

# Tools and Techniques for Effective Distributed Requirements Engineering: An Empirical Study



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## Outline

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- Introduction
- Background
- Project Overview
- Assessing SRS Quality
- Results and Conclusions
  - SRS Quality
  - Groupware Tool Effectiveness
  - Requirements Elicitation Techniques Effectiveness



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## Introduction

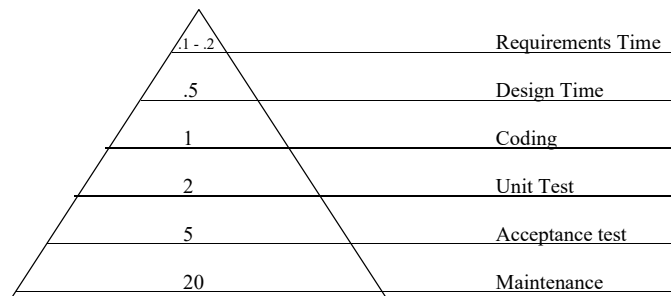
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- Requirements Analysis
  - Defining product requirements
  - Information gathered from interaction with customer or users
  - Ensures that the “right system” is built
  - Detecting and correcting errors is more economical during Requirements Analysis

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## Cost Multiplier for Software Fixes

- From [6] Leffingwell, Managing Software Requirements




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## Why Distributed Requirements Engineering?

- Client request for on-site support
- Project members can not travel or relocate
- Skilled workers not available
- Reduce travel / relocation costs
- Hardware, software resources only available at certain locations

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## Disadvantages of Distributed Software Engineering

- Coordination and versioning of work artifacts (documents, code) across multiple sites
- No unplanned meetings
- Difficulty making contact with remote team
- Difficulty knowing whom to contact from remote group
- Misunderstood priority of information requests
- Language differences
- Time zone differences

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## Groupware

- Time-Space groupware taxonomy

	Same Time	Different Time
Same Place	Face-to-face Interaction <i>Meeting Works</i>	Asynchronous Interaction <i>MOOsburg, Email</i>
Different Places	Synchronous Distributed Interaction <i>Centra Symposium, MOOsburg</i>	Asynchronous Distributed Interaction <i>MOOsburg, Email</i>

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## Research Goals

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- 1) Assess SRS document quality
  - Correlate factors that affected document quality
- 2) Determine which Groupware Tools best support (DRE) Distributed Requirements Engineering
- 3) Determine which Requirements Elicitation Techniques work best for DRE

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## DRE Groupware: GBRAT

- Goal Based Requirements Analysis Tool (GBRAT) [11]
  - Georgia Tech
- Specific to the Goal Based Requirements Analysis Method (GBRAM)
- Software goals classification and organization method
- Shared requirements repository
- Web interface
- Doesn't support elicitation

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## DRE Groupware: FLARE

- Front Loaded Accurate Requirements Engineering (FLARE)
  - US Naval postgraduate school
- Web based requirements repository
- Descriptive video clips to give context

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## DRE Groupware: WinWin

- WinWin System [9]
  - Barry Boehm, University of Southern California
- Supports the WinWin Requirements Negotiation Process
- Distributed multimedia archive of requirements negotiation artifacts organized by domain
- Supports asynchronous distributed work
- Requires augmentation with other tools
  - Email
  - Prototyping
  - Audio/Video conferencing

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## DRE Groupware: TeamWave

- TeamWave
  - University of Calgary
- Graphical room-based collaborative environment, similar to MOOSburg
- Daniela Herlea configured a collaborative Requirements Engineering space using available collaborative tools

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## DRE Empirical Study

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- CS5704 students role-play as requirements engineers
- CS5734 students role-play as customers
- GOAL: To specify a company wide scheduling system

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## Requirements Engineering Process

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- 1) Capture high-level user requirements
- 2) Requirements elicitation, and analysis
- 3) Write the software requirements specification document (SRS)
- 4) Verification and revision of specification document

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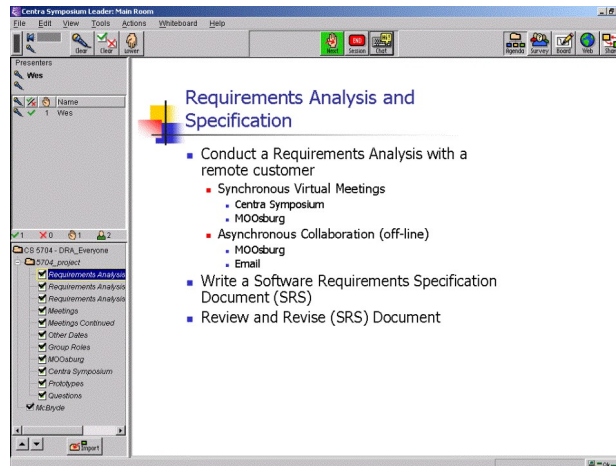
## Virtual Meetings

