it? (c



- These platforms hide the complexity and details of the underlying infrastructure from users and applications by providing a very simple graphical interface or API (Applications Programming Interface)

## Assignment Project Exam Help

- The illusion of infinite computing resources available on demand
  - on demand services, that are always ON, anywhere, anytime and any place

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

So, what is it? (c



- The ability to use of computer resources on a short-term basis as needed (e.g., processors by the hour and storage by the day) and release them as needed

WeChat: cstutorcs

- Pay for use and as needed Assignment Project Exam Help

- scale up and down in capacity and functionalities

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## In summary



- Cloud computing is an umbrella term used to refer to Internet based development and services
- A number of characteristics define cloud data, applications, services and infrastructure:
  - Remotely hosted: services or data are hosted on remote infrastructure
  - Ubiquitous: services or data are available from anywhere
  - Commodified: The result is a utility computing model similar to traditional that of traditional utilities, like gas and electricity - you pay for what you would want!

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutores@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Motivating cloud computing



- Very large data centres can save hardware, network bandwidth and power for 1/5 to 1/7 the prices of a medium-sized data centre

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcse@163.com

QQ: 749389476

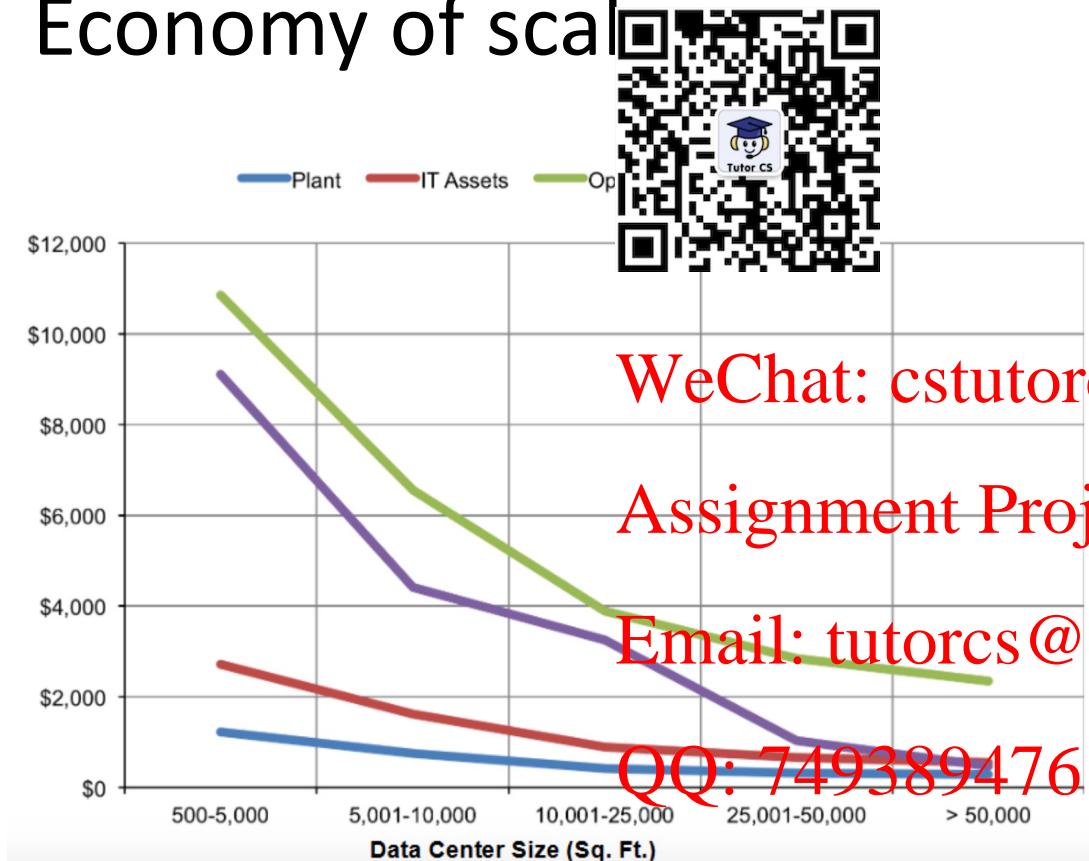
<https://tutorcs.com>

| Data Center Size (sq. ft.) | No. of Racks | Avg Compute Load (kW) | Avg Rack Density (kW) | Average Cost Per kW |         | Average Cost Per Rack |         |
|----------------------------|--------------|-----------------------|-----------------------|---------------------|---------|-----------------------|---------|
