GRP_15: Academic Planner for Biomedical Computing

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Course Modelling Project

CISC/CMPE 204

Logic for Computing Science

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Abstract

Choosing your courses and ensuring you are set up to take all of the required courses and prerequisites for your degree can be very stressful. This project aims to assess what courses a student must take to complete the Biomedical Computing specialization degree at Queens University.

The model will demonstrate the path that shows a student enrolled in all the mandatory fourth year courses needed to graduate. If no such path exists from first year to fourth, then it means that the student does not have all the correct courses. If the model does exist that means all the prerequisites needed are met and the student is set up to graduate with a Biomedical Computing degree.

Propositions

BIOL/CHEM/BCHM COURSES

- 1st Year
  - B_{102} = Completed BIOL 102
  - B_{103} = Completed BIOL 103
  - B_{112} = Completed CHEM 112
- 2nd Year
  - B_{218} = Completed BCHM 218
  - B_{205} = Completed BIOL 205
  - B_{282} = Completed CHEM 282 (OR CHEM 222+CHEM223)
- 3rd Year
  - B_{331} = Completed BIOL 331
  - B_{334} = Completed BCHM 334
  - B_{315} = Completed BIOL 315

MATH REQUIREMENTS

- 1st Year:
  - T_{111} = completed 1 of the required Linear Algebra options (MATH 112 & CISC 102 / MATH 111 CISC 102 / MATH 110)
  - T_{120} = completed one of the required Calculus options (MATH 120 / MATH 121 / MATH 123 & MATH 124)
- 2nd Year:

- S_{263} = Completed STAT 263 (or STAT option)

CISC REQUIREMENTS

- 1st Year:
  - C_{121} = Completed CISC 121
  - C_{124} = Completed CISC 124
  - C_{102} = Completed CISC 102
- 2nd Year:
  - C_{203} = Completed CISC 203
  - C_{204} = Completed CISC 204
  - C_{221} = Completed CISC 221
  - C_{223} = Completed CISC 223
  - C_{235} = Completed CISC 235
  - C_{271} = Completed CISC 271
- 3rd Year:
  - C_{320} = Completed CISC 320
  - C_{330} = Completed CISC 330
  - C_{332} = Completed CISC 332
  - C_{352} = Completed CISC 352
  - C_{360} = Completed CISC 360
  - C_{365} = Completed CISC 365
- 4th Year:
  - C_{471} = Completed CISC 471
  - C_{472} = Completed CISC 472
  - C_{497} = Completed CISC 497
  - C_{499} = Completed CISC 499 (or CISC 500)

ADDITIONAL REQUIREMENTS

- A = completed 12 units in CHEM 281/282/285, CISC 220, PHGY 215/216 (OR OTHER ANAT/ BIOL/ BCHM/ CANC/ CISC/ CRSS/ DDHT/ EPID/ LISC/ MBIO/ MICR/ PATH/ PHAR/ PHGY at 300-level or above)

OVERALL DEGREE REQUIREMENTS:

- D = Student has graduated with a degree in Biomedical Computing
- B_1 = Completed all first year BIOL/CHEM/BCHM required courses

- B_2 = Completed all second year BIOL/CHEM/BCHM required courses
- B_3 = Completed all third year BIOL/CHEM/BCHM required courses
- B_4 = Completed all fourth year BIOL/CHEM/BCHM required courses
- C_1 = Completed all first year CISC required courses
- C_2 = Completed all second year CISC required courses
- C_3 = Completed all third year CISC required courses
- C_4 = Completed all fourth year CISC required courses
- T_1 = Completed all first year MATH required courses
- T_2 = Completed all first year MATH (STAT) required courses
- Fi = Completed first year
- S = Completed second year
- T = Completed third year
- Fo = Completed fourth year

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.

