Automatic Design of Evolutionary Algorithms for Multi-Objective Combinatorial Optimization

Supplementary Material

Leonardo C. T. Bezerra, Manuel López-Ibáñez, and Thomas Stützle

IRIDIA, CoDE, Universit Libre de Bruxelles, Brussels, Belgium
{lteonaci,manuel.lopez-ibanez,stuetzle}@ulb.ac.be

Abstract. Multi-objective evolutionary algorithms (MOEAs) have been the subject of a large research effort over the past two decades. Traditionally, these MOEAs have been seen as monolithic units, and their study was focused on comparing them as blackboxes. More recently, a component-wise view of MOEAs has emerged, with flexible frameworks allowing the combinations of algorithmic components from different MOEAs. The number of available algorithmic components is large, though, and an algorithm designer working on a specific application cannot analyze all possible combinations. In this paper, we investigate the automatic design of MOEAs, extending previous work on other multi-objective metaheuristics. As test benchmark, we use four variants of the permutation flowshop problem that differ as to the number and nature of the objectives they consider. Moreover, given the different characteristics of the variants, we also investigate the performance of an automatic MOEA designed for the multi-objective PFSP in general. Our results show that the automatically designed MOEAs are able to outperform six traditional MOEAs, thus confirming the importance and efficiency of the automatic design methodology.

List of Tables

List of Figures

Table 1: Parameter settings chosen by irace for all MOEAs on Cmax-TFT. Column *Other* refers to parameters specific to a given MOEA.

Cmax-TFT

MOEA	*pop*	*off*	p_C	p_{mut}	p_X	*Other*
HypE	30	91%	29%	78%	28%	-
IBEA	30	96%	15%	91%	27%	I_ϵ
MOGA	50	160%	14%	67%	36%	$\sigma = 0.39$
NSGA-II	20	123%	38%	90%	37%	-
PAES	10	-	-	-	7%	$l = 2$
SMS-EMOA	10	-	31%	76%	34%	-
SPEA2	20	128%	20%	91%	31%	$k = 3$

Cmax-TT

MOEA	*pop*	*off*	p_C	p_{mut}	p_X	*Other*
HypE	30	88%	68%	100%	25%	-
IBEA	30	109%	44%	97%	17%	I_ϵ
MOGA	30	121%	56%	86%	33%	$\sigma = 0.32$
NSGA-II	20	104%	25%	96%	7%	-
PAES	10	-	-	-	9%	$l = 2$
SMS-EMOA	10	-	14%	93%	14%	-
SPEA2	10	128%	47%	86%	38%	$k = 3$

TFT-TT

MOEA	*pop*	*off*	p_C	p_{mut}	p_X	*Other*
HypE	100	179%	13%	100%	53%	-
IBEA	30	157%	75%	96%	18%	I_ϵ
MOGA	20	129%	23%	84%	48%	$\sigma = 38$
NSGA-II	80	162%	62%	100%	41%	-
PAES	30	-	-	-	21%	$l = 2$
SMS-EMOA	10	-	31%	90%	34%	-
SPEA2	20	49%	44%	87%	33%	$k = 1$

Cmax-TFT-TT

MOEA	*pop*	*off*	p_C	p_{mut}	p_X	*Other*
HypE	50	158%	82%	96%	29%	-
IBEA	30	157%	51%	68%	44%	I_ϵ
MOGA	20	120%	69%	96%	36%	$\sigma = 0.81$
NSGA-II	50	171%	25%	79%	32%	-
PAES	10	-	-	-	19%	$l = 2$
SMS-EMOA	10	-	41%	87%	40%	-
SPEA2	10	142%	53%	57%	31%	$k = 6$