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- Four planned formal sessions
- Meeting 1
  - Introduction, high level requirements
- Meeting 2, 3
  - Requirements elicitation, management
- Meeting 4
  - SRS review

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# Centra Symposium



The screenshot shows the Centra Symposium Leader Main Room interface. The main content area displays a presentation slide titled "Requirements Analysis and Specification". The slide lists the following items:

- Conduct a Requirements Analysis with a remote customer
  - Synchronous Virtual Meetings
    - Centra Symposium
    - MOOsburg
  - Asynchronous Collaboration (off-line)
    - MOOsburg
    - Email
- Write a Software Requirements Specification Document (SRS)
- Review and Revise (SRS) Document

The interface also shows a "Presenters" list on the left with "Wes" listed. Below the presenters list is a navigation pane with a tree view containing items like "Requirements Analysis", "Meetings", "Meetings Continued", "Other Dates", "Group Roles", "MOOsburg", "Centra Symposium", "Prototypes", "Questions", and "Activity".

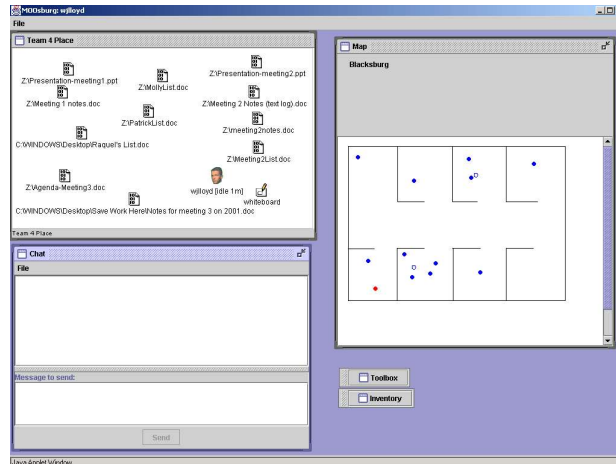
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# Centra Symposium

- 1:many audio conferencing
- Application sharing
- Shared whiteboard
- Public, private synchronous chat
- Slideshow
- Voting
- Shared web browser

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# MOOsburg



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# MOOsburg

- Room based collaborative environment
- Asynchronous and synchronous collaboration
  - Shared whiteboard
  - Text chat
  - File sharing
  - Shared list editor

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## Group List Server

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- Messages distributed to all group participants
- Asynchronous collaboration

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## Requirements Elicitation Techniques

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- Brainstorming / Idea Reduction
- Interviews
- Question and Answer
- Storyboards
- Use Cases
- Prototyping
- Questionnaires
- Requirements Management

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## Customer Roles

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- Secretary
  - Currently in charge of scheduling at the company
  - Concerned about ease of use and job security
- Engineer
  - Technical person with ideas for system features
  - Very busy with customers
- Vice President
  - Primary concern is to keep project on budget
  - Familiar with computer buzzwords, but not their meaning

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## Team Formation

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- Requirements Engineers
  - Took Software Engineering/Programming experience survey
  - Attempted to balance teams based on experience
- Customers
  - Belbin Self-Perception Inventory used to measure participant's natural role tendencies.
  - Roles assigned based on role measurement

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## Participant Instruction

- Groupware tutorial
  - Class session on use of Centra Symposium and MOOsburg
  - For requirements engineers, customers
- Requirements Engineering Tutorial
  - Class session on Requirements Engineering as applicable to the empirical study
  - For requirements engineers

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## Distributed Meeting Facilities

- Lab facilities
  - Torgersen 3060
  - Torgersen New Media Center Lab
- Networked Dell workstations with headset microphones
- Centra Symposium, and MOOsburg client on all machines

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## Data Collection

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- Note taking of observations for all virtual meetings
- Meetings recorded via Symposium client
- Surveys

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## Surveys

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- Software engineering and programming experience survey
- Requirements engineering experience survey
- Post meeting #1 survey
- Post meeting #2, #3 requirements engineer survey
- Requirements Engineer Peer participation survey
- Final online survey

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## SRS Quality Measurement

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- Overall SRS Quality is average of these four metrics
  - SRS Grade
    - Student assessment
    - Professor impression of SRS document quality
    - Assigned as a percentage
  - Document Evolution
    - Measurement of SRS maturity
    - Requirements are enumerated
    - Requirements are classified as having evolution or not.
    - Value is percentage of total requirements with evolution

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## SRS Quality Measurement - 2