|                            |              |                       |                       | Annually            | Monthly | Annually              | Monthly |
| 500 to 5,000               | 28.5         | 105                   | 3.5                   | \$26,495            | \$2,208 | \$37,614              | \$3,134 |
| 5,001 to 10,000            | 58           | 318                   | 5.7                   | \$13,662            | \$1,135 | \$74,689              | \$6,224 |
| 10,001 to 25,000           | 95           | 620                   | 6.5                   | \$8,464             | \$705   | \$65,212              | \$4,604 |
| 25,001 to 50,000           | 128.5        | 972                   | 8                     | \$6,734             | \$561   | \$50,841              | \$4,245 |
| > 50,000                   | 183          | 1,400                 | 7.8                   | \$5,467             | \$456   | \$41,825              | \$3,485 |

Data taken from a report made in 2016

# 程序代写代做 CS编程辅导

## Economy of scale



WeChat: cstutorcs

Assignment Project Exam Help Data taken from a report made in 2016

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

This is good for me



- Parallel batch processing

- Batch processing and analytics jobs can analyse terabytes of data and take hours to finish
- If there is enough parallelism, users can use hundreds of servers to complete the job quickly
- Tools such as Hadoop can be used to reduce the complexity of implementing these jobs

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

This is good for me



- The rise of analytics

- A special case of batch processing is business analytics
- A growing share of computing resources is now spent on understanding customers, supply chains and buying habits
- Market Sentiment analysis using Twitter data is a good example of this

Email: tutorcs@163.com

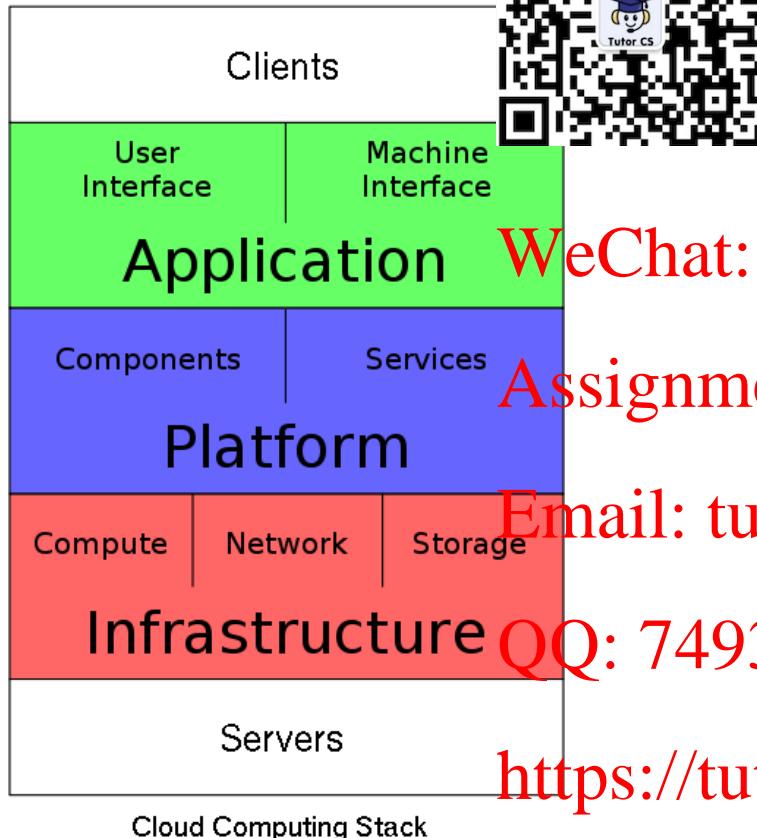
QQ: 749389476

<https://tutorcs.com>



# 程序代写代做 CS编程辅导

## Cloud architecture



WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476 Database as a Service (DbaaS)