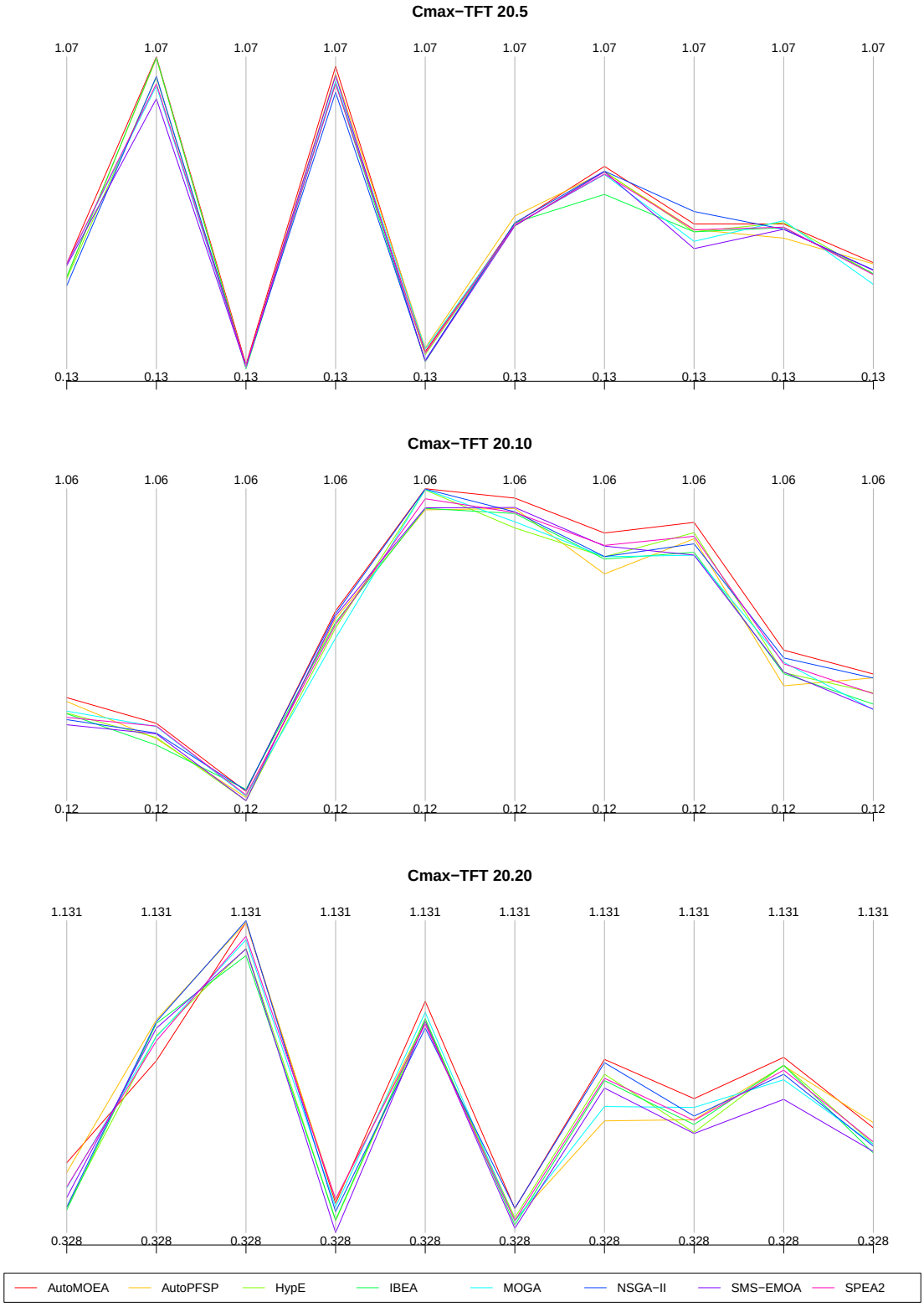

Fig. 1: Average hypervolume over 10 runs on 10 instances with 20 jobs each of Cmax-TFT.

