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COMP-3150 Assignment 1

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“I, Keerthana Madhavan 104995097, confirm that I have not received any unauthorized assis- tance in completing this assignment. I acknowledge that a mark of zero may be assigned for copied work.”

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Questions

Q1: Explain how the knowledge and skills learned in the courses listed below are related to our course Introduction to Software Engineering (COMP-3110): (12 points)

COMP-3150 Database Management Systems.

Database Management System is a software package designed to define, manipulate, retrieve and manage data in databases that usually has a structures data format, record structure and file structure.

The development of huge software systems is complex process involving “a variety of individual tasks, collaborative work, and lifecycle management of the resulting products and product parts”.[1] Due to the sophisticated material in software engineering it needs DBMS to stay highly-structured and goal-oriented. So, the use of Database technology is needed for software engineering and DBMS has provided a wealth of concepts, methods systems and tools to solve the “structure” problem in Software Engineering.

Databases technology and software engineering are related in many numbers of ways such as:

1. Construction of Software engineering must provide database functionality to develop database applications or software.
2. Database technology may support through appropriate services in the software development process.

COMP-2120 Object-Oriented Programming Using Java.

Object oriented programming is an evolutionary kind of development in software engineering. Software Engineering led to the existence of object-oriented

[1] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.5.7451&rep=rep1&type=pdf

languages with features like closed procedures, modules and abstract data types, information hiding, encapsulation, enforcement of interface and layering.[2]

Also Object-Oriented Programming relate to three of software engineering goals: reusability, extensibility, and flexibility.

COMP-2540 Data Structures and Algorithms.

Data structures and Algorithms is prominent when you want to develop software applications because we can solve complex problems with it. A data structure is a specialized format for storing data.[3] The essential for managing large amounts of data in complex software systems. The well-known data structures are classes, set, hash table or graph.

COMP-3300 Operating Systems Fundamentals.

An operating system is a collection of software that manages computer hardware and provides services for programs. Understanding how operating system work is a fundamental and critical to every software developer. When you want to develop your own OS or software; knowledge of multiprogramming operating systems, CPU scheduling, concurrent process, process synchronization and inter process communication, memory management and file systems is important. [4]

[2] http://people.cs.vt.edu/~kafura/cs2704/oop.swe.html

[3] https://dl.acm.org/citation.cfm?id=2031599

[4] http://angom.myweb.cs.uwindsor.ca/teaching/cs330/330Outline.pdf

Q2: What are the best software engineering techniques and methods? (10 points)

Software engineering became popular in the late 1960s as a new engineering discipline which covered all concepts of software production rather than the traditional program and source code for a software product. The notion of software engineering was first mentioned in 1968 in a conference called the software crisis. Since the software crisis more software engineering techniques and methods were developed, such as “structured programming, information hiding, and object-oriented development”.[5] Software Engineering focuses on concepts, principles, techniques and tools that is used by software engineers to develop high quality professional software. Software Engineering techniques and methods is what constitutes in developing an efficient end product. Before the existence of “software engineering” computer programmers relied on programming languages to develop products that is not quite efficient to be evolved over time or did not scale up to function for large and complex software systems. The best part of software engineering is that there is no single method or techniques to develop a software but multiple evolving methods and techniques over time to make your project successful. [6]

Software Engineering Techniques

The most used techniques used to reduce problem complexity in software is abstraction and decomposition.

Abstraction

One would use abstraction to reduce the complexity of the problem by discarding the irrelevant details of the problem and focusing on a certain aspect of the problem to be solved. After that “certain” problem is solved you would move on to the omitted aspects of the problem, traverse to the lower abstraction level(s) until the entire problem is solved.

Decomposition

In this approach you divide a complex problem into multiple smaller problems and then further divide into smaller problems and then solve it one by one, similarities to divide-and-conquer method. However, the trickiest part of this technique is that each

[5] https://lvivity.com/software-development-methodologies

[6] Summarization from “Software Engineering” 10e by Ian Sommerville

decomposed (divided) problem must be completely solved and the solution of different sub-problems should be combined to get a full solution. The worst case for decomposition technique is that each divided sub-problem must be independent of each other.

These are the most used techniques when a software team tries to decode and solve a major problem. However, different techniques such as the object-oriented programming and analysis, and the software process (requirement analysis, design, implementation, testing, and evolution).