- Requirements Evaluation
  - Requirements are enumerated
  - Requirements are classified based on defect type.
    - Ambiguous
    - Incomplete
    - Inconsistent
    - Not Traceable
    - Not Verifiable
  - Value is the percentage of defect-free requirements

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## SRS Quality Measurement - 3

- Original Requirements
  - Number of original requirements supported is counted.
  - Value is percentage of original requirements supported

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## SRS Quality

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- High Performance Groups

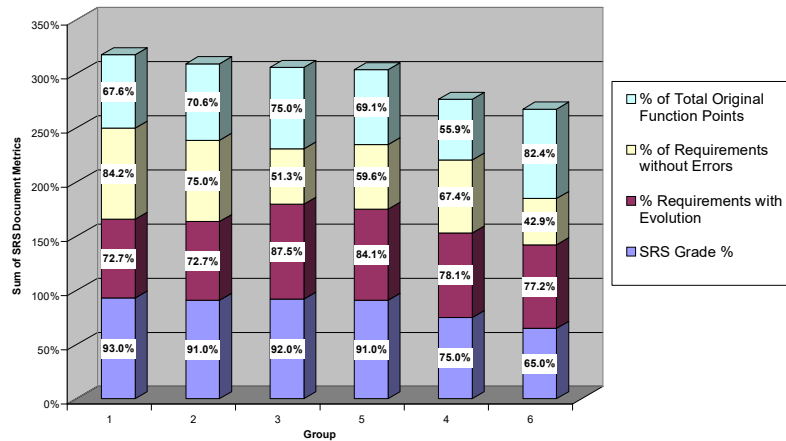
Group 1	79.34 %
Group 2	77.32 %
Group 3	76.44 %
Group 5	75.96 %

- Low Performance Groups

Group 4	69.11 %
Group 6	66.85 %

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## SRS Quality



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## SRS Quality: Results

- Groups with less software engineering experience produced higher quality SRS documents
  - $r(df=4) = -.81, p < .05$
  - Average SE experience scores for groups was lower when SRS quality was higher.
  
- Groups who reported lower effectiveness of requirements elicitation techniques produced higher quality SRS documents
  - $r(df=4) = -.74, p < .09$
  - Ineffectiveness of Prototyping and Questionnaires for groups with high SRS quality create this trend.

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## SRS Quality: Results - 2

- Groups who reported Symposium Text Chat as a more effective tool produced lower quality SRS documents.
  - $r(df=4)=-.73, p<.10$
  - Groups with lower SRS quality used text chat more frequently because of language barriers.
  - Notably Groups 2 & 4
  - *"some customers (dure to their lack of english knowledge ) didn't participate in req process as much as they had to"*

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## SRS Quality: Results - 3

- Groups who obtained more information using email tended to produce lower quality SRS documents.
  - $r(df=4)=-.64, p<.17$
  - Low performance groups did not receive enough feedback from virtual meetings and therefore relied on email for information gathering.
    - Poor planning for meetings
    - Poor administration of meetings
    - Language barriers with customer

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## Additional SRS Quality Results

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- Groups who perceived fellow group members as contributing more to the group tended to produce higher quality SRS documents. (NS)
- Groups having more experience with requirements elicitation techniques tended to produce higher quality SRS documents. (NS)

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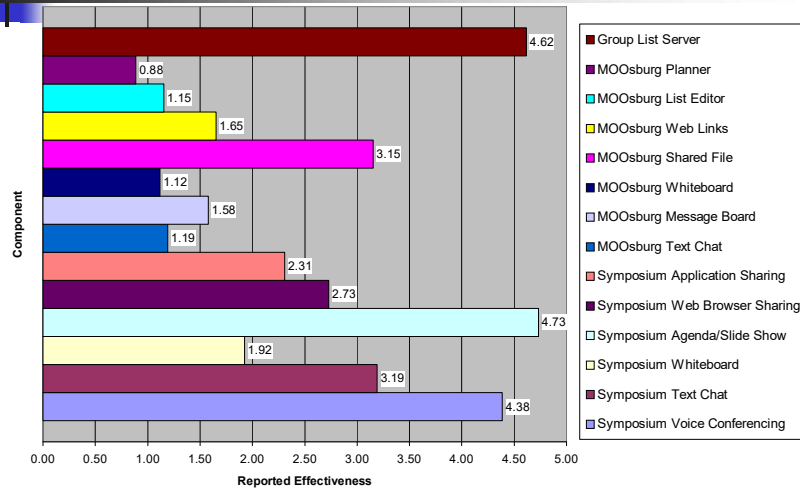
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## Groupware Tool Effectiveness