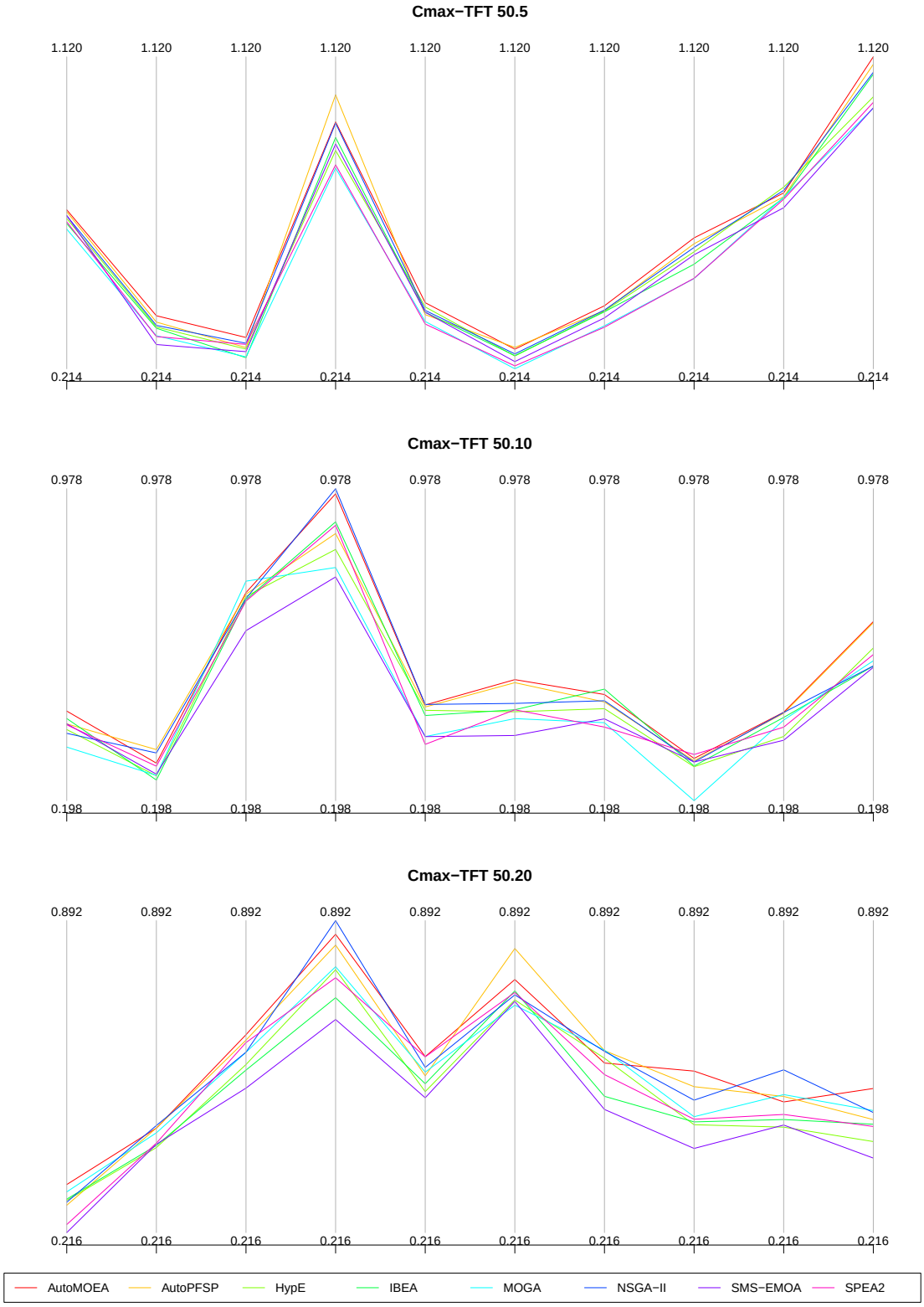

Fig. 2: Average hypervolume over 10 runs on 10 instances with 50 jobs each of Cmax-TFT.

