DAT321/DIT847:
Software Quality

Welcome to the examination for the *Software Quality* course. The examination is intended to last for max **4 hours** and is intended to be **anonymous** (i.e., the teacher grading your exam will not know your name). Therefore, it is important that you follow the instructions (in the separate exam cover sheet) and **do NOT leave any information that would reveal your name.**

Each question has a number of points assigned shown in the square brackets. When the question is broken down into smaller sub-questions the part of the points for that specific sub-questions are also shown as following:

1. *[10 pts].*
    a. *[2 pts]*
    b. *[8 pts]*

The percentage of points and the corresponding grade is presented below (100 points in total):

% of points	DAT321	DIT847
[0, 50%)	U	U
[50%, 65%)	3	G
[65%, 85%)	4	G
[85%, 100%]	5	VG

Write your answers in the exam sheets. Before handing in your exam, number and sort the sheets in task order. Write your **anonymous code** and page number on every page!

It is important that you write **clearly** so that the examiner can read you. If your handwriting is unreadable, then you will not get any points for that question. We will NOT assess grammar or spelling as long as your answer is readable, understandable and unambiguous.

The questions in this exam refer to the **ISO 25010:2011** that categorises internal and external software quality attributes into eight characteristics.

Simple calculators are also allowed, but NOT calculators in mobile phones.

Questions about the exam contact:
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The exam review is scheduled for 2019-11-29, between 13:30 – 15:30 at Jupiter building, 4th floor, Room 427.

The questions in this exam are related to the context below. Note that you must justify your answers with i) the theory and terminology from software quality and ii) their connections to the elements in this context (e.g., teams, product, processes, architecture, customers, etc.).

Context: You are hired by GPS-Co, a company that develops a cloud-based system that offers various Global Positioning System (GPS) services. You are the quality assurance manager for teams B and C (see description of the teams below).

Software product:
The product is composed of several services, all of them related to GPS positioning and navigation. The product uses a microservices architecture, where the different services are loosely coupled and independently deployable. There is no graphical user interface to use or test the product, since the services are accessed and integrated via APIs endpoints (i.e., entry points that work as method calls). The company requires all teams to use Continuous Integration practices and tools.

Customers and business:
Currently GPS-Co has contracts with other companies that use the services provided by your software product. Currently, your main customer is the FoodDelivery-Co, which delivers food orders from supermarkets to customers. FoodDelivery-Co uses the GPS services on their fleet of trucks that deliver all food orders from supermarkets to customers who ordered online.

Today, GPS-Co signed a contract with another customer, Automotive-Co which is an automotive company that wants to use the GPS services for track and navigation of its manufactured cars. Therefore, as part of the contract, Automotive-Co will request several new features from your software product.

Teams and software development process:
Team A is responsible for developing and maintaining the main features of your software product: i) the main application with the various GPS features, ii) the cloud infrastructure and platform where the service is hosted, iii) all non-functional aspects of the product.

Team A has 50 members and is internally divided into small groups based on specific the services provided by the software product. Team A is composed of experienced engineers with various testing and development skills.

Team B handles the development of customised features for FoodDelivery-Co, and is a small team with 8 people, all of them with wide experience in software development and agile software development. Team B reuses the features created by Team A in order to customize the product for FoodDelivery-Co.

GPS-Co is also hiring developers and testers for Team C that will work similarly to Team B but for Automotive-Co. Therefore, you are likely to help with recruitment for this team.

1. **[20 pts]** Using the context above, answer the following questions:
   a. [15 pts] Choose three software product quality's characteristics, **and** provide examples of why they are relevant to the software product at GPS-Co.
   b. [5 pts] Explain the differences between internal and external quality.

2. **[15 pts]** Using your knowledge on software quality measures, answer the following:
   a. [10 pts] Describe how you can use Henry and Kafura to improve the quality of your software product. Your description must: i) include the artefact and attribute under investigation, and ii) justify why Henry and Kafura is the right choice.
   b. [5 pts] Your colleague Martin suggests measuring only the lines of code of the software system, since other quality measures can be complicated to understand and difficult to monitor. Do you agree with Martin? Justify your answer.

3. **[20 pts]** Considering the Acceptance, System, Integration and Unit levels of the V-model, explain how you will do testing at GPS-Co products. Your answer must contain, **for each level of testing**: i) what is being tested, ii) the goal of the test, and iii) relevant aspects that a tester should consider.

4. **[15 pts]** GPS-Co wants to contribute with sustainability in ICT. You must propose or explain two sustainable features of your software product. Your explanation must include: i) description of the feature and ii) how it is connected to a sustainability dimension.

   Note: Here, you can interpret features as: new functionalities/services of your product, updates to the development process, or changes in the current software system.

5. **[10 pts]** Using your knowledge on Bayesian Data Analysis (BDA):

   c. [5 pts] Explain what the four main reasons are to use multilevel models.

   d. [5 pts] We have run two models with one predictor each, estimating bc and bf, and we see that they both have predictive power. Of course, adding both of the predictors to one model should make things even better, so let's do that and check the output.

   Can you explain **~~why~~ bf** helps or does not help with prediction?

	Mean	**Std. Dev**	**Lower 0.89**	**Upper 0.89**	**N. Eff.**	**Rhat**
a	0.43	0.16	0.19	0.68	2733	1.00
bc	1.14	0.20	0.82	1.46	2650	1.00
bf	0.00	0.10	-0.16	0.16	3259	1.00

6. **[20 pts]** In order to properly plan for the upcoming weeks of development, you want to be able to predict the number of faults that can be introduced based on the code churn of each code commit. Note that the faults and code churn can vary depending on the service being changed, because each service should be loosely independent from each other. You are able to collect data from the past two years of modifications (example shown below):

VersionID	**Faults**	**Code Churn**	**Service**
1	5	45	Service A
1	7	35	Service B
2	10	-20	Service A
2	2	-5	Service C
…			

Write down the *mathematical model definition* for this prediction using *any* variable names and priors of your choice. State the ontological and epistemological reasons for your likelihood. Remember to clearly state and justify the choices and assumptions regarding your model.