CSE/ECE 848 Introduction to Evolutionary Computation

Module 4 - Lecture 20 - Part 5

Dynamic Problems in EC: Coevolution

Wolfgang Banzhaf, CSE
John R. Koza Chair in Genetic Programming

Coevolution and Dynamic Problems

- Coevolutionary methods work by having two (or more) populations of individuals working either cooperatively or competitively to solve a problem (optimize a fitness function)
- CoEAs are using the same principles as regular EAs (variation and selection, survival of the fitter)
- CoEA do not require the definition of a fitness function in closed form. Instead, individuals can be compared on the basis of interactions among each other
- “Subjective” vs objective (fitness) function
- This function changes with time, just as in dynamic problems

Two simple Coevolutionary Algorithms

- Single-population CoEA vs multi-population CoEA

Algorithm 1 SINGLEPOPULATIONCOEA

```
Initialize population
Select evaluators from population
Evaluate individuals from population by interacting with evaluators
while not done do
    Select parents from population
    Produce children from parents via variation
    Select evaluators from (children + parents)
    Evaluate individuals from children by interacting with evaluators
    Select survivors for next generation
end while
return solution
```

Algorithm 2 MULTIPOPULATIONCOEA

```
for each pop ∈ populations do
    Initialize pop
    Select evaluators from (populations − pop)
    Evaluate individuals from pop by interacting with evaluators
end for
while not done do
    for each pop ∈ populations do
        Select parents from pop
        Produce children from parents via variation
        Select evaluators from (populations − pop)
        Evaluate individuals from children by interacting with evaluators
        Select survivors for next generation
    end for
end while
return solution
```

Types of Interactions in Coevolutionary Algorithms

- Dynamics of CoEAs can be (frustratingly) complex
- Fitness function perspective: Interaction creates changing fitness landscape, depending on rest of population/other populations (DOPs)
- Interaction perspective: The interaction "creates" the fitness landscape without having to define it explicitly (games)
- Traditional description of CoEAs: Cooperative vs competitive. In cooperative CoEA, individuals/populations work together to create a solution, whereas in competitive CoEAs, individuals work against each other
- Better description of the class of approaches: Test-based vs. compositional approaches
  - Test-based: Interaction between A and B is a challenge
  - Compositional: Interaction between A and B is forming a team

Examples

	Single-population, test-based	Two-population, test-based	Multi-population, compositional
Interactive Domain	Game of Checkers	Apply dataset to sorting network	Determination of complete job-shop schedule
Test	Set of playing strategies	Collection of datasets	Floor plans for widgets, arbitrator for conflict resolution
Potential Solution	Playing strategy	Sorting network	Set of floor plans for each widget and arbitrators
Problem	Find a strategy that beats the most opponents	Find smallest correct network	Find an efficient and robust job-shop schedule
References	Blondie24, Chellapilla & Fogel 1999	Hillis 1990	Husbands & Mills 1991