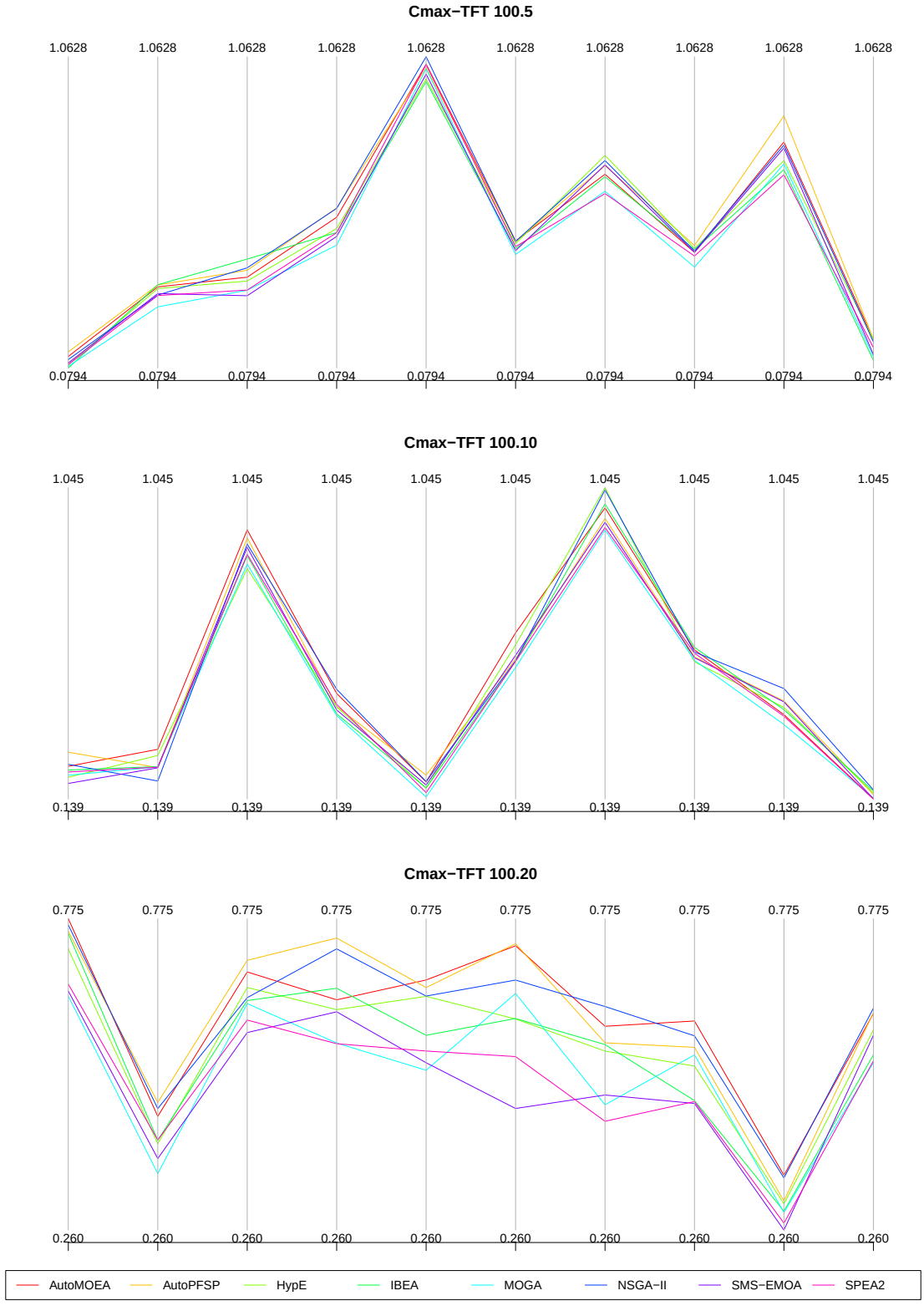

Fig. 3: Average hypervolume over 10 runs on 10 instances with 100 jobs each of Cmax-TFT.

