Research Rapport

Research Topic: Using Density-Based Clustering to enhance particle swarm optimization convergency.

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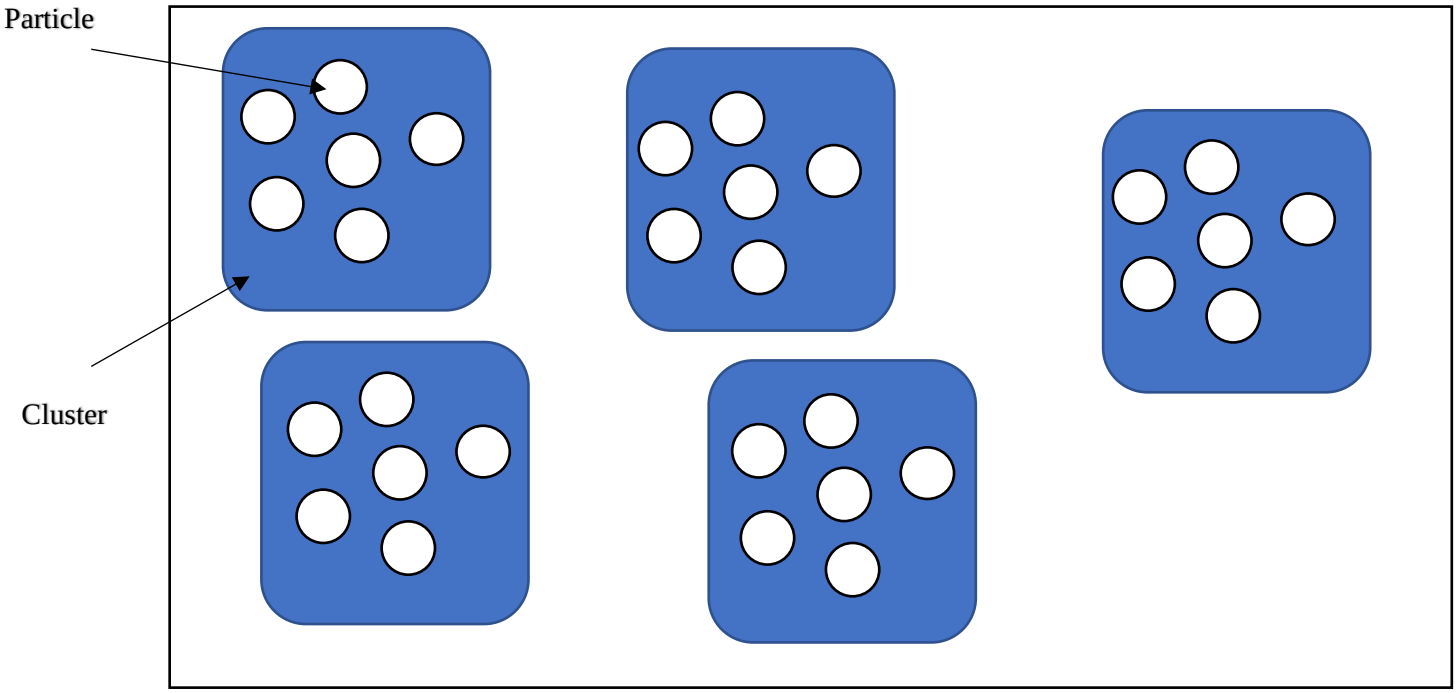
Introduction

Particle swarm optimization also known as PSO is a well-known clustering algorithm meanly used for continuous problems, and also it has been converted to be used in combinatorial problem, this algorithm is swarm oriented that use particle social and cognitive components to get into the global optimum, due to its simple implementation and concept, PSO attracted researchers from it birth, and multiple papers has been written to enhance initial PSO, in this rapport we show a new idea that use a

Method Implemented

We start by defining a very standard particle swarm optimization, consider n particles with random position, then a clustering using Density-Based Spatial Clustering of Application with Noise Algorithm meanly named DBSCAN algorithm is used to cluster this particle based on their position as shown here:



