# Project Summary

*Short summary of the project setting.*

# Propositions

*List of the propositions used in the model, and their (English) interpretation.*

# Constraints

*List of constraint types used in the model and their (English) interpretation. You only need to provide one example for each constraint type: e.g., if you have constraints saying “cars have one colour assigned” in a car configuration setting, then you only need to show the constraints for a single car. Essentially, we want to see the pattern for all of the types of constraints, and not every constraint enumerated.*

# Model Exploration

*List all the ways that you have explored your model – not only the final version, but intermediate versions as well. See (C3) in the project description for ideas.*

## Missing TAs

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Here, I noticed there were no TAs. It occurred to me that I need a constraint to say how many TAs we need for a particular course. This led me to the following constraint…

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Unfortunately, while this assigned a TA to every course, it had two issues. (1) some had many TA’s, and (2) some had just one (see right). The fix was to identify the exact two TA’s for a course like this:

A computer screen with text and numbers

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This led to exactly 2 assigned to every course.

## Better Student Pref Display

I was struggling to get a sense of what the preferences led to with respect to the course selection. To overcome this, I made the grid of students x courses prettier, and made the entries of course selections green. This let me very quickly see that every course has 2 Tas, and what their preference was.

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## Forcing a Bad Nash

The Nash Equilibrium constraint – that no two students mutually want to swap – is a fairly complex one:

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In order to test that things are working, I changed it ever so slightly so that we force every pair of students assigned to different courses to be violating the Nash Equilibrium:



This led to the following solution:

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Indeed, we can confirm that every assignment has a better option on every other course.

## Forced Imperfection

To explore the model further, I decided to force sub-optimal preference assignments. Similar to the Nash Equilibrium, the idea is to force *some* other option for every student that looks better. This runs up again the Nash Equilibrium constraint in an interesting way, and forces a more complex solution to be computed. This was the constraint specification:

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Note that the options range over all courses, and not just levels on a single course. This is one solution that was computed:

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Note that every student has another course of a higher preference, but no Nash Equilibrium constraint is violated.

# Jape Proof Ideas

*List the ideas you have to build sequents & proofs that relate to your project.*

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## If a student isn’t assigned to 2 of 3 courses, they must be assigned to the third.

The way I’ll interpret this is that (1) a student must be assigned to one of three courses, and also (2) they are not assigned to c1 and not assigned to c2. Then we deduce that they are assigned to c3.

We will use propositions such as **Ps1ATc1** to mean that s1 is assigned to course c1. The final sequent we have is then,

(Ps1ATc1 ∨ Ps1ATc2 ∨ Ps1ATc3), ¬Ps1ATc1 ∧ ¬Ps1ATc2  
 ⊢ Ps1ATc3

## If a student is assigned to a course, then it isn’t one with a preference of one.

**Premise**: for all students and all courses, if the student assigns it a preference of one, then they are not assigned the course. This follows closely the exact constraint in our code:

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∀x.∀y.(PrefOne(x,y)→¬Passigned(x,y))

**Additional premises:** We have a student i1 that is assigned to course i2:

actual i1, actual i2, Passigned(i1,i2)

**Conclusion:** They don’t have a preference of one for the course:

¬PrefOne(i1,i2)

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## If there are 3 students, and a prof ranks one low, then the other two must be ranked highly

# First-Order Extension

*Describe how you might extend your model to a predicate logic setting, including how both the propositions and constraints would be updated.* ***There is no need to implement this extension!***

## Domain of Discourse

* Natural numbers (used for levels)
* Objects for profs
* Objects for students (TAs)
* Objects for courses

## Predicates

* Assigned(x,y): Student x is assigned to course y for a TA’ship
* Preference(x,y,z): Student x has a preference level of z (1->5) for course y
* ProfPref(w,x,y,z): Prof w has a preference for TA x at level z (1->5) for course y
* MaxGrad(x,y): The maximum number of graduate students TA’ing course x is y
* Assume that we have equality for objects (e.g., or )
* …

We may want to specify the types of individual objects, so that the quantification is a little more oriented to the objects we use. These would be the types for this particular project:

* Student(x): x is a student
* Prof(x): x is a prof
* Course(x): x is a course
* Num(x): x is a number

## Functions

## Constraints

* All TAs can be assigned to only one course  
     
    
  If we want to make sure that the objects are of the correct type, then the formula would be:

Because it makes the formulae unwieldy to always include the types of the objects we quantify over, we will assume that they are implicitly included whenever we have a quantifier.

* No course gets a TA ranked 2 or lower by the instructor
* Some profs can veto certain TAs  
   Interpreted as: a prof can forgo assigning *any* level to a particular TA (across all courses)  
     
    
   If instead, we interpret it as having a value of 1 for the TA
* Nash equilibrium: no swap of TAs/Courses should lead to a better outcome (i.e., more preferences satisfied)

## Theorems

* If a prof didn’t rank a student 1-4, then they must have ranked them 5  
   …

# Useful Notation

*Feel free to copy/paste the symbols here and remove this section before submitting.*