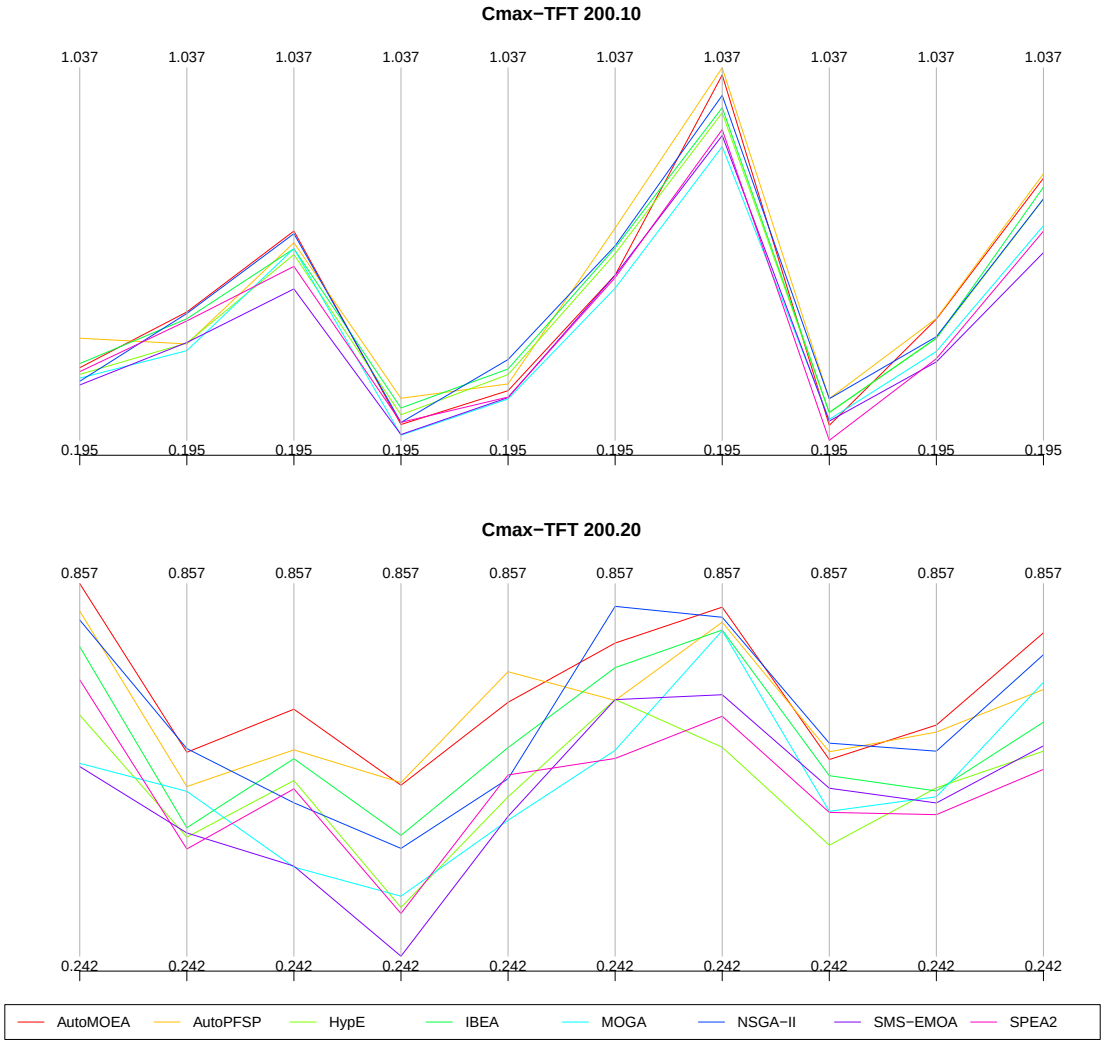

Fig. 4: Average hypervolume over 10 runs on 10 instances with 200 jobs each of Cmax-TFT.