BIOL/CHEM/BCHM CONSTRAINTS

- $B_{103} \rightarrow B_{102}$
  - If you have completed BIOL 103, then you must have completed BIOL 102
- $B_{218} \rightarrow B_{112} \wedge B_{103}$
  - If you have completed BCHM 218, then you must have completed BIOL 103 and CHEM 112
- $B_{205} \rightarrow B_{103}$
  - If you have completed BIOL 205 , then you must have completed BIOL 103

- $B_{331} \rightarrow B_{218} \wedge B_{205}$
  - If you have completed BIOL 331, then you must have completed BCHM 218 and BIOL 205.
- $B_{334} \rightarrow B_{218}$
  - If you have completed BCHM 334, then you must have completed BCHM 218.
- $B_{315} \rightarrow B_{218} \wedge B_{282}$
  - If you have completed BCHM 315, then you must have completed BCHM 218 and either CHEM 282 (or the other CHEM option outlined in propositions).

CISC CONSTRAINTS

- $C_{124} \rightarrow C_{121}$
  - If you have completed CISC 124, then you must have completed CISC 121
- $C_{203} \rightarrow C_{121} \wedge C_{102}$
  - If you have completed CISC 203, then you must have completed CISC 121 and CISC 102
- $C_{204} \rightarrow C_{121} \wedge C_{102}$
  - If you have completed CISC 204, then you must have completed CISC 121 and CISC 102
- $C_{221} \rightarrow C_{124}$
  - If you have completed CISC 221, then you must have completed CISC 124
- $C_{223} \rightarrow C_{124} \wedge C_{204}$
  - If you have completed CISC 223, then you must have completed CISC 124 and CISC 204
- $C_{235} \rightarrow C_{203} \wedge C_{124}$
  - If you have completed CISC 235, then you must have completed CISC 124 and CISC 203
- $C_{271} \rightarrow C_{121} \wedge T_{111} \wedge T_{120}$
  - If you have completed CISC 271, then you must have completed CISC 121 and 1 of the required algebra options and 1 of the required calculus options
- $C_{320} \rightarrow C_{235}$
  - If you have completed CISC 320, then you must have completed CISC 235

- $C_{330} \rightarrow C_{271}$
  - If you have completed CISC 330, then you must have completed CISC 271
- $C_{332} \rightarrow C_{124} \wedge C_{102}$
  - If you have completed CISC 332, then you must have completed CISC 124 and CISC 102
- $C_{352} \rightarrow C_{235}$
  - If you have completed CISC 352, then you must have completed CISC 235
- $C_{360} \rightarrow C_{124} \wedge C_{204}$
  - If you have completed CISC 360, then you must have completed CISC 124 and CISC 204
- $C_{365} \rightarrow C_{204} \wedge C_{235} \wedge C_{203}$
  - If you have completed CISC 365, then you must have completed CISC 204, CISC 203 and CISC 235
- $C_{471} \rightarrow C_{352} \wedge C_{271} \wedge C_{365}$
  - If you have completed CISC 471, then you must have completed CISC 352 and CISC 271 and CISC 365
- $C_{472} \rightarrow C_{330}$
  - If you have completed CISC 472, then you must have completed CISC 330
- $C_{497} \rightarrow C_{365}$
  - If you have completed CISC 497, then you must have completed CISC 365
- $C_{499} \rightarrow C_{365}$
  - If you have completed CISC 499, then you must have completed CISC 365

YEAR FACULTY CONSTRAINTS:

- $T_1 \rightarrow T_{111} \wedge T_{120}$
  - If you have completed the 1st year MATH (only MATH) requirements, then you must have completed T_{111} (1 of the required LinAlg options) and T_{120} (1 of the required Calculus options).
- $T_2 \rightarrow S_{263}$

  - If you have completed the 2nd year math requirments, then you must have completed S_{263}

