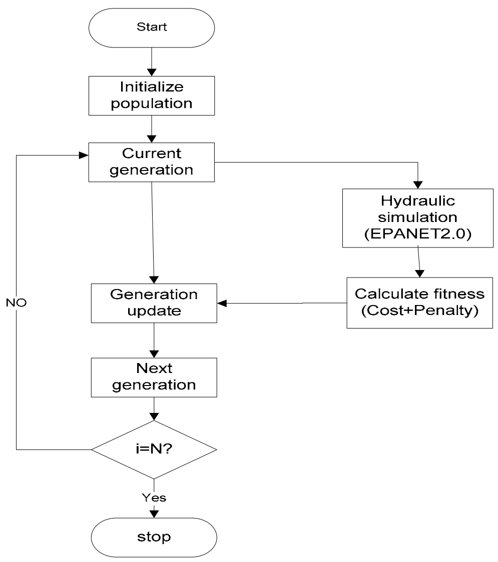
Appendix A. General flow chart for WDN optimization using evolutionary algorithm

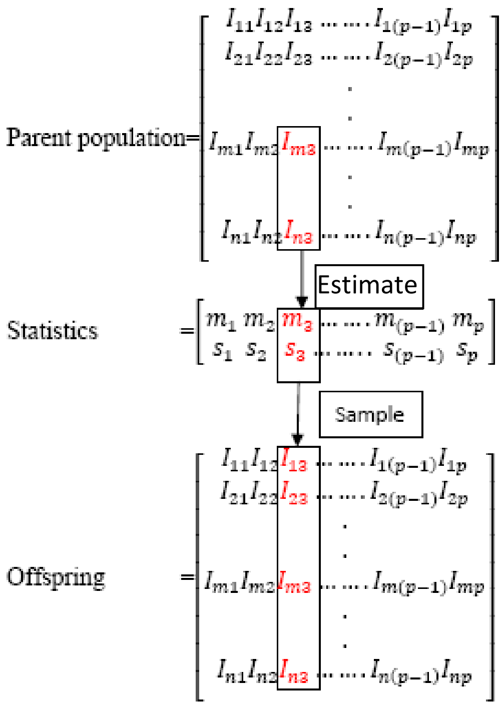


(Note:" i" is the generation index and "N" is the maxim number of generations)

Appendix B1. Typical EDA algorithm pseudo codes

P <= Initialize the population
Evaluate the initial population
While iter_number $\leq$ Max_iterations do
P_s<= Select the top s individuals from p
M<= Estimate a new Model from P_s
P_n <= Sample n individuals from M
Evaluate P_n
P<= Select n individuals from $P \cup P_n$
iter_number =iter_number +1
End while

Appendix B2. Flow chart of distribution estimation (sorted by descending order)



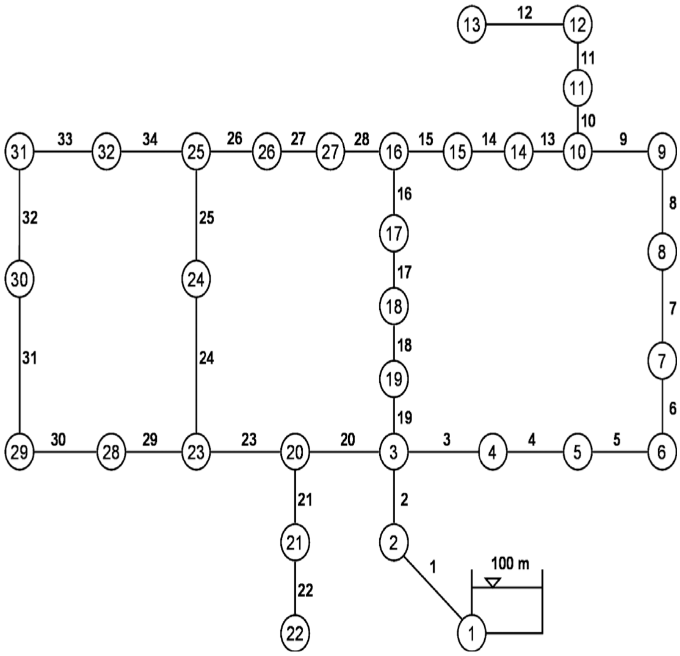
where n is the population size; p is the dimensionality of the problem; m is the mean value of the corresponding dimension; s is the standard deviation of the dimension. The above flow chart shows the process of updating diameters of pipes in the offspring population by the Gaussian distribution calculated according to the top individuals in the parent population.

