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Cheetah (Cutting hot edge evolving technology- algorithms hive)

Evolution of Mimics of Algorithms of Nature (E-man)

Part 7[#]: Prospects of Honey-bee-foraging-algorithm (Hb_Fa) and Honey-bee-Mating-algorithm (Hb_Ma) in Omnimetrics[#]

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CONSPECTUS

Background

The implicit knowledge of bio-processes of honey bees in hive site selection, foraging, communication of status of nectar resources through waggle dance, defense against invaders, mating, fertilization and brood care in nature is mimicked in nature inspired optimization algorithms. This tutorial, Eman.Hb_Fa and brood care, Eman.Hb_Ma is focused around pedagogy of state-of-honeybee_inspired_algorithms in Omnimetriccs and futuristic research in chemical sciences by 2020.

Honey bees in nature:The honey bees in nature fulfills the diverse traits viz. site selection for hive, honey bee hive building /maintenance/defense, foraging food, conversion of nectar from the flower patches into honey in its gut through a series of biochemical changes, preserving honey for long shelf life etc. The honey making process begins with the secretion of an enzyme on the nectar in the work bee stomach. The bee unloads the nectar to empty honeycomb cells and some extra substances are added in order to avoid the fermentation and the bacterial attacks. The filled cells with the honey and enzymes are covered by wax.

*Honey bee dances:*The waggle dance, round dance, jostling dance, tremble dance, grooming dance, and jerking dance are expressions of the honeybees after grasping the angle between sun-hive-food source and the effort needed or distance of the flower patch from the hive. They also communicate new hive selection through dance patterns. The queen bee performs a pre-mating flight dance to inform the drones of the colony.

Honey bee foraging algorithm (HB_Fa): An off shoot sprinkle from knowledge pool of Mother Nature is the inspiration for artificial bee algorithm (ABC). Koraboga group proposed it in the year 2005.The location of flower patches corresponds to the converged solution and amount of nectar to fitness function value. The search of foraging/scout bees (for better sources of food) is similar to global and neighborhood search of optimum solutions on response surface. The onlooker bees' decision to continue or reject the food source is akin to continue the local search or to start afresh from another location. The basic version of ABC underwent several modifications over a decade and is now one of the trustworthy procedures in

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[##]**Part 6:** *J. Applicable Chem.*, **2015,** 4(6): 1597-1690.

the nature inspired algorithm warehouse. The modifications include Levy flight in initiation of artificial foraging bees. The functioning of foraging algorithm for different simulated and real life data sets are compared with GA, PSO, DE and PS_EA. The binary hybridization of Hb_Fa with Levy flightdistribution,Grenade Explosion, chaotic probes, heuristic search methods and neighbourhood structure increased the potential/scope of algorithm. A part of honey bee dance is translated in bee dance algorithm and improvements for wide spread use are awaited

HB_Fa applications: The applications spread into diverse tasks viz. nuclear power reactors, protein sequence prediction, electrical power generation/distribution, image analysis, clustering, and communications. Hb_Fa has success in continuous/discrete optimization of several simulated bench mark functions.

Queen bee mating in nature:The function of a queen bee is to participate in mating flights with a series of drones until the spermatheca is full, generation of broods almost all through its life span (i.e. over a period of three to four years). Drones are male species of honeybee family and what all they do is participating in mating flight with queen bee. Any of the individual members of honey bee family, right from long lived queen, drones dying immediately after mating with queen/driven off from the hive in winter, work-bees/foraging bees do not have intelligence leave alone super-/hyper-intelligence. But, not only the life cycle but also a stable species all over the globe in widely varying environment is a just consequence of common genetic expressed knowledge, sharing information, communication amongst them, following hierarchy, performing its duty in Toto, service/sacrifices. The special biochemical skills inherited through genes in synthesis of royal jelly (a food material for queen), stickysubstance for hive, pheromones to keep female work bees sterile normally and so on. Any of tasks cited, leave alone all in such a tiny size in an artificial honeybee is no doubt beyond realm with today's artificial intelligence tools.

Honey bee mating algorithm (HB_Ma): The honey bee mating algorithm translated from part of queen bee mating with drones can be understood in a nut shell as a combination of simulated annealing, genetic algorithm and local search procedures.Thequeen has best genes and they continue both in female and male off spring in unfertilized and fertilized eggs. It is similar to elite preservation. The different versions mathematical procedures used a variety of cross-over/ mutation operators, altruism, multiple-populations, Pareto front etc. Care taking of broods by work bees is equivalent to applying heuristics in refinement of solution. One of the popular paradigms, chaotic local search is used to generate initial population of broods and improved local refinement. Hb_Ma found a niche in industrial synthesis of phthalic anhydride, simulation of cancer, optimization of solar cell model parameters, electrical thermal power systems/ distribution, dispatch of power and time series tasks. It hybridized with SAA, neighborhood structure, chaotic search, Linde–Buzo–Gray (LBG), vector quantization, fuzzy sets, greedy search, cooperative PSO and so on. The efficiency and cost to benefit ratios are compared with performance of PSO, Binary_PSO, Hybrid cooperative- comprehensive- learning based PSO algorithm (HCOCLPSO), Fast Otsu's method, fuzzy logic, Nelder–Mead simplex search + PSO [PSO-NM], ACO, exhaustive search, GA and Taboo search.

A few key features of honey bee mating translated into mathematical frame in Hb_Ma are (a) queen honey bee choosing a drone of highest fitness through matching her flying speed with that of drone (b) decrease of speed after every mating (c) pooling up sperm of different drones until spermatheca is full, (d) worker bee care of broods by feeding with royal jelly and other foods. In mathematical frame they correspond respectively to probability, annealing schedule, pooling up all best basic tools (with a little difference) at one place and local heuristic procedures. The definition base and jpeg images are integrated with in-house matlab programs for display purpose. E-man_ToolBox is updated with honey bee specific m-functions.

Keywords:E-man, Honeybee, Foraging, Mating, algorithm, Multi-object-functions, Nature mimicking mathematical procedures, knowledge_bio_processes,heuristics_choice_program_flow.