<https://tutorcs.com>

- Three main categories

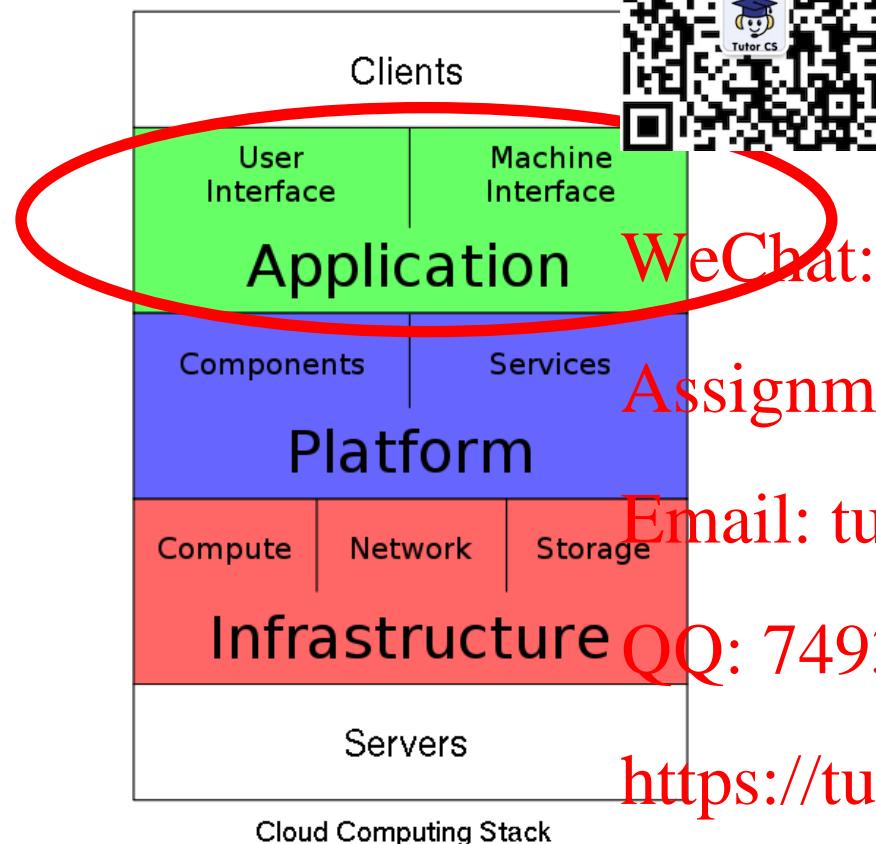
- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

Other services categories include

- Storage as a Service (STaaS)