- $B_1 \rightarrow B_{102} \wedge B_{112} \wedge B_{103}$
  - If you have completed 1st year BIOL/CHEM/BCHEM requirements, then you must have completed BIOL 102, CHEM 112 AND BIOL 103.
- $B_2 \rightarrow B_{218} \wedge B_{205} \wedge B_{282}$
  - If you have completed 2nd year BIOL/CHEM/BCHEM requirements, then you must have completed BCHM 218, BIOL 205 and B_{282} ([CHEM 222 and CHEM 223] or CHEM 282)
- $B_3 \rightarrow B_{331} \wedge B_{334} \wedge B_{315}$
  - If you have completed 3rd year BIOL/CHEM/BCHEM requirements, then you must have completed BIOL 331, BCHM 334 and BCHM 315.
- $C_1 \rightarrow C_{121} \wedge C_{124} \wedge C_{102}$
  - If you have completed 1st year CISC requirements, then you must have completed CISC 121, CISC 124 and CISC 203.
- $C_2 \rightarrow C_{203} \wedge C_{204} \wedge C_{221} \wedge C_{223} \wedge C_{235} \wedge C_{271}$
  - If you have completed 2nd year CISC requirements, then you must have completed CISC 203, CISC 204, CISC 221, CISC 235, CISC 223 and CISC 271.
- $C_3 \rightarrow C_{320} \wedge C_{330} \wedge C_{332} \wedge C_{352} \wedge C_{360} \wedge C_{365}$
  - If you have completed 3rd year CISC requirements, then you must have completed CISC 320, CISC 330, CISC 332, CISC 352, CISC 360 AND CISC 365.
- $C_4 \rightarrow C_{471} \wedge C_{472} \wedge C_{497} \wedge C_{499}$
  - If you have completed 4th year CISC requirements, then you must have completed CISC 471, CISC 472, CISC 497 AND CISC 499.

OVERALL DEGREE CONSTRAINTS:

- $Fi \rightarrow B_1 \wedge T_1 \wedge C_1$
  - If you have completed first year, then you must have completed all first year BIOL,CHEM,BCHM,MATH, and CISC courses.
- $S \rightarrow B_2 \wedge T_2 \wedge C_2$
  - If you have completed second year, then you must have completed all second year BIOL,CHEM,BCHM, MATH(STAT), and CISC courses.

- $T \rightarrow B_3 \wedge C_3$
  - If you have completed third year, then you must have completed all third year BIOL,CHEM,BCHM, and CISC courses.
- $Fo \rightarrow B_4 \wedge C_4$
  - If you have completed fourth year, then you must have completed all fourth year BIOL,CHEM,BCHM, and CISC courses.
- If you have a degree in Biomedical Computing, then you must have competed first, second, third and fourth year and the additional requirements A
- $D \rightarrow Fi \wedge S \wedge T \wedge Fo \wedge A$

Model Exploration

1. We explored our model to explore the relationship between the different scopes our propositions covered. For example, we have propositions that are True if the student has taken the course, a proposition for completing the CISC requirements in 1st year, completing all 1st year requirements and completing all requirements for completing the degree.
   Our first formula uses the prerequisite constraints (e.g. C124 –¿C121) to show how C499 a fourth year course being True (meaning the student has completed the course) entails that all 1st, 2nd and 3rd year courses have been completed.
   Our 2nd formula does the same but with the BIOL/CHEM/BCHM requirements.
   Finally, we show Fi being True (completing 1st year requirements) entails that B102,B112,...,C102 (all 1st year courses) have been taken.
2. To check our constraints, we created a 4th year registration portal in python, where a user can input courses they desire to take in fourth year, and are then prompted to answer questions regarding if they took the prerequisites or not. If they took all required prerequisites the programs tells them they are able to go forward with the 4th year course.

First-Order Extension

If we were to use predicate logic to go about representing our model we would create predicates that represent each year's requirements based on faculty. For example, B1(x) would be the set of all biology 1st year requirements.
An example would be:
$\forall x.\exists y.(B2(y) \rightarrow B1(x))$
This means that there exists a 2nd year biology course (that was taken) implying that all first year biology courses were taken (since they are prerequisites).
This division of required courses into predicates that indicate each year would extend to the CISC courses and will also extend to all courses required to be taken in one year.
Example:

$\forall x.(B2(x) \wedge C2(x)) \implies \forall y.S(y)$
S(y) being all courses taken to satisfy the 2nd year Biomedical Computing requirements.

Useful Notation

$$\wedge \quad \vee \quad \neg \quad \rightarrow \quad \forall \quad \exists$$