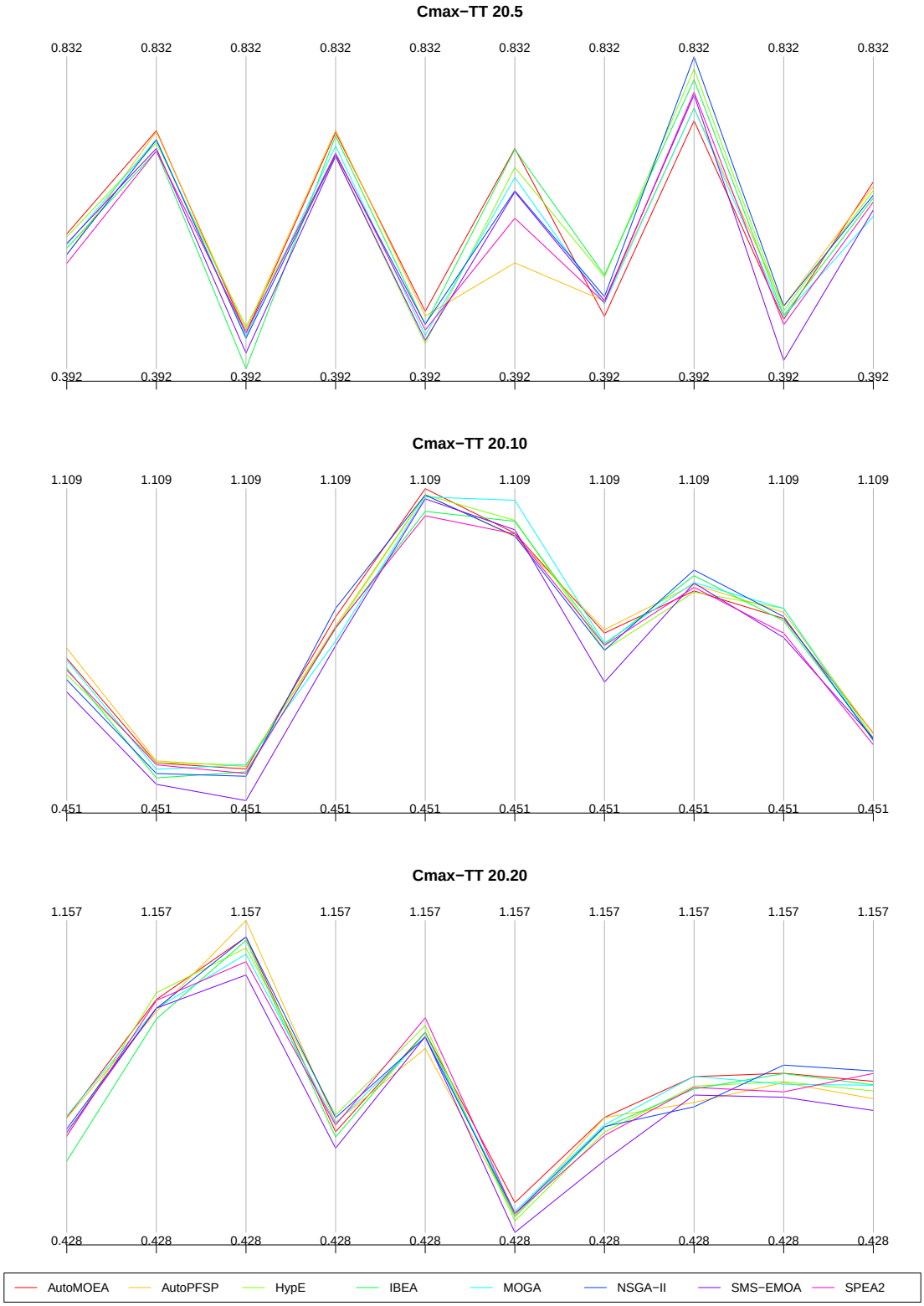

Fig. 5: Average hypervolume over 10 runs on 10 instances with 20 jobs each of Cmax-TT.