# 程序代写代做 CS编程辅导

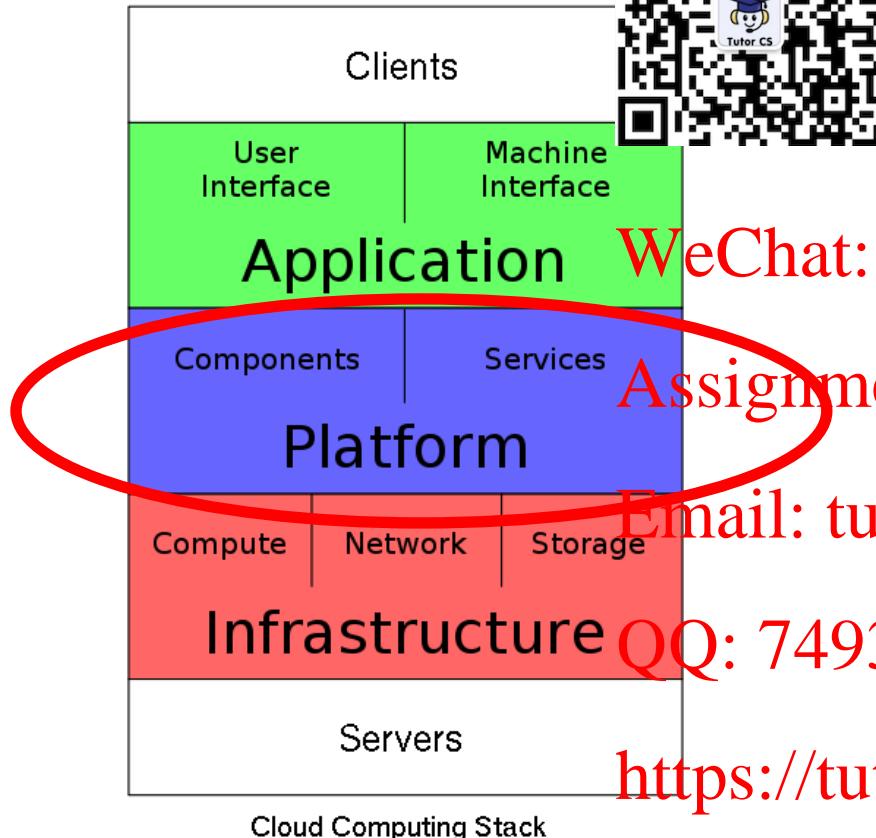
## Software as a Service



- Software is hosted on a cloud and clients typically access the software via a web browser
  - Examples: Facebook, Netflix, YouTube
- Software can be leased on a subscription basis or supported via ad revenue and data services
- Migration of traditional software to SaaS model
  - Microsoft Office → Office 365
  - DVD Games → Steam

# 程序代写代做 CS编程辅导

## Platform as a Service



- Cloud owners provide a platform for users to develop, run and manage web applications
  - Examples: IBM Bluemix, Google's AppEngine, Microsoft Azure

WeChat: cstutorcs

Assignment Project Exam Help

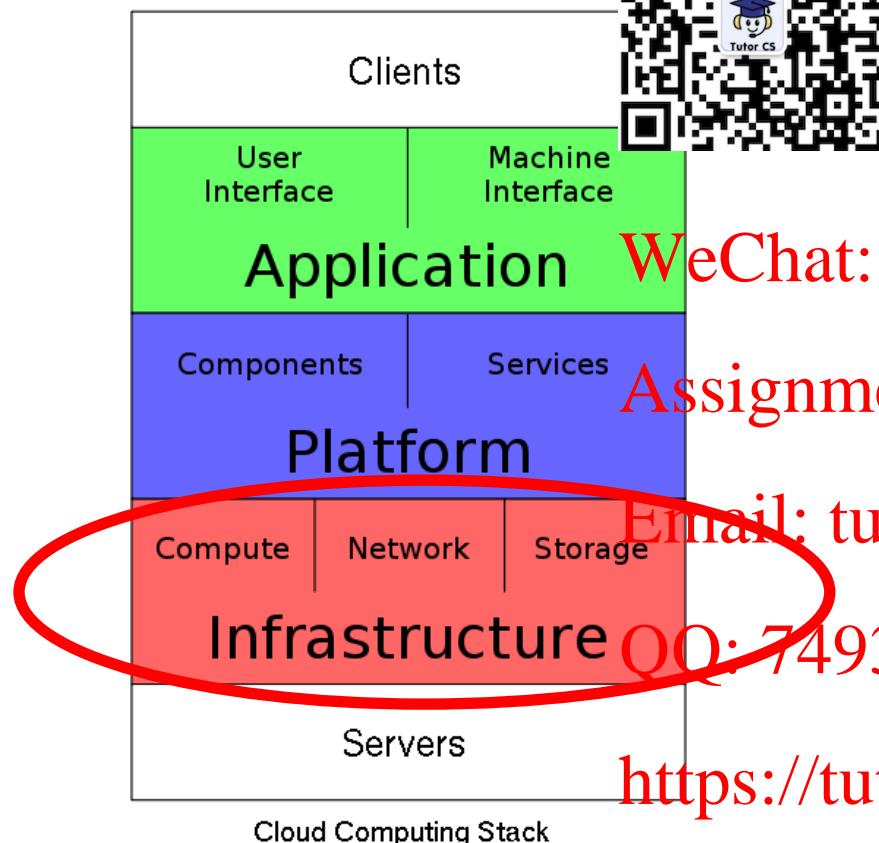
Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Infrastructure as a Service



