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Advanced Topics of Software Engineering

Module: IN2309

Date: Thursday 21st April, 2022

Examiner: Prof. Dr. Florian Matthes

Exam: Retake

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Last update:

Monday 9th May, 2022

Σ (Retake)	Grade (Retake)	Grade intervall
41.5	5.0	[0.0; 42.0)

Notes:

- Please make sure that the total amount of credits stated above is correct.

Corrections:

The table below lists all corrections (image recognition and complaints during review) that are already considered in the calculation of your grade. If a problem or subproblem is listed multiple times, the correction with the highest number (column "Correction") takes precedence.

Problem	Correction	credits	Annotations
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**Note:**

- During the attendance check a sticker containing a unique code will be put on this exam.
- This code contains a unique number that associates this exam with your registration number.
- This number is printed both next to the code and to the signature field in the attendance check list.

Advanced Topics of Software Engineering

Exam: IN2309 / Retake
Examiner: Prof. Dr. Florian Matthes

Date: Thursday 21st April, 2022
Time: 11:00 – 12:40

P 1

P 2

P 3

P 4

P 5

P 6

P 7

P 8

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Working instructions

- This exam consists of **16 pages** with a total of **8 problems**.
 Please make sure now that you received a complete copy of the exam.
- The total amount of achievable credits in this exam is 100 credits.
- Detaching pages from the exam is prohibited.
- Allowed resources:
 - one **non-programmable pocket calculator**
 - one **analog dictionary** English ↔ native language
- Subproblems marked by * can be solved without results of previous subproblems.
- **Answers are only accepted if the solution approach is documented.** Give a reason for each answer unless explicitly stated otherwise in the respective subproblem.
- Do not write with red or green colors nor use pencils.
- Physically turn off all electronic devices, put them into your bag and close the bag.

Left room from _____ to _____	/	Early submission at _____
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Exam empty