Software Engineering Methods

There exist numerous methods for software development and best methods include: the waterfall model, incremental development, prototyping, Spiral Model, Scrum, and agile development.[7] Some the important methods are described in brief as follows[8]:

Waterfall Model

Waterfall model is the most obvious way to develop software. It was first published in 1970 to be used in military systems engineering. In this model there exist separate identified phases: requirements analysis and definition, system and software design, implementation and unit testing, integration and system testing, and operation and maintenance. Waterfall model is a plan-driven process; all the plans, schedules, timelines, requirement, specification, and the process must be predefined before the system development phase (cascading from one phase to another like a waterfall.

Incremental Development

Incremental Development is based on the idea of first developing an initial implementation and then use the feedback/analysis approach from users and evolve the software to its final product. Incremental model is one of the most common used approach for software development.

[7] Retrieved from the Dr. Roohollah Etemadi’s Slides

[8] https://acodez.in/12-best-software-development-methodologies-pros-cons/

Prototyping

Prototyping is the most used method by most students and business individuals. Prototype is a dummy version of a software system that is used to “demonstrate concepts, try out design options, and find out more about the problem and its possible solutions”.

Conclusion

There are numerous software engineering methods that software engineers use to develop feasible and acceptable software products. With software projects different techniques can be used for different types of systems. For example, an entertainment application can be developed using any type of models or approach like prototype whereas a security system application must go through strict specification and requirements for it to be developed like waterfall model.

Q3: What differences has the Internet made to software engineering? (10 points)

“The internet transformed the software industry”, the development of the internet and World Wide Web has had a profound effect in everyone’s live. With fractions of seconds you can access various information on the web without the need to surf through encyclopedia. “The web has led to the availability of software services and the possibility of developing high distributed service-based systems”, Web Based development is rising, and it has important advances in Business, programming languages (scripting) and software reuse.[9]

After the internet revolution in 2000, web-based systems and web browsers began evolving. These developments led to an evolution in business and organizational software and made it cheaper to create software products, since the software would be deployed to the web server instead of each individual pc. Also, the development of desktop software is dead, “to understand the reason for the gradual desktop decline, it’s worth examining the popularity of web-based applications”.[10]

The abrupt changes in web has also led to a dramatic change in businesses and the way they were organized. Before the web, businesses were “monolithic” meaning that only single programs were running on a single computer or pc, but now it’s a network of

[9] Pg 27 of Software Enginnering 10e, Ian Somerville

[10] https://productcoalition.com/is-developing-for-desktop-dead-f8d7ba9fd180

mass communications because software is distributed across the world and so it has effective communications.

Not only the software organization had a lasting effect on business but also affected software engineering principles for web-based systems. For example, software reuse, incremental development, service-oriented software engineering, and interface development technology.

Software Engineering apply to the internet and Web-based applications or software products because the fundamentals of the software processes are applied. In present time, "Web based applications are getting larger and larger, and so does the software engineering techniques are getting evolved". [11]

In conclusion, the internet is constantly changing as "new types of technology and applications advance" there is more need of new tools and software techniques to adapt to the constant changes. It is the sole purpose of software engineering, to adapt to changes by evolving its product requirement and specifications over time.

Q4: Explain why the waterfall model is not the right process model in situations where software requirements change quickly? (10 points)

The waterfall model was introduced by Dr. Winston W. Royce in a research paper in 1970 as a software development process. The waterfall model follows a series of logical and distinct steps that is taken throughout the software development life cycle (SDLC), the cascade from one phase to another. Waterfall methodology is the common design process in the industry, and it has vast advantages such as "structure organization, early design changes, simple and easy to use, easy to manage, and works well with understood requirements", but it also comes with a lot of disadvantages. Although waterfall is respected widely, now it is facing criticism for being an outdated model.[12]

The waterfall model is not the right process model in situations where informal team communication is possible and software requirements change quickly.[13] It assumes that no development error is done by the software engineers during the software life cycle. Some disadvantages include:

[11] https://link.springer.com/content/pdf/10.1007%2Fs13174-011-0019-x.pdf

[12] https://www.lucidchart.com/blog/pros-and-cons-of-waterfall-methodology

[13] Summarized and paraphrased from the book

1. You cannot move on to the next phase without completing the previous one. So, it is highly expensive to use waterfall model unless it is used for critical systems engineering.
2. difficult to respond to changes
3. Only appropriate when the requirements are well-understood
4. There is very little focus on the end user, customers or clients associated with the project (lucid chart)
5. One major flaw is that testing is not done until the end
6. For users it is more expensive to maintain, difficult to use. For employees it requires in-depth research for user needs and requirements, difficult to customize and requires more training for employees. (lucid Chart)
7. Mostly used for big projects or Large systems
8. Only few business systems have stable requirements and others are iterative or agile based.