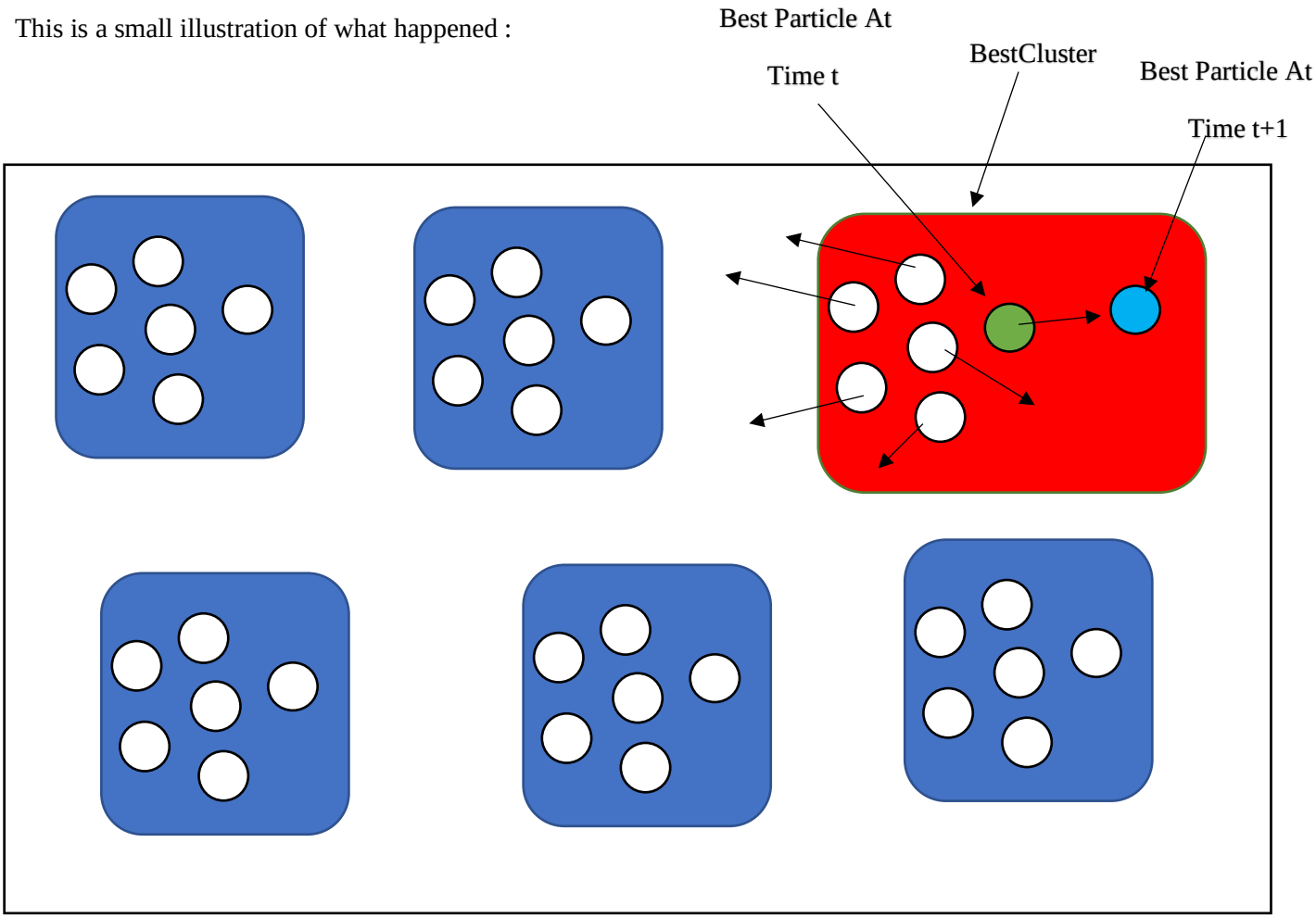
In every Iteration the cluster that contains the best particle so far is named BestCluster, Then the new velocity of a particle is equal:

new_v = w.old_v + c0 * r1 * (p_best – x) + c1 * r2 * (lbest – x)

Where w is the interia, c0 and c1 are the cognitive and social component, r1 and r2 random number between 0 and 1 , p_best is the personal best of particle , and lbest if the best of the BestCluster that contains the best particle, note that maybe the best particle in BestCluster has been moved before attempting this iteration of this particle.