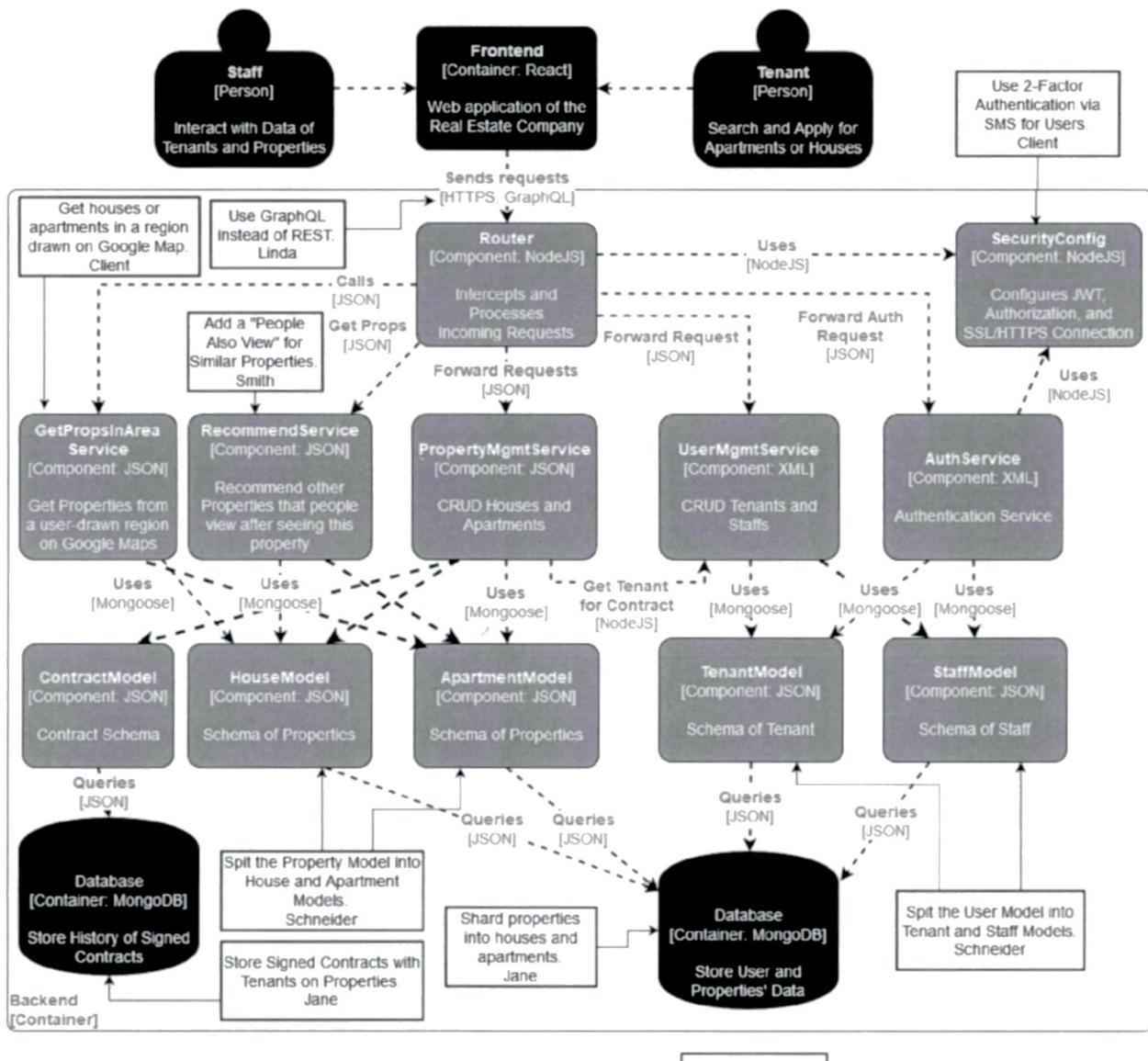




Problem 1 Anti-pattern (12 credits)

Jonas and his team is extending a web application to showcase apartments and houses of Semobilien, a small real estate company. Each month, Semobilien offers around 20 active real estates for rent and purchase in five areas: Munich city, Freising, Dachau, Eching and Ismaning. 50 percent of Semobilien's properties are in Munich City. The company requires their customers to register and login for applying to a house or apartment. Semobilien only aims to serve customers in the Munich and nearby districts, without expanding to another area.

Jonas and his teammates are designing the backend. Below is the most recent sketch of their backend architecture expressed as a C4 Component Diagram:



Comment

- 0 2.0 a) * What is the anti-pattern in the backend architecture design? Give two reasons to justify.

1	Wissens Too Overcomplicated (f.e. separate model for staff, tenant,...)
2	- uses too many Mongoose Models too many frameworks
3	- similar queries are done by many models
4	- all services use their specific model with Mongoose
5	- too many comments needed to explain model comments are there to give you the hint about the antipattern





- 0.0 b) * Propose one solution to solve the anti-pattern. Briefly justify your answer

<input type="checkbox"/>	0
<input type="checkbox"/>	1
<input type="checkbox"/>	2
<input type="checkbox"/>	3

Analyze the component and built ~~one service as one with from all services, one model from all models etc.~~ For example use interfaces and each model implements the interface or service.

- 1.0 c) * Name and briefly explain **two** of the seven deadly sins in software engineering.

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<input checked="" type="checkbox"/>	1
<input type="checkbox"/>	2

- Sloth: Invest not enough time
- Greed: try to solve everything at once

- 0.0 d) * Briefly explain what is a software quality.

<input type="checkbox"/>	0
<input type="checkbox"/>	1
<input type="checkbox"/>	2

~~Software quickly can be for example the quality of code in reading. The code is readable and understandable.~~
See extra space





Problem 2 Dependency Structure Matrix (13 credits)

You are a project manager at a software company and for your next project, you are assembling a web development team. To better understand the relationship between the developers, you asked an intern to build a Dependency Structure Matrix (DSM) of all existing web developers in the company.

After a week, she proposed the following matrix where weights indicate the number of projects in which one developer depends on the other:

	Alice	Bob	Carrie	Dennis
Alice	-		5	
Bob	1	-	1	2
Carrie	3		-	4
Dennis				-

0 1.0 a)* In how many projects does Carrie depend on other developers?

1 In 6 Projects

0 0.0 b)* Upon further examination, you realized that the DSM is not partitioned yet. Draw a partitioned version of the DSM such that it is in a block triangular form (use crosses (X) instead of exact weights to represent dependencies).

	Alice	Bob	Carrie	Dennis
Alice	-			
Bob	X	-		
Carrie	-	X	-	
Dennis		-		

0 4.0 c) After partitioning the DSM, justify whether it is in an **optimal form** (lower triangular) or not. If not, propose a way to achieve it.

