New Frameworks of Inetractive Evolutionary Computation

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First, we discuss one research direction of computational intelligence (CI) in the 21st Century. Key techniques of CI in the last Century were neural networks, fuzzy systems, and evolutionary computation (EC), and they have been used practically and widely. What comes next? My view is that human factors become important in/for CI at the beginning of this century. Imagine consumer robots which market is expanding in Japan now; cute, interesting, funny, or emotional behavior are much important for them, while accuracy and efficiency are the keys for industrial robots. Such emotional behaviors cannot be designed and controlled without human evaluation. I am calling this direction as Humanized Computational Intelligence.

Second, we state that interactive EC (IEC) is one of approaches to realize the Humanized Computational Intelligence. Then, we explain what IEC is and how to use it. The IEC is the EC which evolutionary process is controlled by human directly. In other words, the fitness function of the IEC is human itself. Conventional system optimization requests a numerical target to make a cost function. However, there are many tasks which performances cannot be measured objectively but can be evaluated based on human auditory, vision, or other sensory. The IEC is a good design tool for these tasks.

We view a wide variety of IEC applications. It includes: graphic arts and animation, music, editorial design, 3-D CG lighting, industrial design, facial image generation, speech processing and synthesis, hearing aid fitting, virtual reality, media database retrieval, data mining, image processing, control and robotics, food industry, geophysics, education, entertainment, social system, environmental engineering, MEMS design, and therapy.

Third, we turn into to the main topic of this talk: some new IEC frameworks. Most of the mentioned IEC applications use conventional interactive genetic algorithms (IGA) or interactive genetic programming. Here, we introduce other IEC: interactive Particle Swarm Optimization (PSO), tournament IGA and simulated breeding, and interactive differential evolution (DE).

Interactive PSO is an IEC where PSO is used as an EC part. The complexity of IEC landscape is so simple that IEC users can find satisfactory solutions with a few population size and a few searching generations. PSO shows better performance than GA for simple tasks in general. However, interactive PSO vs. IGA does not show this tendency. We analyzed them and found that it was due to the too much sensitivity of interactive PSO to quantization noise in fitness. We propose its solutions and show their better performance for less complex tasks than conventional IGA as expected from PSO vs. GA.

Tournament IEC requests an IEC user to compare pair individuals, which reduces IEC user fatigue, while conventional IEC requests him/her to compare all individuals and evaluate them to make offspring. Simulated breeding requests his/her to compare all individuals and *choose* better parents. Although *choosing* and *evaluating* look similar, one click for the former and thinking evaluation level relatively and inputting the evaluation level for the latter are quite different from the user fatigue point of view. Drawback of both tournament IEC and simulated breeding are slow conversion due to lack of evaluation information.

Paired comparison-based interactive DE has both features of pair comparisons like a tournament IEC and full evaluation like a conventional IEC. Thanks to them, it causes less user fatigue and converges faster. At this moment, this method looks the best IEC framework.

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