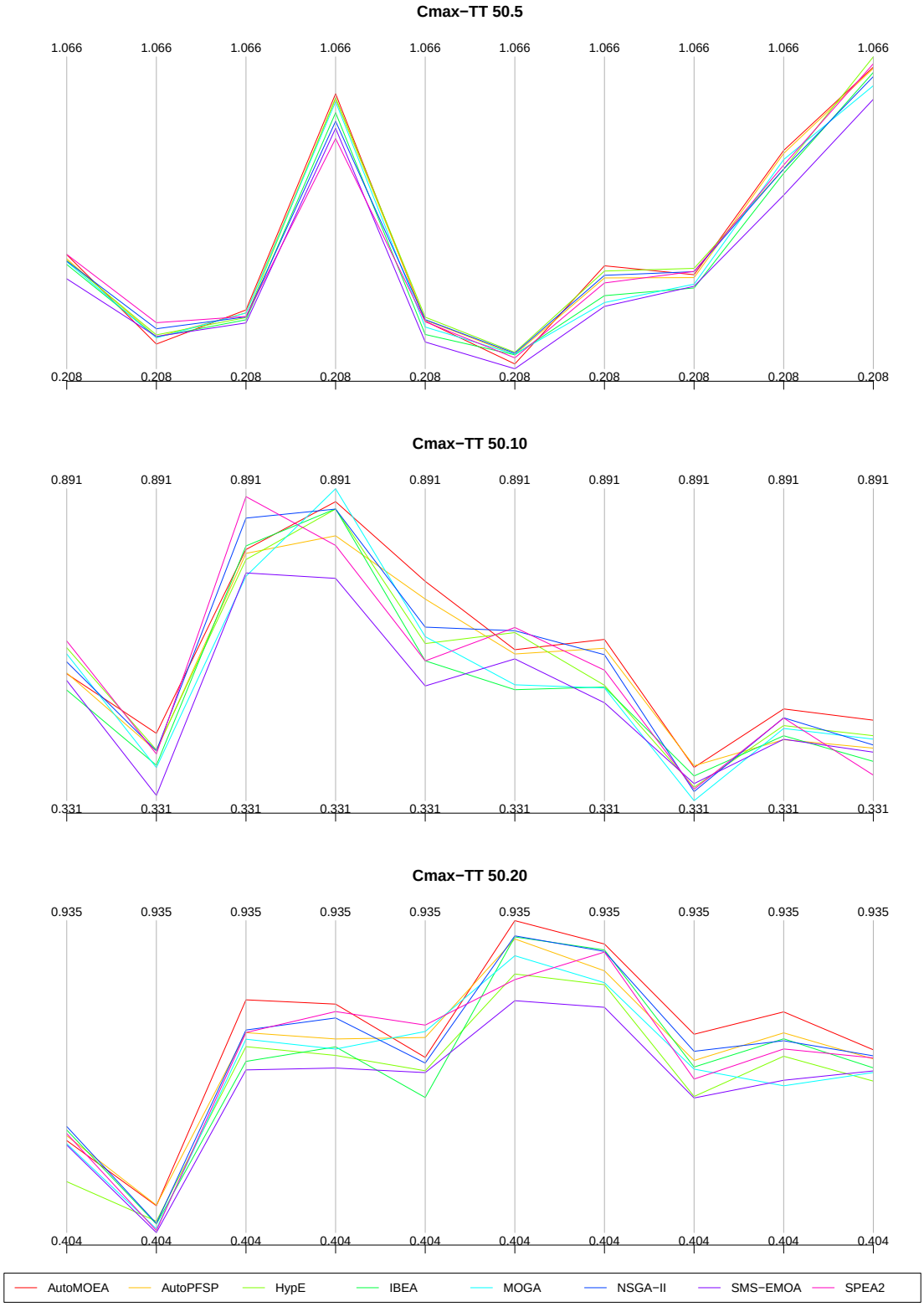

Fig. 6: Average hypervolume over 10 runs on 10 instances with 50 jobs each of Cmax-TT.

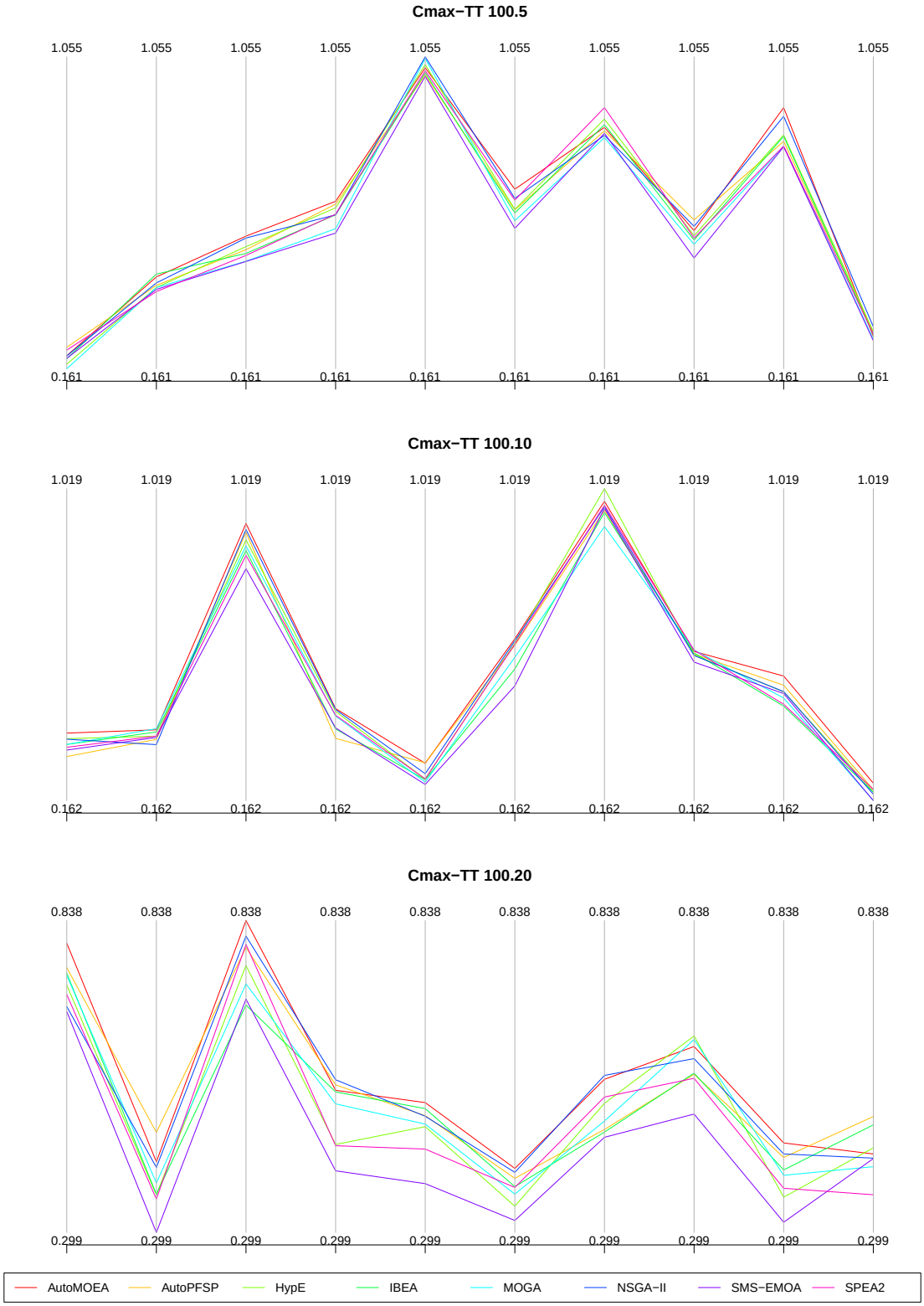

Fig. 7: Average hypervolume over 10 runs on 10 instances with 100 jobs each of Cmax-TT.