- Cloud owners provide direct access to virtual (or in rare cases physical) machines which users can configure
  - Examples: IBM Bluemix Virtual, Machine and Amazon's EC2

WeChat: cstutorcs

Assignment Project Exam Help

- Users can select from a wide variety of operating systems and hardware configurations

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Quick recap



- SaaS: provides access to application software. No need to worry about the installation, setup and running of the application.
  - Examples: Google Apps, Microsoft Office 365

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Quick recap



- SaaS: provides access to a software. No need to worry about the installation, setup and running of the application.
  - Examples: Google Apps, Microsoft Office 365
- PaaS: provides computing platforms which typically includes operating system, programming language execution environment, database, web server etc.
  - Examples: AWS Elastic Beanstalk, [tutordotcs@gmail.com](mailto:tutordotcs@gmail.com), Google App Engine

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

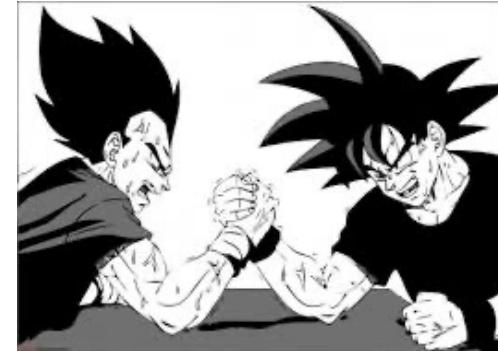
## Quick recap



- SaaS: provides access to a software. No need to worry about the installation, setup and running of the application.
  - Examples: Google Apps, Microsoft Office 365
- PaaS: provides computing platforms which typically includes operating system, programming language execution environment, database, web server etc.
  - Examples: AWS Elastic Beanstalk, Windows Azure, Google App Engine
- IaaS: provides the computing infrastructure, physical or virtual machines and other resources like virtual machine disk image library, block and file-based storage, firewalls, load balancers, IP addresses, virtual local area networks etc.
  - Examples: Amazon EC2, Windows Azure, Google Compute Engine.

# 程序代写代做 CS编程辅导

## IaaS vs PaaS



- IaaS is more powerful as resources available and customization possible

WeChat: cstutorcs

- From great power comes great responsibility

- User responsible for scaling applications (some tools like Amazon's Autoscaling can help but configuration required)
- User responsible for updating OS and machine image (happens automatically on PaaS)

QQ: 749389476

- In general PaaS less complex, many concepts are abstracted from the user

# 程序代写代做 CS编程辅导

## Example 1



- A biology lab creates 400  for every experiment and wants to move its data processing to the cloud
- Choose a service model (IaaS, PaaS, SaaS) for the lab and explain why you chose this model?

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>



程序代写代做 CS编程辅导

## Example 1



- IaaS is probably the most flexible model

- The described data processing might require complex code that may not be easily integrated into a SaaS or even a PaaS service.

WeChat: cstutorcs  
Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>





程序代写代做 CS编程辅导

## Example 2



- A web application wants its hosting to the cloud.
- Choose a service model (IaaS, PaaS, SaaS) for the lab and explain why you chose this model?

WeChat: cstutorcs  
Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

## Example 2



- SaaS is probably the most popular model

- A web application is usually a relatively simple application and the transference of the application into the SaaS cloud should be quite easy
- This reduces the labour costs associated with managing the hosting architecture

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>



# 程序代写代做 CS编程辅导

## Cloud computing



- When deciding to migrate a service to the cloud there are a number of considerations to make:

WeChat: cstutorcs

- The expected average and peak resource utilisation

Assignment Project Exam Help

- Operational costs

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

## Cloud Computing's elasticity



- The pay as you go model
- The key advantage of elasticity is that it reduces the risk of overprovisioning (underutilisation) and under provisioning (saturation)
- Most users deliberately provision for the expected peak and allow resources to remain idle at non peak times
- The more pronounced the variation the greater the waste

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Example



- A service has predictable utilization where the peak require 500 servers at noon but then requires only 100 servers at midnight  
**WeChat: cstutorcs**
- The average utilisation over a whole day is 300 servers and the actual utilization of the whole day is  $300 \times 24 = 7200$  server hours  
**Email: tutorcs@163.com**
- If we buy servers we must provision for the peak of 500 servers so we pay  $500 \times 24 = 12000$  server hours  
**QQ: 749389476**

<https://tutorcs.com>



## 程序代写代做 CS编程辅导

Your turn!