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## Groupware Tools: Results

- Usability and Configuration issues caused participants not to use MOOsburg.
  - No participants reported having meetings in MOOsburg
    - *"I wouldn't use MOOsburg..., There were too many issues with MOOsburg to list them all, but they include things such as navigatitability, awareness, chatting, file sharing, etc."*
    - *"It's interface is intimidating. I'd probably start there and delve deeper over time."*
    - *(MOOsburg issues are) "Length of time required to load. Performance over a dial-up connection."*

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## Groupware Tools: Results - 2

- Centra Symposium Whiteboard, Agenda/Slideshow, Web Browser Sharing are useful tools when customers participate actively in the meeting
  - $r(df=24) > .44, p < .025$
  - Perceived Customer Participation correlates with Centra groupware tool effectiveness
  - *"Centra allowed us to have effective meetings. We could chat, share web-browsers, view their presentations. Without a tool like these meetings would have been just about impossible."*

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## Groupware Tools: Results - 3

- Groupware tools in general are more effective when customers participate actively in virtual meetings.
  - $r(df=24) = .49, p < .025$
  - The average effectiveness of all groupware tools is greater when perceived customer participation is higher.

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## Groupware Tools: Results - 4

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- Centra Symposium is more effective when customers participate more actively in virtual meetings.
  - $r(df=24)=.39, p<.05$
  - Centra Symposium was rated as more effective at supporting requirements analysis when perceived customer participation was higher.

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## Additional Groupware Tools Results

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- Centra Symposium Text Chat may be a useful tool when customers are not active in virtual meetings. (NS)
- Asynchronous Tools (Group Email listserver, MOOsburg shared files) tended to be reported as being more effective when groups did not obtain enough information from virtual meetings. (NS)

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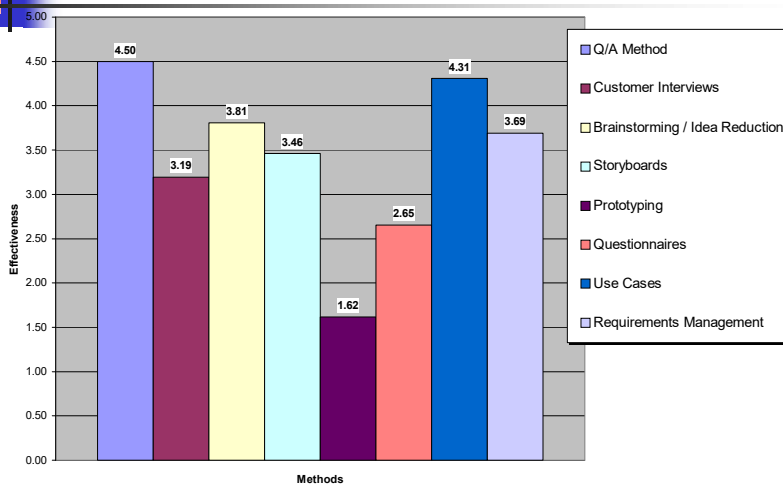


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# Requirements Elicitation Technique Effectiveness



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## Requirements Elicitation: Results

- Requirements Management is more effective when the engineer(s) applying the method have more experience with it.
  - $r(df=24)=.30, p<.03$
- Brainstorming is an effective requirements analysis technique when participants are active in virtual meetings.
  - $r(df=44)=.30, p<.05$

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## Requirements Elicitation: Results - 2

- Questionnaires tended to be more effective requirements analysis technique when customers participate actively outside of virtual meetings.
  - $r(df=24)=.30, p<.14$

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## Requirements Elicitation: Results - 3

- Requirements Elicitation techniques in general are more effective when customers participate actively in virtual meetings.
  - $r(df=24)=.42, p<.05$
  - Q/A method has the strongest correlation with perceived customer participation.
  - *"If they were more proactive and put more effort into participation we could have accurately captured what they really wanted and elicited what they hadn't thought of. Instead, they constantly said yes to our suggestions ..."*

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## Conclusions

- Customer Participation is important for Distributed Requirements Engineering
- Asynchronous Techniques tended to not provide enough information causing groups relying on these methods to produce lower quality SRS documents.
- Communication challenges led participants to using text chat and email for requirements elicitation which tended to be less effective.

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## Future Work

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- An empirical study to compare face-to-face versus distributed requirements analysis
- Empirical studies with control variables to discover more about effectiveness for distributed requirements analysis
  - Requirements Elicitation Techniques
  - Groupware tools
  - Synchronous vs. Asynchronous groupware tools
- Empirical studies with more experienced Requirements Engineers

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## Future Work - 2

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- Empirical Studies with customers having a higher stake in project success
- Build a prototype groupware system with groupware functionality identified in this study, then conduct further empirical studies
  - Video-conferencing
  - Integrated System

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## Acknowledgements

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- Committee
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## Questions

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