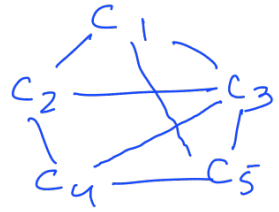
Consider courses as nodes, and if a common student exists between two courses then add an edge between those two courses. Then, this becomes a graph coloring Problem

Quiz Local Search

Artificial Intelligence – Spring'25, Sec-13

Instructor: Ipshita Bonhi Upoma



Name: _____ **ID:** _____

Section: _____

A study group consisting 6 students offers study sessions for 5 courses, and there is a list of student enrollments specifying which students are taking which courses. Two courses' sessions must not be scheduled at the same time if there is at least one student enrolled in both.

5 courses: {C1, C2, C3, C4, C5}. **Student enrollments:** Student A: {C1, C2, C3}, Student B: {C2, C4}, Student C: {C3, C5}, Student D: {C1, C5}, Student E: {C3, C4, C5}, Student F: {C4, C5}

1. There are three available slots to schedule the sessions for these courses. The objective is to schedule the sessions so that no two courses with same students have sessions on the same slot. **Encode the chromosome for this problem.** (ie. you are to represent probable solutions using strings. What should be the length of the string? What should the string's indices and their respective values represent?) What should be the **Fitness function**? [3+2]

string length = 5 (for five courses)
index represents the course and value represent the assigned time-slot.

fitness = Total # edges − # of conflicting edges.

maximization algo or fitness = $\frac{1}{\#\text{ conflicting-edges} + 1}$

2. Simulate genetic algorithm with population size 4, mutation rate and crossover rate 1 for one iteration. [5]

Mutation rate = 1 meaning all chromosomes will be mutated.
crossover rate = 1 meaning all chromosomes have equal probability of selection.

Initial population:
2 2 1 3 1
3 2 1 2 1
1 1 1 2 2
3 2 1 2 3

random selection:
2 2 | 1 3 1
3 2 | 1 2 1
1 1 1 | 2 | 2
3 2 1 | 2 | 3

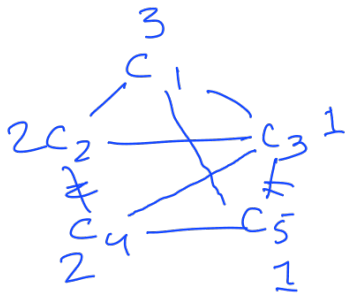
crossover:
2 2 1 2 1
3 2 1 3 1
1 1 1 2 3
3 2 1 2 2

Mutation → new popu.
2 1 1 2 1
3 2 1 3 2
2 1 1 2 3
3 3 1 2 2

Example chromosome 3 2 1 2 1

conflicting edges = 2

fitness = $\frac{1}{2}$ [$\frac{1}{1 + \#\text{ conflicting edges}}$].



or fitness = 8 − 2 = 6

[Total # of edges − # of conflicting edges]

3. Use this scenario to demonstrate the difference between Hill-Climbing and Simulated annealing problem in terms of neighbor selection. You have to show examples. [5]

In hill climbing if a worse/same valued neighbor is found the search stops and returns the current solution. for example. if current neighbor is 32121 with value 1/2, and the neighbor generated is 12121 worsening the value to $\frac{1}{5}$, Hill climbing will get stuck and return 32121 as its best found soln. On the other hand Simulated annealing accepts bad neighbors based on a probability $e^{-\Delta E/T}$

ΔE is the difference of fitness between the solutions. In this example $P = e^{-(1/2 - 1/5)/T}$ T is a decreasing parameter, ensuring that with each iteration probability of selecting a bad neighbor decreases.

Quiz Local Search

Artificial Intelligence – Spring'25, Sec-17

Instructor: Ipshita Bonhi Upoma

Name: _____ **ID:** _____

Section: _____

A semiconductor company is designing a new microprocessor. The processor consists of 5 functional units (A, B, C, D, E), and each unit needs to be connected with specific other units to optimize data flow and minimize wire length. The objective is to place the units on a chip layout such that: each unit is visited exactly once in an optimal order (minimizing wire length), the total connection length (sum of the wire distances between interconnected units) is minimized and the placement must form a single, closed loop, ensuring all units are efficiently wired together.

1. **Encode the chromosome for this problem.** (ie. you are to represent probable solutions using strings. What should be the length of the string? What should the string's indices and their respective values represent?) What should be the **Fitness function**? Explain your suggested encoding and fitness using an example. [3+2]
   The length of wire needed between different units is represented as:

	A	B	C	D	E
A	0	5	2	6	3
B	5	0	7	4	2
C	2	7	0	3	6
D	6	4	3	0	5
E	3	2	6	5	0

TSP problem.
String length: 5,
Index: order of unit/components
Value: component itself.
fitness: Σ Wire length needed between two neighboring units.

2. Simulate genetic algorithm with population size 4, mutation rate and crossover rate 1 for one iteration. You may use single point crossover.[5]

Example fitness C A B D E
CA + AB + BD + DE + EC
2 + 5 + 4 + 5 + 6 = □

simulation same as ~~first~~ problem.

Catch: Single point cross-over will cause multiple loops. Mutation should be random resetting

of repeated values. So, mutation rate should be defined differently.
or: crossover should be done differently.

3. Use this scenario to demonstrate the difference between Hill-Climbing and Simulated annealing problem in terms of neighbor selection. You have to show examples. [5]

Show example like the first problem.

Quiz Local Search

Artificial Intelligence – Spring'25, Sec-18

Instructor: Ipshita Bonhi Upoma

Name: _____ **ID:** _____

Section: _____

A political strategist is working on dividing a large voter base into two distinct groups to target with customized campaign messages. The goal is to maximize the ideological separation between the two groups, ensuring that people who strongly disagree on political issues end up in different groups.The strategist needs to split the voter network into two subsets such that the sum of the disagreement scores (edge weights) between the two groups is maximized.

1. **Encode the chromosome for this problem.** (ie. you are to represent probable solutions using strings. What should be the length of the string? What should the string's indices and their respective values represent?) What should be the **Fitness function**? Explain your suggested encoding and fitness using an example. [3+2]

   Consider five voter groups: Urban Liberals (A), Suburban Moderates (B), Rural Conservatives (C), Young Progressives (D), Older Traditionalists (E). The disagreement strength between two demographics, measured using surveys or historical election data are given below.

	A	B	C	D	E
A	0	5	2	6	3
B	5	0	7	4	2
C	2	7	0	3	6
D	6	4	3	0	5
E	3	2	6	5	0

binary string of length 5
index representing voter groups.
value representing the subset

fitness

$\sum$ disagreement score between two subsets $-$ $\sum$ disagreement within subset

$-\sum$ disag. within subs.

2. Simulate genetic algorithm with population size 4, mutation rate and crossover rate 1 for one iteration. You may use single point crossover.[5]

Example 1 1 0 0 1

disagreement between subsets.

AC + AD + BC + BD + CE + DE

disagreement within 1

$-(AB + AC + BC)$

disagreement within 0. – CD.

fitness = 2 + 6 + 7 + 4 + 6 + 5 − (5 + 2 + 7) − 3

Simulation same as before.

3. Use this scenario to demonstrate the difference between Hill-Climbing and Simulated annealing problem in terms of neighbor selection. You have to show examples. [5]

Example as before for solutions of this problem.