1 It is not ~~the~~ optimal form, since it has the form  instead of  because Dennis & Alice both have dependency on Bob. It can be achieved by ~~partitioning~~ a block Dennis / Alice & Carrie.

0 2.0 d)* List **two** benefits of using a DSM as discussed in the lecture.

- 1 - With high number ~~of~~ dependencies, it is easy to read ~~with~~
- 2 - Easy to scale





Problem 3 Message-oriented Architectures (14 credits)

A world-famous sushi restaurant in New York City, U.S.A contacted you for getting consultancy regarding their supply chain. Currently, the restaurant is ordering fresh fish from a market in Japan, and it takes up to a day for the fish to be delivered. The restaurant utilizes the following software and hardware components to track the location of their deliveries and do menu planning:

- Sensors: Continuously transmits data about the location of the deliveries
- Track-App: Provides a web interface for restaurant managers to track the location of the deliveries
- Whats-on-the-Menu-App: Provides available product information based on the location of the deliveries (e.g. "Tuna sushi will be on the menu if the deliveries pass the Pacific Ocean by 10 AM"). Updates app users daily with the new menu

- 0.5 a) * Your first task is to identify which message queue pattern should be used between which components and entities (e.g. app users). Justify your decisions.

Since the sensors are sending the data continuously, the product information can always access their corresponding delivery location. So it makes sense to provide information for app users only when requested, since at every possible request point the information can be retrieved (track app). ~~The whats-on-the-menu app~~ can use publish pattern so early or on specific time ~~the sensors~~ the track-app publishes the availability of each delivery. ~~To who?~~

- 0.0 b) * After your initial inspection, you realized that a traditional message-oriented middleware is used between the components. You know that with the current setup, communication between each component is handled separately and each publisher needs its own configuration. Propose a solution that would create a hub and spoke communication infrastructure for integrating the components (just the name is sufficient) and briefly explain **two** challenges of it.

- Challenge 1: It has to be ensured that only ~~one~~ component speaks at a time
- Challenge 2: It has to be ensured that all ~~components are listening~~ when one component speaks

- 4.0 c) * Briefly explain **two** motivations for using messaging.

- New components can be added easily and included in messaging system
→ easy scaling.
- Common message type ensures that all ~~components~~ can communicate with each other without using another specific format → even very different components can communicate without knowing how other component is implemented.
→ more secure.





Problem 4 Security (12 credits)

CriticalEater is an online delivery application exclusively for high-end restaurants. The application provides an interface for users to order food from available restaurants and pay instantly through the payment service. The application also has a forum section where users can write their reviews about restaurants.

Recently, users started complaining about getting blackmailed by people who claim to have their credit card information. You have been hired by the company as a security consultant to analyze this issue and explore any vulnerabilities in the codebase.

After inspecting the codebase, you discovered the following issues:

- No input sanitization is done on the reviews entered into the forum section
 - Upon login, user credentials (including the credit card data) are stored in a **non-Http-Only cookie** on the client-side

0 0.0 a) Name the attack (and its type) which can be used to send the credentials of every user that visits the forum section, to a malicious server. Briefly explain how the attack can be executed.

~~SQL-tracejchan~~: use f.e. post operation to send specific information.
f.e. ~~Customer~~ have account and then the corresponding statement
is retrieved (f.e. credit card number) \Rightarrow see extra space

