

**Department of Computer Science (IDI)**

**Examination paper for TDT4171 Methods in Artificial Intelligence**

**Examination date: May 15<sup>th</sup>, 2020**

**Examination time (from-to): 0900 - 1300**

**Permitted examination support material:** All support material is allowed

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### **OTHER INFORMATION**

If a question is unclear/vague – make your own assumptions and specify in your answer the premises you have made. Only contact academic contact in case of errors or insufficiencies in the question set when no reasonable assumptions can be made.

**Saving:** Answers written in Inspira are automatically saved every 15 seconds. If you are working in another program remember to save your answer regularly.

**Cheating/Plagiarism:** The exam is an individual, independent work. Examination aids are permitted. All submitted answers will be subject to plagiarism control. [Read more about cheating and plagiarism here.](#)

**Citations:** It is not expected that you will need to use sources of information outside the curriculum. Nevertheless, if you do use such sources (e.g., to argue in favor of a modelling choice), you will need to cite them adequately. Give author, name of paper/web-page, and a complete URL. Sources that are not freely and easily available during grading (including, e.g., discussion forums that require log-in, private communication, etc.) are not accepted. If you choose to rely on sources outside the curriculum, you will need to consider their relevance and quality – if you make claims based on dubious sources, you will not receive as many points as if you had used relevant high-quality sources.

**Notifications:** If there is a need to send a message to the candidates during the exam (e.g. if there is an error in the question set), this will be done by sending a notification in Inspira. A dialogue box will appear. You can re-read the notification by clicking the bell icon in the top right-hand corner of the screen. All candidates will also receive an SMS to ensure that nobody misses out on important information. Please keep your phone available during the exam.

**Weighting:** The exam consists of four questions. Each question can give you a maximum of 20 points. Hence, the exam can give a total of 80 points. Additionally, you will get between 0 and

20 points from the assignments. The up to 100 points combined from exam and assignments determine your final grade, where 41 points or more is required to pass.

**File uploading:** The exam is submitted as one PDF file. The files must be uploaded before the examination time expires. 15 minutes are added to the examination time to manage the sketches/calculations/files. (The additional time is included in the remaining examination time shown in the top left-hand corner.)

[How to digitize your sketches/calculations](#)

[How to create PDF documents](#)

[Remove personal information from the file\(s\) you want to upload](#)

## **ABOUT SUBMISSION**

**Your answer will be submitted automatically when the examination time expires and the test closes**, if you have answered at least one question. This will happen even if you do not click “Submit and return to dashboard” on the last page of the question set. You can reopen and edit your answer as long as the test is open. If no questions are answered by the time the examination time expires, your answer will not be submitted.

**Withdrawing from the exam:** If you wish to submit a blank test/withdraw from the exam, go to the menu in the top right-hand corner and click “Submit blank”. This can not be undone, even if the test is still open.

**Accessing your answer post-submission:** You will find your answer in Archive when the examination time has expired.

## 1. Probabilistic Reasoning - Medical Diagnosis (20 points)

Using the information in the table below, design a system that would suggest the most likely condition given the symptoms. Assume that flu is a rare condition while common cold and allergies are common conditions.

Guidelines:

1. Draw a Bayesian network that includes any 2 conditions and at least 3 symptoms. Assign conditional probabilities corresponding to words “common”, “sometimes”, “rare” and “never”. Choose prior probabilities for the conditions.
2. Using the network and probabilities, show how the model determines the most likely condition on 1 test example, include calculations.
3. Elaborate on whether a Bayesian network is a good choice to represent this type of knowledge? Is there another model in this course that can be used here? What are the advantages and disadvantages of using it instead?

| Symptom                  | Common Cold | Flu       | Allergy   |
|--------------------------|-------------|-----------|-----------|
| Fever                    | Rare        | Common    | Sometimes |
| Dry cough                | Rare        | Common    | Sometimes |
| Loss of smell and taste  | Common      | Common    | Common    |
| Shortness of breath      | Never       | Never     | Common    |
| Headaches                | Rare        | Common    | Sometimes |
| Aches, muscle pain       | Rare        | Common    | Never     |
| Sore throat              | Common      | Sometimes | Never     |
| Fatigue                  | Sometimes   | Common    | Sometimes |
| Chills, repeated shaking | Rare        | Common    | Never     |
| Diarrhea, vomiting       | Never       | Sometimes | Never     |
| Swollen toes             | Never       | Never     | Never     |
| Runny nose               | Common      | Sometimes | Common    |
| Sneezing                 | Common      | Sometimes | Common    |

## 2. Rational Decisions – Choosing Courses (20 points)

Imagine that you have a hard time choosing between two courses next semester. You want to make your decision as rational as possible using methods learned in this course. How would you do that?

Guidelines:

1. Come up with 2 courses to use as examples. A course should have at least 3 attributes that contribute to its utility. You don't need to use real courses.
2. Represent your decision with one of the models for rational decision making.
3. Show how to do inference with this model using the example courses.
4. Assume that one of the attributes for one of the courses is missing. Show how to calculate the value of this information.
5. Specify any quantities and assumptions used in the calculations.

### 3. Sequential Decisions – Career Planning (20 points)

Imagine that after graduation you decided to stay in Trondheim to get a job in a company called StrongAI. Unfortunately, StrongAI mostly recruits from their competitors rather than hiring directly. Fortunately, there is another AI company in town, WeakAI, competitor to StrongAI. It is much easier to get a job in WeakAI directly, but it's not a great place to work.

You can only apply to one job per year. Starting without a job, you must decide what to do: (1) apply to StrongAI directly or (2) apply to WeakAI, work there for *one or two* years and then apply to StrongAI. Every year of work in WeakAI increases your chance to get a job in StrongAI. Every time you apply to StrongAI, there is a small chance that your boss at WeakAI will find out about it and fire you. This means you will need to start from the beginning.

Guidelines:

1. Model this problem as Markov decision process (MDP). Make one or several tables to define probabilities and rewards.
2. Show how to derive an optimal policy to get a job at StrongAI. Show calculations of utilities for the first iteration.
3. Specify any assumptions necessary to solve this problem.

### 4. Case-Based Reasoning - AI Method Recommender (20 points)

Design a case-based reasoning system that recommends an AI method from this course for a real-life problem.

Guidelines:

1. Define a case structure with no less than 5 attributes – characteristics of a problem.
2. Provide 5 example cases to populate your case base.
3. Come up with a new problem to be solved by your CBR system.
4. Define some domain knowledge that can be used in one of the steps of the CBR cycle.
5. Describe how each step in a CBR cycle is applied to solve the new problem using the example cases and domain knowledge.
6. Specify all necessary components of the CBR system used in solving the problem.