One of the best benefits of Waterfall approach is that, if you team is small and you have a predictable project, then waterfall will be the ideal framework for keeping your team organized and on track.

Q5: Suggest the most appropriate generic software process model that might be used as a basis for managing the development of the following systems. Explain your answer according to the type of system being developed: (12 points)

a. A system to control traffic lights.

   This is a like developing a safety system, so it requires a lot of up-front analysis before even implementing. It needs a plan-driven approach for development with all the requirements carefully analyzed.

   Since all the requirements and specifications must be taken care of before the development process. A waterfall model for this system would be more appropriate to use.

b. The customer accounting system in a bank.

   This is a system whose requirements are easy to determine and well-known amongst users and developers. The requirements of this system can be predicted in advance because of existing accounting systems and be evolved to meet the requirements. This is also an important system like the safety systems, and the requirements are stable and reusable. So, the waterfall model or a reusable model will be a better approach.

c. A new video games.

This is a system where requirements will change often and there will be more updates for customers or users. So, incremental development model would be the best approach for this project. The requirements of the system will change and cannot be predicted before the implementation usually because of user reviews and post-analysis the product.

d. A navigational system for a spacecraft

A prototype model and a bit of incremental model approach would benefit this system. In this case the customer (the space agency) defines a set of general objectives for software, so an early version of the navigation system would be created to test the success rate of the project. The prototype in this case would be like a "throw-away" type because all is needed is to validate the system requirements. One cannot take prototype version for directions to go to space.

Q6: Explain what is a software product line? (12 points)

Software Product line Engineering is also a field or study that can be traced back to the mid 1970s (same time around when waterfall was introduced).[14]

Software product line is a set of application programs that are built from a common set of software modules. A software product line (SPL) is a formal procedure for designing the modules based on predicting on how they can be "reused" to solve a variety of problems.[15] In other words it is a family of related application programs. Software Product line have high resemblance to the software life cycle development, since it follows similar software process.

[14] https://en.wikipedia.org/wiki/Software_product_line

[15] https://www.pcmag.com/encyclopedia/term/62411/software-product-line

The idea of product line was used by manufacturers way back, similar products include using common factory that assembles and configures parts designed to be reused across the product line. [16]

The software product line from previous effort is predictive rather than opportunistic software reuse. Only when “reuse” is predicted in one or more products, then the software product line approach is used. So, software product line engineering relies on fundamentals distinction of development for reuse and development with reuse.[17]

So, Software Product Line is a set of software systems that contain the following features:

1. Common, managed set of features
2. Particular market segment or mission
3. And common set of core assets
4. Variability management – individual systems are considered as variations of a common theme.
5. Business and architecture centric
6. Two-life-cycle approach, where individual systems are developed based on a software platform and have their individual lifecycles as well.

Some benefits include high productivity and quality, less cost, low labor need and flexibility to move into new markets.

So basically, software product lines emphasize the concept of strategic, planned reuse. The product line concept is more about new technology and it is the new way of doing software business.[18]

[16] https://en.wikipedia.org/wiki/Software_product_line

[17] https://pdfs.semanticscholar.org/5386/b52254bb70c18d75a8d1159daf2983a496fe.pdf

[18] https://www.slideshare.net/pagsousa/software-product-lines

Q7: List ScrumMaster services to the product owner, the development team, and the organization in the Scrum framework? (12 points)

Scrum is an agile process framework for developing, delivering, and sustaining complex products. A scrum is a framework within which people can address complex adaptive problems, while being productive and creatively delivering products of the "highest possible value". [19] Scrum is lightweight, iterative, and incremental framework for managing complex work. It is also a people centric framework for managing work based on a set of values, principles, and practices along with the scrum practices. The scrum framework consists of Scrum Teams and their associated roles, events, artifacts, and rules.[20]

ScrumMaster Services to the product owner

The product owner is responsible for maximizing the value of the product with the work done by the development team. (what will be developed in what order) As a product owner he/she must be the

1. Central point of leadership
2. Decide which and when features and functions are to be build
3. Give a clear vision of what the Scrum team is trying to achieve and be responsible for the overall success of the solution
4. Actively collaborates with the Scrum master and the development team
5. Finding techniques for effective product backlog management [21]
6. Most importantly the project owner has a vision of what he/she wants tto create, "the vision is broken down in an activity called Grooming into a set of features that are collected into a. prioritized list called a product backlog".