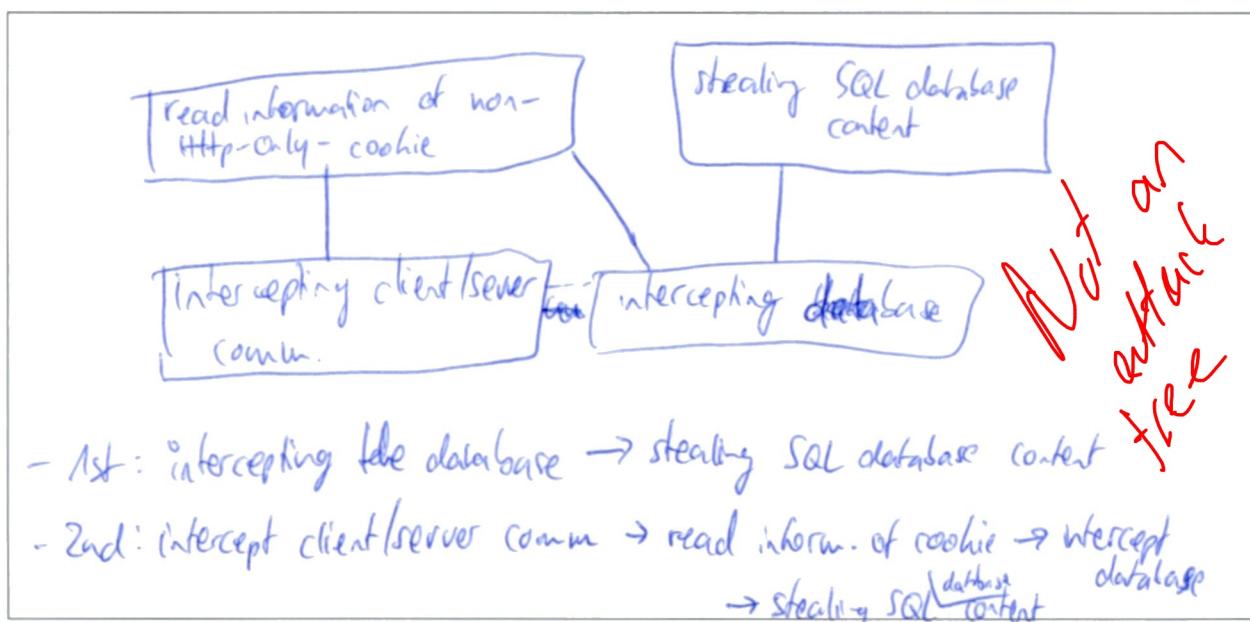
0  1.0 b) Briefly explain how this attack can be prevented to some extent and why it is not trivial to prevent it completely.

~~Ensuring that a correct header with meta-information has to be sent with the DDoS attack because even with the correct meta-information, the operation could still be an attack.~~

0 c) Besides the attack you have discovered initially, you also found the following ways to steal the credit card information of users:

- By intercepting the client/server communication
 - By stealing the SQL database content

You know that any of these three options (including the attack you have discovered initially) are sufficient enough to steal users' credit card information. Draw an attack tree including all these attacks and find **two** ways to steal the SQL database content (show them in the attack tree as well).





Problem 5 Blockchain (14 credits)

- 2.5 a) Blockchain is one of the most hyped technologies these days, and one of the reasons for that is the advantages it provides over centralized platforms. It is known that centralized platforms can suffer from *availability*. Briefly explain how blockchain-based architectures overcome this problem. Also, list **two** more drawbacks of centralized platforms as described in the lecture.

	0
	1
	2
	3
	4

- Drawback 1: Vulnerable to attacks X

- Drawback 2: Hard to ~~scale~~ scale X

More than one platform contains the data and technology so there is redundancy and ~~duplication~~ But it ensures that it is available even if one platform is not available.

- 1.5 b) * Proof-of-Work (PoW) is the protocol that has been utilized by some of the popular blockchains such as Bitcoin and Ethereum (1.0) for determining the next block creator. Explain how PoW makes it impractical for an attacker to successfully operate a 51% attack.

	0
	1
	2
	3
	4

A ~~problem~~ pride has to be solved and the corresponding solution has to be sent. So the problem has to be known and then the correct solution should be sent.

- 2.0 c)* Smart contracts cannot directly access external data available outside the blockchain (e.g., weather data, exchange rates). Name the characteristic property of smart contracts that ensures this and briefly explain why it is needed. Also, name the entity that allows smart contracts to access external data.

	0
	1
	2
	3
	4

A certain sensor is needed to access external data. Oracle
Smart contracts are open-closed (open to ~~changes~~ changes, closed to modifications) and it ensures that no external attack can manipulate the contract. That makes smart contracts secure.

- 2.0 d)* Decentralized platforms such as blockchains are not the most fitting architecture for every use case. List **two** advantages of centralized platforms over decentralized platforms as described in the lecture.

	0
	1
	2

- Less duplications & redundancy

- Easy to maintain





Problem 6 SCRUM (13 credits)

Steven and his team is developing a web application for ordering online fruits and vegetables for a grocery store. Currently, the shop owner requires the system to elegantly display the information of the shop and its goods, enable pick-and-go ordering of food in the store with credit or debit card payment, and the website is displayed in German or English.

