# Chapter 4 Ant Colony Optimization Algorithm for Electrical Power Systems Applications: A Literature Review

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## ABSTRACT

Optimization has been an active area of research for several decades. As many real-world optimization problems become increasingly complex, better optimization algorithms are always needed. Recently, meta-heuristic global optimization algorithms have become a popular choice for solving complex and intricate problems, which are otherwise difficult to solve by traditional methods. This chapter reviews the recent applications of ant colony optimization (ACO) algorithm in the field of electrical power systems. Also, the progress of the ACO algorithm and its recent developments are discussed. This chapter covers the aspects like (1) basics of ACO algorithm, (2) progress of ACO algorithm, (3) classification of electrical power system applications, and (4) future of ACO for modern power systems application.

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## Box. List of symbols

Symbol	Definition
$\tau_{ij}$	pheromone trail deposit ed between city <i>i</i> and <i>j</i> by ant <i>k</i> ,
$\alpha$ and $\beta$	two parameters which influence the relative weight of pheromone trail and heuristic guide function,
$\eta_{ij}$	visibility or sight and equal to the inverse of the distance or $(= 1/d_{ij})$ .
$\eta_{ij}$	transition cost between city <i>i</i> and <i>j</i>
<i>q</i>	cities that will be visited after city <i>i</i> ,
$N_i^k$	a tabu list in the memory of ant that recodes the cities visited to avoid stagnations
$\tau_{ij}(t+1)$	pheromone after one tour or iteration
ρ	pheromone evaporation
ε	elite path weighting constant
$\tau_o = 1/d_{ij}$	incremental value of pheromone of each ant
λ	large positive constant
d <sub>best</sub>	shortest tour distance.
$P_{gj}$ and $Q_{gj}$	active/reactive power outputs from the generator bus j
$P_{dj}$ and $Q_{dj}$	active and reactive power demand at bus <i>j</i> ,
$V_i$ and $V_j$	voltages at sending end <i>i</i> and receiving end <i>j</i> ,
$Y_{ij}$ and $\theta_{ij}$	admittance magnitude and angle between buses <i>i</i> and <i>j</i>
$\delta_i$ and $\delta_j$	phase angles of voltages at buses <i>i</i> and <i>j</i> ,
$P_{DGj}$ and $Q_{DGj}$	active and reactive power injections at location <i>j</i> ,
QCj	the reactive power injection at location <i>j</i> .
VSI <sub>j</sub>	the voltage stability index of bus <i>j</i> ,
Vi,	the voltage magnitude of sending end bus <i>i</i>
$P_j$ and $Q_j$	the total active and reactive power load fed through bus <i>j</i> ,
$R_{ij}$ and $X_{ij}$	the resistance and reactance of the line connected buses <i>i</i> and <i>j</i> , respectively.
$w_1, w_2$ and $w_3$	weighting factors.
P <sub>Loss</sub>	the total real power loss
$P_i$ and $Q_i$	the net active and reactive power at bus <i>i</i> ,
$N_b$	the system buses number.
R <sub>ij</sub>	line resistance between buses <i>i</i> and <i>j</i> ,
VD	total voltage deviation
VSI	voltage stability index
$G_{ij}$ and $B_{ij}$	mutual conductance and susceptance between bus <i>i</i> and <i>j</i> ,
N <sub>PQ</sub>	load buses number
$P_{L_i}$ and $Q_{L_i}$	active and reactive power demand at bus i
$Q_{C_i}$	capacitive or inductive power of existing VAR source installed at bus <i>i</i> .
N <sub>pv</sub>	total number of voltage-controlled buses;
	tapping change of a transformer
N	total number of on-load tap changing transformers.

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