Then the positions are updated using new_x = old_x + new_v, and we cluster the new position using the same methods.

This is a small illustration of what happened :



As shown here, The best cluster particle moves based to formulas, and then the lbest is determined after we determined the BestCluster and particle moves due to particle swarm moves , then all others particle are affected by this cluster , so BestCluster is the set of neighborhood or the Topology of our PSO.

This Method Show A High Convergency when we applied to CEC 2005 Benchmarks Functions for 30 dimensions :

#1 Function Sphere-- > Value : 9.832379255206995e-299 Position 1.786793500708045e-1501.79756015480608e-1501.8797018549335998e-1501.851897806158718e-1501.8590382630414659e-1501.836104916692804e-1501.7834472071191044e-1501.9214316277427e-1501.732445465135891e-1501.8380176780809667e-1501.7278644149513874e-1501.70271383731485e-1501.7573394684748853e-1501.7251737031789602e-1501.8056709025329836e-1501.8985016313793293e-1501.8110543300496525e-1501.8600908920206362e-1501.7927470189451993e-1501.8536682041466157e-1501.788573148021358e-1501.7789102924966426e-1501.8611041712641522e-1501.7788160827975724e-1501.8324932430094988e-1501.8129910330461368e-1501.7453224574637818e-1501.7177452061326738e-1501.8547864965562325e-1501.8921689943578173e-150

#2 Function De Jong's f4 -- > Value : 0.0 Position 1.5086542831200246e-1322.2754961099088314e-132-8.768800548865495e-133-7.079326805969118e-1332.0147941909158323e-1325.081575325799396e-133-5.888686689605595e-134-7.920129070800548e-1331.464328726301094e-132-9.412487899097047e-1338.860551452404672e-1348.990548275477576e-1331.5812344723220727e-1328.601025236098694e-1336.467788272793767e-133-2.2780680108186214e-1331.1794106543388031e-132-9.707148316677382e-1337.620922533798019e-1338.144001177397623e-133-1.8548849873748473e-1336.824523493526127e-1331.2028936710321444e-1323.652735766771745e-1337.121597326457053e-1331.084692084159143e-132-5.1186021066919474e-1335.652750575460113e-1337.64725844950032e-1331.5760480068880258e-132

#3 Function Griwank -- > Value : 0.0 Position -2.6028676364278357e-109-1.377223788064852e-108-9.466467614653913e-109-9.985215110544486e-111-1.1007443932765707e-108-8.889891612656597e-109-1.3145661070145538e-108-1.8332065964764558e-109-8.528949240670685e-109-1.2043012094669213e-108-1.0497430585738e-108-9.702164776656064e-109-2.460575311348324e-109-8.361985452470331e-109-3.3270433449891136e-109-1.2700235098768054e-109-8.285502572851288e-109-1.1713061225005062e-108-9.171115431250212e-109-7.748867408565928e-109-1.5217898953083319e-109-7.863481250008463e-1092.7252496307729872e-1091.9697443930548413e-111-1.1080123094859316e-108-4.663151296014027e-109-4.9207798590026786e-110-6.137855216665233e-109-5.642211604615245e-109-5.634130881866654e-109

#4 Function Rosenbrock -- > Value : 0.0 Position 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0

#5 Function Alpine -- > Value : 1.3081570667269333e-95 Position -3.1475806305434025e-96-3.0197837595714037e-96-3.1606379566348423e-96-6.157265500020618e-96-4.779450040607601e-96-3.0137109111749054e-96-3.865930446719059e-96-6.852532225242617e-96-3.843882468728446e-96-4.988457898171429e-96-5.026478011109576e-96-5.126208971421152e-96-3.044231894168622e-96-4.111131103739226e-96-2.8922766820177336e-96-4.268291422511762e-96-3.6255557640403937e-96-5.607887854827649e-96-5.3503923449121706e-96-3.141944683555148e-96-3.1909119681142236e-96-4.08015317907582e-96-4.890603741784019e-96-5.225389841077724e-96-5.8461959831799384e-96-3.990134020940015e-96-6.65694118331192e-96-4.382929122298224e-96-4.618530930368785e-96-2.9102861328248997e-96