However, in the future, the system can have other features that the owner have not decided yet, such as purchasing coupon, shop-to-home delivery, supporting various payment methods, or reserving seasonal food items.

Steven's team consists of five members: one UI Design expert, an experienced full stack developer, and three newly graduated Master's students who do not have remarkable practical experience in full-stack software development.

- 0 4.0 a) * Steven's team plans to use SCRUM for developing the web application. Is SCRUM applicable to the current scenario? Briefly explain **two** reasons to support your answer.



Yes it is applicable :

- The short iterations and therefore fast feedback helps ~~the~~ the unexperienced developers to find problems ~~at~~ fast and get fast feedback if they are developing in the correct direction. ✓✓✓

~~with no clear dead~~

- ~~With young developers it is hard to say if hard deadlines can be met.~~
~~Scrum does not need hard deadlines.~~

* Briefly state **two** activities in each of the following SCRUM events:

- 0 1.5 b) Sprint Planning



~~discuss & plan~~

- ~~Decide what has to be done in ~~duration~~ the sprint~~ ~~Split tasks~~ ✓

~~discuss & plan~~

- ~~Decide who is responsible for certain tasks~~ ~~Split tasks~~

refine?

- 0 2.0 c) Daily Scrum



- review what was done and what is still to be done ✓

- review problems and discuss how to overcome them ✓





1.5 d) Sprint Retrospective



- review the whole sprint and discuss problems ✓ and what went well
- discuss how to improve the whole sprint ✓





Problem 7 Microservice and Database (14 credits)

0 4.5 a) * Briefly explain **four** challenges of microservice development.

1 Since microservices is highly distributed, there may be redundancy and ~~duplicate code~~ (since 2 microservices may be implemented similarly) ✓
 2 ~~there~~ - shared library can help
 3 it can be hard to maintain and it is challenging to analyze dependencies ✗
 4
 5
 6

7 It is challenging to check what can be split in several microservices and what individual problem each service solves ✓
 8 One idea
 9 2 answers

10 - each microservice should ~~not~~ be able to run independently, so there may be ~~duplicate code~~ to achieve this and it has to be analyzed how to achieve this which can be difficult

0 0.0 b) * Which problem is solved by the Service Discovery pattern?

1 It solves the problem of calling the right microservice for a specific task.
 2 → API Gateway

0 0.0 c) * Briefly explain what is a server-side service discovery and what is a client-side service discovery?

1 - Service side: Regularly check which microservices are responding and running, check if they run correctly by calling the corresponding microservice ✗
 2
 3

4 - Client side: Calling the microservice needed for a specific ~~task~~ task the client needs ✗ how?
 5 This sounds like API Gateway, which is different





0.5 d) * Briefly describe **two** properties of document-oriented databases.

<input type="checkbox"/>	0
<input checked="" type="checkbox"/>	1
<input type="checkbox"/>	2

- Intuitive to access and read : documents are easier to read than large tables
- Easy to scale: easy to delete/add document

0.0 e) * Given the following students Table:

<input checked="" type="checkbox"/>	0
<input type="checkbox"/>	1
<input type="checkbox"/>	2

ID	name	study_program	grade
1	Alice	Computer Science	1.7
2	John	Bioinformatics	1.7
3	Stein	Computer Science	3.0
4	Mary	Medicine	1.3

Transform the following query into Map-Reduce:

```
SELECT study_program, COUNT(*) FROM students GROUP_BY study_program
```

Note: Use function **size(array)** to get the number of elements in an array object.

<input type="checkbox"/>	0
<input checked="" type="checkbox"/>	1
<input type="checkbox"/>	2

map study program
reduce (size (FROM students GROUP_BY study-program)))





Problem 8 Quiz (8 credits)

0 4.0
Evaluate the following statements (correct answers + 1 point, incorrect answers -1 point, you cannot get less than 0 points for this exercise):
1
2
3
4
5
6
7
8

	Statement	True	False
1	The state modified by transactions is not stored on the blockchain.	X	
2	Safety ensures the protection of the system from external hazards.	X	
3	Software should aim to achieve content coupling, not data coupling.	X	
4	The non-repudiation security property ensures that it is impossible for a user to inappropriately deny a transaction or having sent a message.	X	
5	A high domain range ratio leads to a good testability.		X
6	Task parallelism focuses on distributing tasks across multiple cores.	X	
7	To develop a robust system, Autonomous Vehicles Architecture includes redundant functions and systems.	-	X
8	In Function as a Service, the consumer has to allocate resources for handling triggered events.	X	-





Additional space for solutions—clearly mark the (sub)problem your answers are related to and strike out invalid solutions.

