# Homework 3 (100 points)
# Due Monday, March 21 @11:59pm
# **Gradescope**

The following homework problems are to be completed and turned in on Gradescope on the due date. **Please follow the Gradescope tutorial on Canvas when submitting homework. Please use Times New Roman font, size 12, single line spacing, normal layout with 1" margins on each side.**

## 1. Decision Diagrams, Decision Trees, Influence Diagrams [25 pts]

Starting with what you learned in class about BDDs, further explore other (or same?) data structures, Decisions Diagrams in general, Decision Trees, Influence Diagrams. For each of them, find and describe recent applications, and in particular if they are used in machine learning (ML) or artificial intelligence (AI) in general. Discuss one application in detail, include some figures and examples to illustrate your findings – any figure you include should NOT take more than 1/8 of the page. (*Your description should be ~1 page long.*)

## 2. SAT solvers and applications [50 pts]

(i) [15 pts] Explore open-source SAT solvers available online. Which programming language is typically used to implement them? What features (algorithmic components, such as the ones we discussed in class) do they include? (*Write ~1/2 page about this.*)

(ii) [10 pts] Find a SAT solver implemented using BDDs and describe how BDDs are used in SAT solvers. (*Write up to 1/2 page.*)

(iii) [25 pts] Explore applications of SAT solvers in ML and AI. Briefly describe several applications. Choose one of the applications and provide details about it, how SAT solver is used, what is novel or interesting about implementation, algorithmic features of SAT solver, application? Include figures illustrating your findings, – any figure you include should NOT take more than 1/8 of the page. (*Your description should be ~1 page long.*)

## 3. Controllability and observability [25 pts]

We talked about controllability and observability don't cares in class. Now, we ask you to explore what in general controllability and observability mean, find the definitions and include them in your answer here. Can you relate these general definitions to the definitions that we discussed in class in the context of don't cares? Give examples of systems where controllability and observability are used. For one example system, provide details. What kind of a system it is, what are the inputs and outputs of the system, how does studying controllability and observability help? Typically, we see controllability and observability explored in the domain of control theory. Are there any ML or AI applications where controllability and observability are used? Can you relate sensitivity analysis to the concepts of controllability and observability? (*Your description should be ~1 page long*.)