Scrum Master Services to the development team

The development team consists of professionals who do the work of delivering a incremental "done" product at the end of each sprint. "A 'done' increment is required at

[19] https://www.scrumguides.org/scrum-guide.html

[20] https://en.wikipedia.org/wiki/Scrum_(software_development)

[21] https://www.scrum.org/resources/blog/scrum-master-role-what-expect

the Sprint Review and only the members of the team create the increment". So, the development team is a diverse, cross-functional mixture of people who are responsible for designing, building, and testing the desired product (5 to 9 members per team).

Some characteristics of the development team include:

1. They must be self-organizing (should not let the scrum master involve)
2. There is no title for the team members, regardless of the work being performed by the person.
3. Individual development team may have specialized skills and areas of focus, but credit goes to the entire team.

Scrum Master Services to the Organization

The scrum master serves the organization in multiple ways:

1. The scrum master creates and maintains the interface between scrum teams and non-scrum teams
2. Provide training components to executives by teaching them business and product development areas and create a safe environment for their scrum environment.
3. Leading and coaching the organization in scrum adoption, and productivity of the scrum organization.

Q8: Describe the following terms in the Scrum framework: (12 points)

Sprint

Scrum sprint is like a time-box (one month or less) which specific work has to be completed and made ready for review; each sprint consists of: sprint planning, sprint backlog, sprint execution, daily scrum, sprint execution, sprint review, and sprint retrospective.

A new sprint starts immediately after the conclusion of the previous sprint and during the sprint:

- No changes are made to the sprint goal that would affect it
- Quality goals do not increase
- The scope of the project can be negotiated between the Product owner and development team.

Each sprint has a goal of," What is to be built, a design and flexible plan that will guide building it, the work, and the resultant product increment".[22]

Product backlog

"A product backlog is never complete"

The product backlog is an ordered list of everything that is known to be needed in the product.[23] It is like the single source of requirements for any changes to be made to the product. The Product Owner is responsible for the "Product Backlog" process in the Scrum Framework, so with input from the rest of the Scrum team and stakeholders, they are responsible for determining and managing the sequence of work in Product Backlog. The scrum product owner then uses the Scrum Product Backlog during the Sprint planning meeting to discuss the top "decisions or entries" to the team.

There is a list of simple to-do list that each Scrum Product Backlog must pertain to that includes: maintain the ToDo List, entries are prioritized and ordered, entries are estimated, and make sure the scrum product backlog is living document.

So, in the ToDo list, high value items appear at the top of the product backlog and the lower-value items are aligned in the bottom and also factors such as value, cost, knowledge, and risk are used to rank the features. (from slides)

Sprint backlog

The Sprint Backlog is a set of Product Backlog items selected for the sprint, plus a plan for delivering the product increment and keeping up with the goals.[24] The Sprint Backlog is taken care of the Development Team about the what features or functionality will be present in the next increment and the work needed for the "done" increment.

[22] https://www.scrumguides.org/scrum-guide.html#events-sprint

[23] https://www.scrum.org/resources/what-is-a-product-backlog

[24] https://www.scrum.org/resources/what-is-a-sprint-backlog

A sprint backlog is a living “artifact” and is updated on a daily basis. The development team provides an estimate of the effort needed or required to complete each task (from notes).

Daily Scrum

The daily scrum is a 15-minute time-boxed event for the development team to synchronize activities and create a plan for the next 24 hours (scrum.org) This initiative optimizes team collaboration and performance by inspecting the work since the last scrum and upcoming sprint. The different part is that the daily scrum is held at the same time (15 min) and place each day to reduce complexity.

Daily Scrum starts off with three questions as follows:

1. What did I approach since the last daily scrum?
2. What do I plan to work on by the next daily scrum?
3. What are the obstacles or impediments that are preventing me from making progress?

The whole notion of the Daily scrum is that “only the pigs should talk; the chickens, if any should attend as observers”, because daily scrum is not a problem-solving activity.

Q9: Explain when an Agile method such as Scrum framework is not useful for developing a soft- ware system? (10 points)

Like every other professional software development process, agile development also requires to be managed for time and resources available to the team. So, solve this problem, the scrum agile framework was developed by software professionals for organizing agile projects and, to provide insights on the overall project timeline.

Scrum was developed for project organization, and it does not mandate the use of specific Software processes. Scrum was originally designed to bring all team members everyday together and organize stand-up meetings. However, nowadays software development involves distributed systems, where members are located in different parts of the world. So, Scrum Framework might not be useful for developing a software system when there exists high distribution of team members.[25]

[25] Pg. 87-88 of “Software Engineering” 10e by Ian Somerville

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