Problem 4

- a) Retrieve the username from the forum and use this information to get the corresponding credit card info in the cookie by using non-HTTP attacks.

Problem 4

- b) The cookie has to be more secure: f.e. delete the cookies after certain time, use HTTP-only cookie to make sure the cookies cannot be accessed from non-HTTP requests ✓ Still, the cookies are stored and therefore, with HTTP-requests the information can be ~~not~~ accessed.

Problem 1

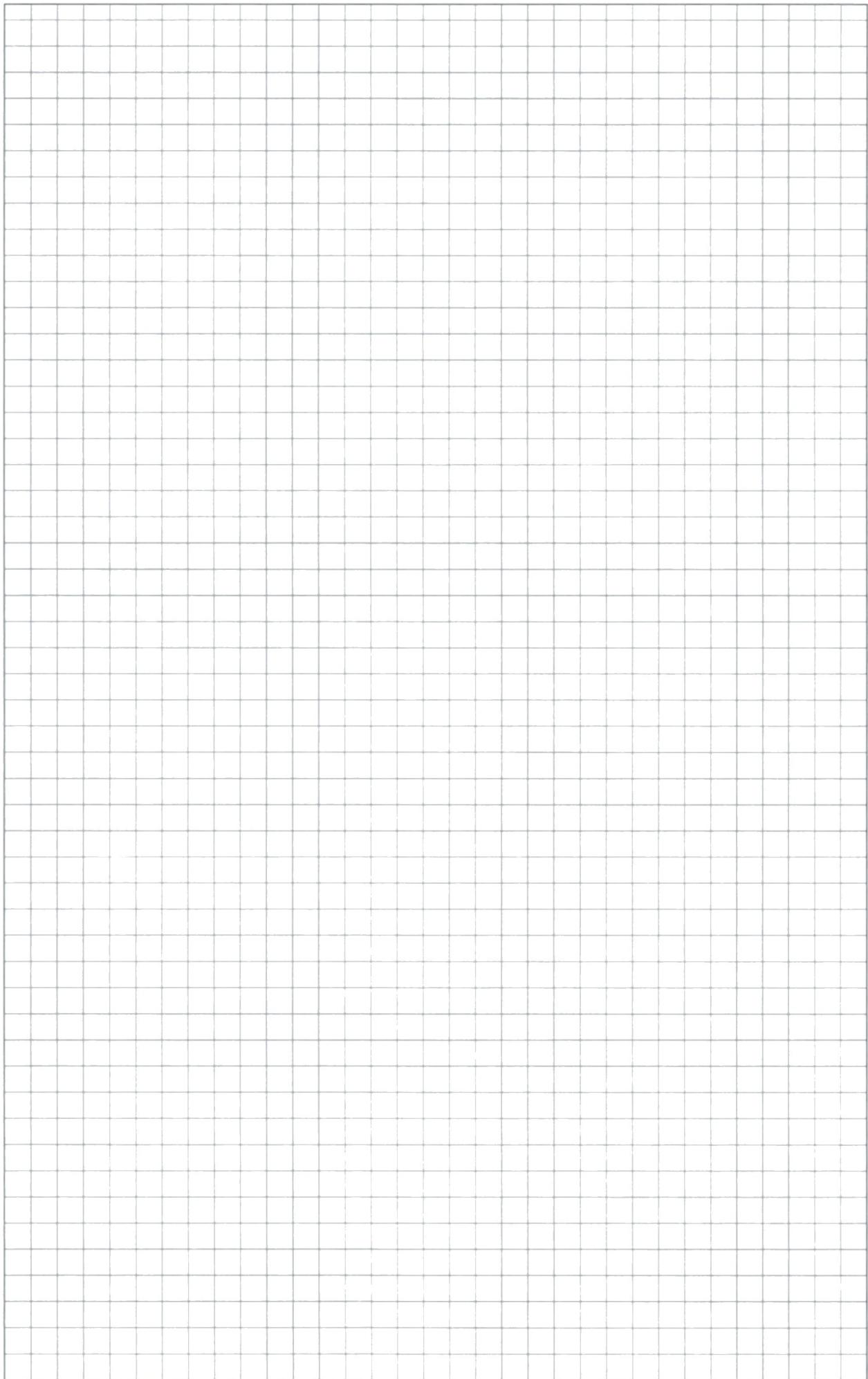
- c) Software quality aims to produce software that has an easy to read, change, maintain, well-documented and easy to scale code. implementation. Further, it aims to solve a problem fast, efficient and correct.