Appendix C. Pseudo codes for the improved sequential PSO-EDA (ISEDPSO) algorithm

Algorithm 2 ISEDPSO

```
1: Initialization for PSO: set the initial positions: X_m^n (t=0), initial velocities V_m^n(t = 0) , personal
       best positions Ẍ_m^n(t=0) , global best position Ω_m^n(t = 0) and historical best H_m^n(t=0).
       (n is population size, m is dimensionality).
2: While t ≤ Max_iterations && t > M_s do
4:     Update the X_m^n(t), V_m^n(t), Ẍ_m^n(t), Ω_m^n(t) according to equation (9) and (10).
5:        If MOD(t, M_f)==0
6              Rank the mixture of Ẍ_m^n(t) and H_m^n(t-1) according to their finesses (ascending).
7:            Take 50% of the top individuals in the mixture as H_m^n(t) as sample for EDA.
8:            Estimate the probabilistic distribution model using H_m^n(t).
9:            Generate n new individuals T_m^n(t) using the estimated distribution model and
              evaluate them.
10:            Mixture T_m^n(t) and H_m^n(t), rank the mixture according to fitness (ascending).
11:           Take better half of the mixture as H_m^n(t).
12:           Use H_m^n(t) to update Ẍ_m^n(t) again.
 13           End If.
14:     t =t +1;
15: End While
```

Appendix D1. Hanoi network (Fujiwara 1991)



Appendix D2. Balerma network (Reca 2006)

Appendix E. The optima achieved for the Balerma network

Best Solution achieved in the present study for the Balerma network is listed below. The numbers are the pipe diameter indexes for all the pipes in the network. The network EPANET file and pipe index can be found in the following link which is provided by Reca (2006).

ftp://ftp.agu.org/apend/wr/2005wr004383.

1	1	1	7	4	4	4	1	4	1	1	2	3
	1	1	1	1	1	1	1	1	7	1	1	7
	1	1	1	1	7	1	1	1	1	1	1	1
	1	3	3	1	1	1	1	1	1	1	1	1
	1	1	1	1	2	2	2	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	4	4	3	1
	1	1	1	1	1	1	2	1	1	1	1	1
	4	4	1	1	1	1	1	1	1	1	5	6
	1	1	1	1	6	1	1	1	7	6	6	1
	1	6	1	1	1	7	1	1	1	1	1	1
	1	1	1	7	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	8	3	2	1	1
	2	1	2	1	1	1	6	6	7	3	2	2
	1	1	1	1	7	1	1	1	4	1	1	4
	7	7	1	1	5	5	1	1	1	1	2	1
	1	8	8	3	3	3	2	8	1	7	1	1
	1	8	1	1	1	1	1	9	1	1	1	1
	1	1	1	1	1	2	2	1	3	3	1	1
	4	5	4	7	5	1	1	1	4	4	3	2
	1	1	1	1	3	1	1	1	1	1	1	1
	3	1	1	1	2	3	9	8	8	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	6	4	3	2	1	1	1	1	1	1
	1	1	6	1	1	3	1	6	5	4	4	4
	1	1	1	1	1	1	1	7	7	8	7	7
	7	4	7	1	1	1	1	1	7	1	1	1
	1	1	4	1	1	1	1	1	1	1	2	1
	1	1	1	1	1	6	6	1	1	1	1	1
	1	1	1	1	1	1	1	2	2	2	1	3
	1	1	6	6	2	2	1	1	2	2	1	1
	1	1	1	1	1	7	1	1	1	1	8	1
	1	1	8	8	1	1	1	1	1	1	1	5
	1	6	3	6	1	5	5	4	4	1	1	1
	4	1	4	1	1	1	1	7	7	7	7	8
	8	8	1	1	3	1	4	7	8	1	1	1
	1	5	1	1	7	1	1	2	1	1	1	8
	1	7	3	1	6	1	1	5	1			

References for the Appendix

1. Fujiwara O, Khang D B. Correction to a two-phase decomposition method for optimal design of looped water distribution networks. Water Resources Research, 1991, 27(5), 985–986
2. Reca J, Martinez J. Genetic algorithms for the design of looped irrigation water distribution networks, Water Resource Research. 2006, 42, W05416, doi:10.1029/2005WR004383