- A service has a peak demand of 500 servers/day and an average utilisation of 200 servers/day. The pay as you go cost is £0.1 per server/hour and the buying cost is £0.05 per server/hour.

Assignment Project Exam Help

- Will we save money using Cloud Computing?  
Email: [tutorcs@163.com](mailto:tutorcs@163.com)

QQ: 749389476

<https://tutorcs.com>



## 程序代写代做 CS编程辅导

Your turn!



- A service has a peak demand of 600 servers/day and an average utilisation of 200 servers/day. The pay-as-you-go cost is £0.1 per server/hour and the buying cost is £0.05 per server/hour.  
**WeChat: cstutorcs**

## Assignment Project Exam Help

- Will we save money using Cloud Computing? Yes  
**Email: tutorcs@163.com**
  - Buying utilisation =  $600 \times 24 = 14400$  server hours
  - Buying cost =  $14400 \times £0.05 = £720$  per day  
**QQ: 749389476**
  - Cloud utilisation =  $200 \times 24 = 4800$  server hours
  - Cloud cost =  $4800 \times £0.1 = £480$  per day  
**https://tutorcs.com**

## 程序代写代做 CS编程辅导

Going forward..



- Of course, buying out a server has a one-shot cost, while cloud computing is a constant cost

WeChat: cstutorcs

HOWEVER  
Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

- These examples actually underestimate the benefits of cloud computing
- In addition to diurnal patterns most nontrivial service also experience seasonal or other periodic demands which need to be incorporated into the analysis, e.g., Ebay or Amazon in December

## 程序代写代做 CS编程辅导

Not only that



- There can be unexpected sursts due to external events (news events) which need to be provisioned for when buying hardware

WeChat: cstutorcs

Assignment Project Exam Help

- It is much easier to adjust for these events with cloud computing

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

## Under provisioning Overprovisioning



- It is difficult to predict performance

WeChat: cstutorcs

- Under provisioning: rejected user generate zero revenue and may not come back due to poor service
- Overprovisioning: you spend more for what you actually need

QQ: 749389476

<https://tutorcs.com>

## 程序代写代做 CS编程辅导

### Transference of



- With cloud computing it ~~is~~ to remove of the risk of under provisioning for expected peak demand  
**WeChat: cstutorcs**
- This is known as the *transference of risk*  
**Assignment Project Exam Help**

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

## Factors to consider when migrating



- There are other factors which potentially alter the economic argument to migrate to the cloud
- These include
  - Resource Utilisation
  - Power, cooling and physical plant costs
  - Operational costs

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

## Factors to consider when migrating



- There are other factors which potentially alter the economic argument to migrate to the cloud
- These include
  - Resource Utilisation
  - Power, cooling and physical plant costs
  - Operational costs

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Resource utilization



- Applications might not make efficient use of computation, storage and network bandwidth

WeChat: cstutorcs

- Some are CPU-bound while others are network bound etc.

Assignment Project Exam Help

- It is possible that an application will saturate one resource while underutilising another

Email: tutorcs@163.com  
QQ: 749389476

- In pay as you go cloud computing, an application can be charged separately for each type of resource, thereby, reducing the waste of underutilisation

程序代写代做 CS编程辅导

## Factors to consider when migrating



- There are other factors which potentially alter the economic argument to migrate to the cloud
- These include
  - Resource Utilisation
  - Power, cooling and physical space
  - Operational costs

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

## 程序代写代做 CS编程辅导

### Power, cooling and physical plant costs



- When buying hardware and server costs such as cooling, power and a physical building to house the servers needs to be considered  
**WeChat: cstutorcs**
- Cloud computing frequently offers facilities such as data replication and backups at no additional cost  
**Assignment Project Exam Help**
- These costs would have to be added when building a data centre to ensure durability and performance improvements  
**Email: tutorcs@163.com**  
**QQ: 749389476**

<https://tutorcs.com>

程序代写代做 CS编程辅导

## Factors to consider when migrating



- There are other factors which potentially alter the economic argument to migrate to the cloud
- These include
  - Resource Utilisation
  - Power, cooling and physical plant costs
  - Operational costs

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Operational costs



- Operate a datacentre is costly
- Troubleshooting: Hardware failures? Software failures?
- Cloud Computing: making operation someone else problem!