→ more generic





For personal review only

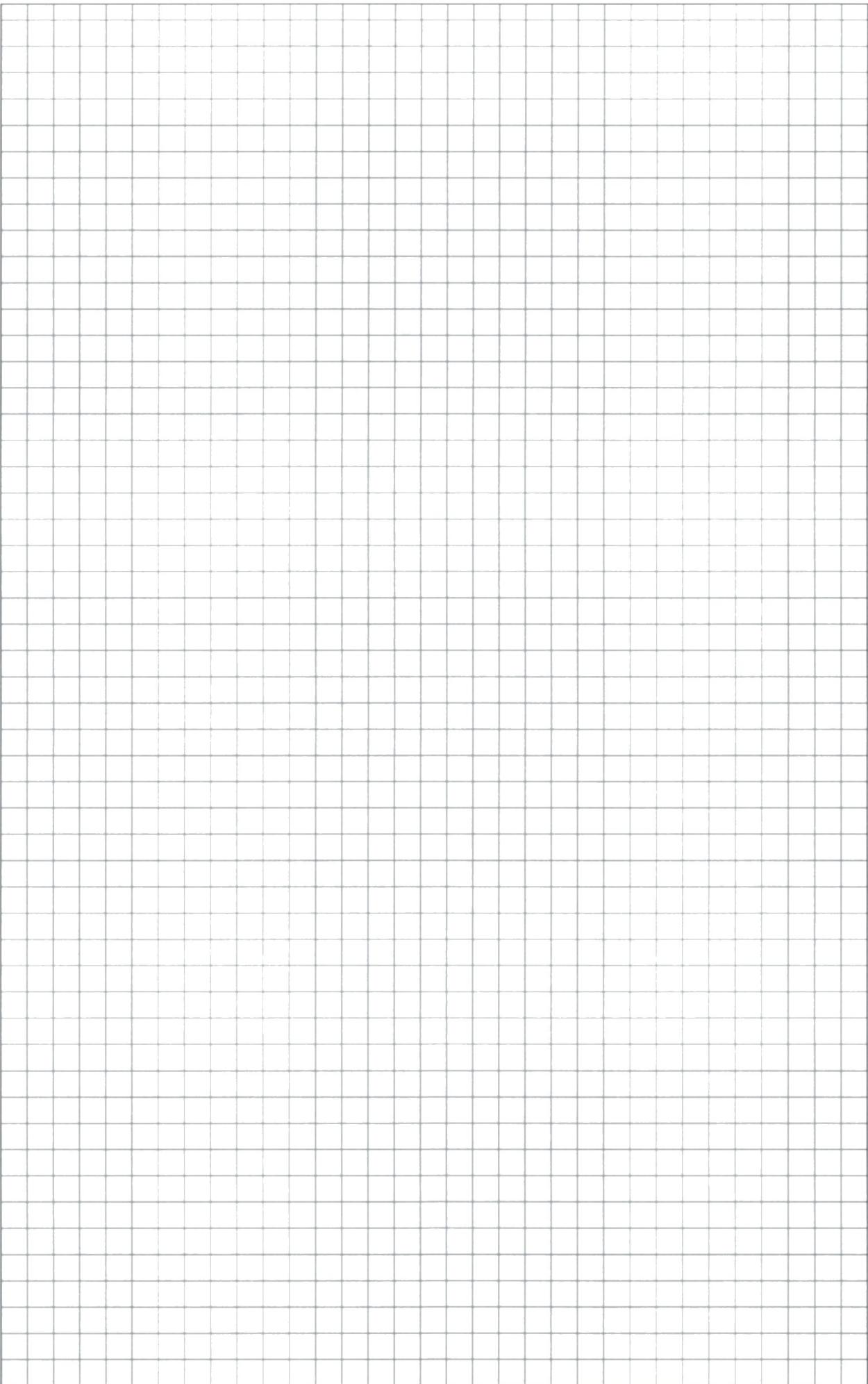


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