#6 Function Rastrigin -- > Value : 0.0 Position 2.7122681136499363e-1472.612781752500083e-1472.822982879157447e-1472.4366940107933657e-1472.6780441162915215e-1472.5050165287884046e-1472.5683023897070037e-1472.577500821265019e-1472.7578239743138925e-1472.4991318713118543e-1472.4739378021482297e-1472.579089252433209e-1472.676531482943912e-1472.546251270377387e-1472.3549065531673596e-1472.4381840486411793e-1472.3729832438880522e-1472.703087828080203e-1472.532008948530749e-1472.3757506982438153e-1472.4051797169038204e-1472.545577231346892e-1472.2786245789011373e-1472.594748949377054e-1472.8561344425859215e-1472.651456046555975e-1472.6042606855752647e-1472.7804907011772145e-1472.4993610727590608e-1472.6496788679334587e-147

#7 Function Ackley -- . Value : 4.440892098500626e-16 Position -1.5461366812536553e-76-1.545260214144506e-76-1.550091880951587e-76-1.555824655881682e-76-1.5294812950710114e-76-1.5514779695500805e-76-1.5607220684858628e-76-1.566150541789634e-76-1.5565593997990834e-76-1.536889947468025e-76-1.5545918654389e-76-1.560744064547671e-76-1.5321814226716717e-76-1.5311936379377503e-76-1.5455187457111833e-76-1.5284593412985526e-76-1.5449941691297167e-76-1.5617290307543672e-76-1.5443240312747995e-76-1.5738960951155996e-76-1.5559779430966685e-76-1.568778532413898e-76-1.5431859548205287e-76-1.5352423438940283e-76-1.5364851306858106e-76-1.555445639389123e-76-1.549711683647921e-76-1.5550514248508924e-76-1.5590158162610942e-76-1.532270442574326e-76

Not Converged !!

#8 Function Easom -- > Value : -0.9446227767970615 Position 3.20687890239923372.958145259375199

Not Converged !!

#9 Function Schwefel -- > Time Used : 13.628081321716309 Value : -1.6211998896912043e+25 Position 3.6765772491040515e+23-3.4307887398200553e+24-5.648788061539264e+24-2.3930485540310178e+24-4.3186370262984216e+24-4.174209466220214e+24-3.596580370838932e+24-3.097547723889754e+24-3.7536006611791565e+24-1.498371205884654e+24-3.672494822359424e+24-1.7967803297410528e+24-

2.473539816098874e+24-2.481086799826709e+24-4.727120710451519e+23-
2.2562746620707992e+241.8131819230613202e+24-1.1627503587687553e+24-
1.9250035613929114e+23-1.8212519745121743e+24-7.752027042181283e+23-
2.494422922703195e+24-1.0417713142635874e+235.8479780270489384e+23-
4.133453172271371e+24-6.744057692543307e+23-1.5040197240359197e+24-
1.223633415622391e+24-2.568846054597611e+24-1.3065462699507325e+24

#10 Function Exponotial -- > Value : -0.006011950448530001 Position -6642513145.9880085-
9580288062.582855-9625172464.68651-9385725086.755798-9036442365.98151-9737844141.341782-
6026109220.631178-9743512720.383606-9758856757.735298-9013243337.701267-
11711038183.928999-9709988094.010075-8784355700.586863-9256923845.817623-
8471619891.173924-8193670064.407568-12810489700.32044-6560019125.826594-9454205022.81266-
7997801359.574433-8903895948.679808-5992308145.920856-6814670529.499521-
10020626537.865196-7944210466.895536-7050028188.744262-9114861502.888607-
7313791416.335159-8839065403.357853-9642004464.972181

#11 Function Shifted Rosenbrock -- > Time Used : 14.584908246994019 Value : 390.0 Position 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0

#12 Function Shifted Rastring -- > Time Used : 14.957834959030151 Value : -330.0 Position 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0

#13 Function Shifted Griwank -- > Time Used : 16.436950206756592 Value : -209.0 Position 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0

#14 Function Shifted Ackley -- > Time Used : 17.66410732269287 Value : -139.9108841216742
Position 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0

#15 Function Shifted Sphere -- > Time Used : 18.624988794326782 Value : -450.0 Position 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0

#16 Function Shifted Shwefel -- > Time Used : 19.417243242263794 Value : -450.0 Position 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
1.0