Email: [tutorcs@163.com](mailto:tutorcs@163.com)

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Example 1



- A biology lab creates 500 data for every lab experiment. A computer of one EC2 instance takes 2 hours per GB to process the data

WeChat: cstutorcs

- The lab has the equivalent of 20 instances locally

Assignment Project Exam Help

- The time it takes to (locally) evaluate the experiment is therefore  $500 \times 2/20 = 50$  hrs

QQ: 749389476

<https://tutorcs.com>

# 程序代写代做 CS编程辅导

## Example 1



- They could process it in a ~~single hour~~ on 1000 instances at AWS. The cost to process one experiment would be  $1000 \times £0.10$  in computation and another  $500 \times £0.10$  in network transfer fees  
**WeChat: cstutorcs**

### Assignment Project Exam Help

- The network transfer rate from the lab to AWS is 20Mbit/second  
**Email: tutorcs@163.com**
- The transfer time is therefore  $(500\text{GB} \times 1000\text{MB/GB} \times 8\text{bits/Byte})/20\text{Mbits/sec}$   
 $= 4,000,000/20 = 200,000\text{ seconds} \Rightarrow \text{approx 55hrs}$   
**QQ: 749389476**
- It takes **50 hours locally** and  $55+1=56$  hours on AWS so they do not move to the cloud  
**<https://tutorcs.com>**

# 程序代写代做 CS编程辅导

Example 1: outc



- No cloud for the lab! (at  scenario)

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

## 程序代写代做 CS编程辅导



### Example 2



- A biology lab generates 1GB per experiment
- One EC2 instance takes 2 hours per GB to process the data
  - WeChat: cstutorcs
  - Assignment Project Exam Help
- They are the equivalent of 25 instances locally
  - Email: tutorcs@163.com
- The network transfer rate is 50Mbit/s
  - QQ: 749389476
- Is it quicker in the cloud or locally?
  - <https://tutorcs.com>

# 程序代写代做 CS编程辅导



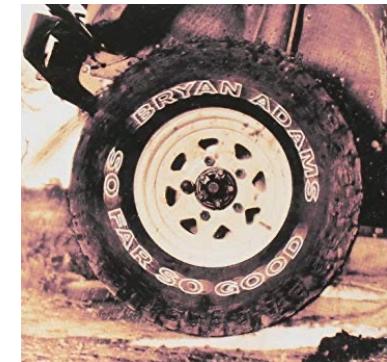
## Example 2



- Local Computation time is  $i/25 = 80 \text{ hrs}$
  - Transfer time is  $(1000\text{GB} \times 1000\text{MB}/\text{GB} \times 8\text{bits}/\text{Byte})/50\text{Mbits/sec} = 160,000 \text{ second or 45hrs}$
  - Total Cloud time is  $45+1=46 \text{ hrs}$
  - May be advisable to move to cloud (Need to consider cost, age of local hardware and other factors)
- WeChat: cstutorcs  
Assignment Project Exam Help  
Email: tutorcs@163.com  
QQ: 749389476  
<https://tutorcs.com>**

程序代写代做 CS编程辅导

So far so good



- It seems like cloud computing (most of the case) the way to go!
- Any obstacles?

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>

程序代写代做 CS编程辅导

## Obstacles

- Privacy!
- The new cash is data!
- This is why there are different deployment models



WeChat: cstutorcs

Assignment Project Exam Help  
Deployment Models

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>



# 程序代写代做 CS编程辅导



WeChat: cstutorcs  
Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

<https://tutorcs.com>