Particle Swarms in Sizing and Global Optimization

by

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Abstract

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In this work, the particle swarm optimization algorithm (PSOA) is implemented, evaluated and studied. A number of recently proposed variations on the PSOA are also considered. The algorithm and it's variants are applied to, firstly, an extended Dixon-Szegö bound constrained global test set, and secondly, the sizing design of truss structures.

Using the extended Dixon-Szegö test set, it is shown that the constriction variant as proposed by Clerc, and the dynamic inertia and maximum velocity reduction variant proposed by Fourie and Groenwold, represent the main contenders from a cost efficiency point of view.

In the interests of finding a reliable general purpose 'off-the-shelf' PSOA for global optimization, a parameter sensitivity study is then performed for the constriction and dynamic inertia and maximum velocity reduction variants. In doing so, it is shown that inclusion of dynamic inertia renders the PSOA relatively insensitive to the values of the cognitive and social scaling factors.

The constriction and dynamic inertia and maximum velocity reduction variants are then applied to the optimal sizing design of truss structures. While few results with the PSOA for constrained problems have previously been presented, a simple approach is proposed herein to accommodate the stress and displacement constraints during the initial stages of the swarm searches. Increased social (peer) pressure, at the cost of cognitive learning, is exerted on infeasible birds to increase their rate of migration to feasible regions.

Extensive numerical results are presented for the extended Dixon-Szegö test set, as well as a number of well known truss structures with dimensionality of up to 21. The results indicate the suitability of the gradient free PSOA for the two programming classes considered.

Opsomming

Titel:	Partikel Swerms in Afmetingsontwerp en Globale Optimering
Auteur:	Jaco. F. Schutte
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In hierdie verhandeling word die partikel swerm optimeringsalgoritme (PSOA) geimplementeer, ge-evalueer en bestudeer. Verskeie onlangs voorgestelde variasies op die PSOA word ook beskou. Die algoritme en die variasies daarop word dan toegepas op, eerstens, 'n uitgebreide Dixon-Szegö stel rand begrensde globale toetsprobleme, en tweedens, die afmetingsontwerp van stangstrukture.

Met behulp van die uitgebreide Dixon-Szegö toetsprobleme word aangetoon dat die inkrimping variant, voorgestel deur Clerc, en die dinamiese momentum en maksimum snelheid vermindering variant voorgestel deur Fourie en Groenwold, die belangrikste mededingers is vanuit 'n oogpunt van koste effektiwiteit.

In belang van die formulering van 'n betroubare, algemeen toepasbare PSOA vir globale optimering, word 'n parameter sensitiwiteit studie gedoen vir die inkrimping en die dinamiese momentum en maksimum snelheid vermindering variante. Hierdie studie toon aan dat die insluiting van dinamiese momentum vermindering die PSOA onsensitief maak vir waardes van die kognitiewe en sosiale skaleringsfaktore.

Die inkrimping en dinamiese momentum en maksimum snelheid vermindering variante word dan toegepas op die probleem van optimale ontwerp van stang strukture. Alhoewel min resultate voorheen met die PSOA vir begrensde probleme bereken is, word 'n eenvoudige benadering hierin voorgestel om spanning- en verplasingsbegrensings gedurende die aanvanklike stadiums van die swerm soektog te hanteer. Verhoogde sosiale druk (groepsdruk) word ten koste van kognitiewe leer op ontoelaatbare partikels toegepas. Hiermee word gepoog om die migrasie tempo na gunstige gebiede te bespoedig.

Omvattende numeriese resultate word voorgelê vir die uitgebreide Dixon-Szegö toetsprobleme, asook 'n paar bekende stangstrukture met dimensionaliteit van tot 21. Die resultate toon die toepaslikheid van die gradiëntlose PSOA vir die twee programmeringsklasse onder beskouing aan.

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