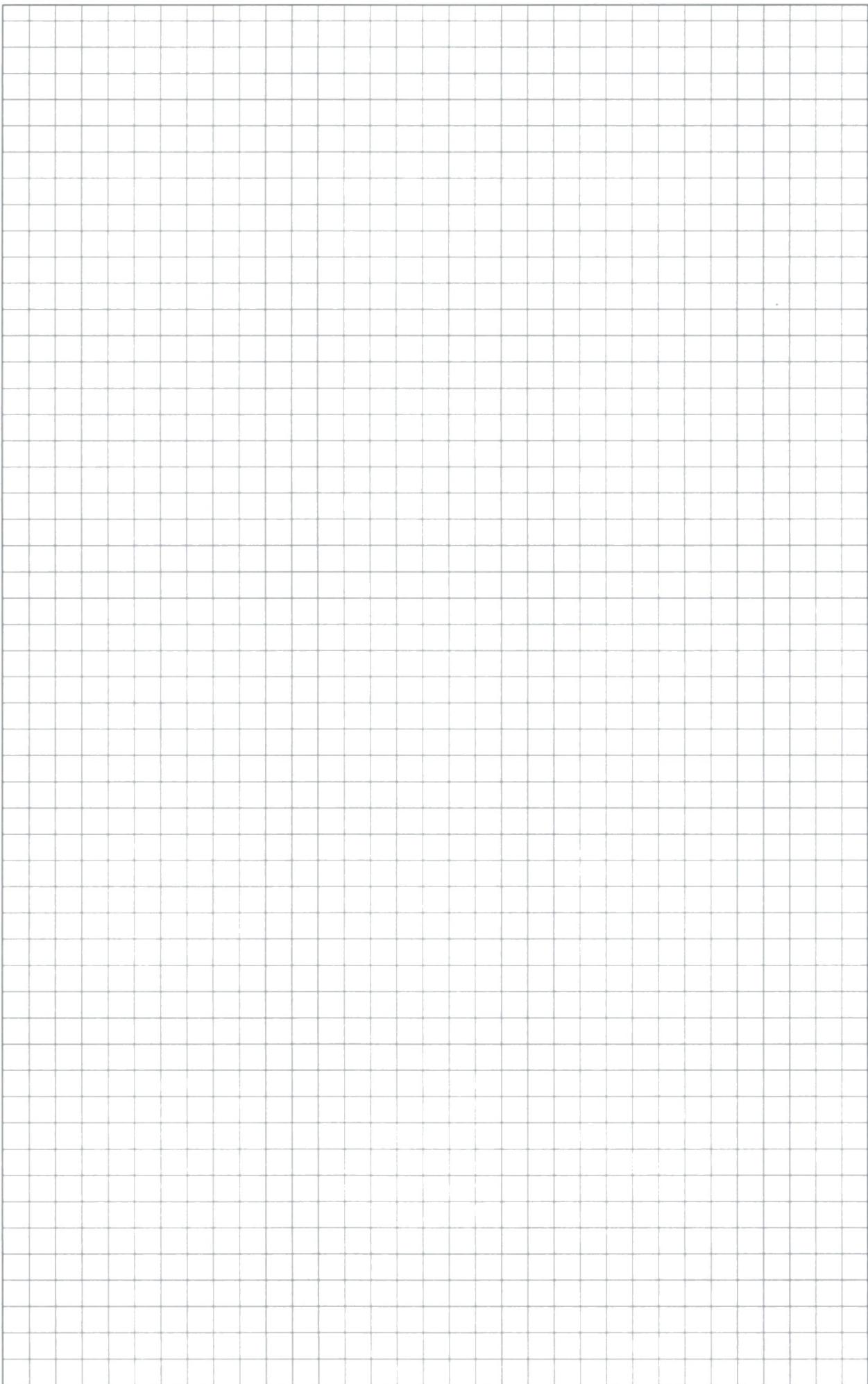


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