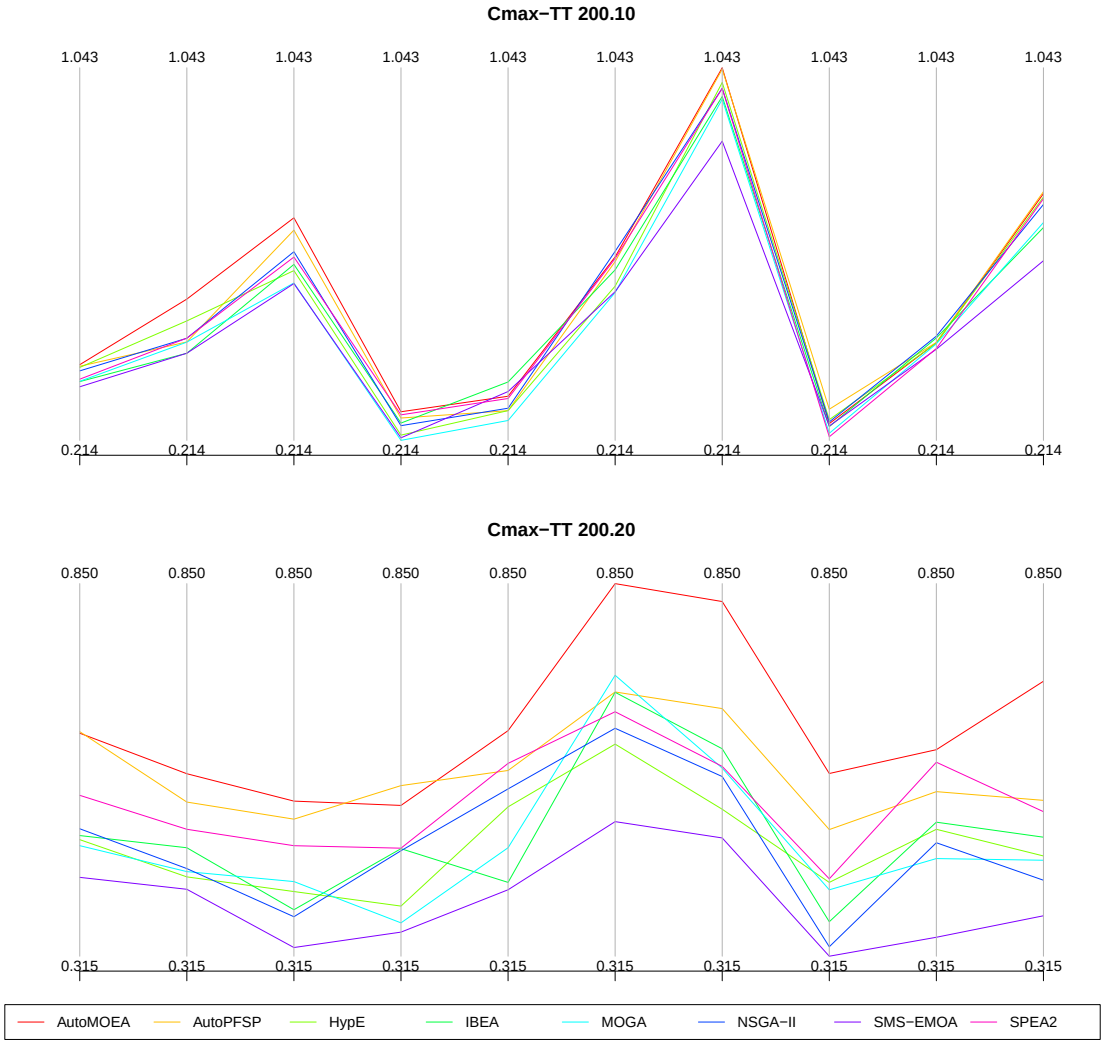

Fig. 8: Average hypervolume over 10 runs on 10 instances with 200 jobs each of Cmax-TT.

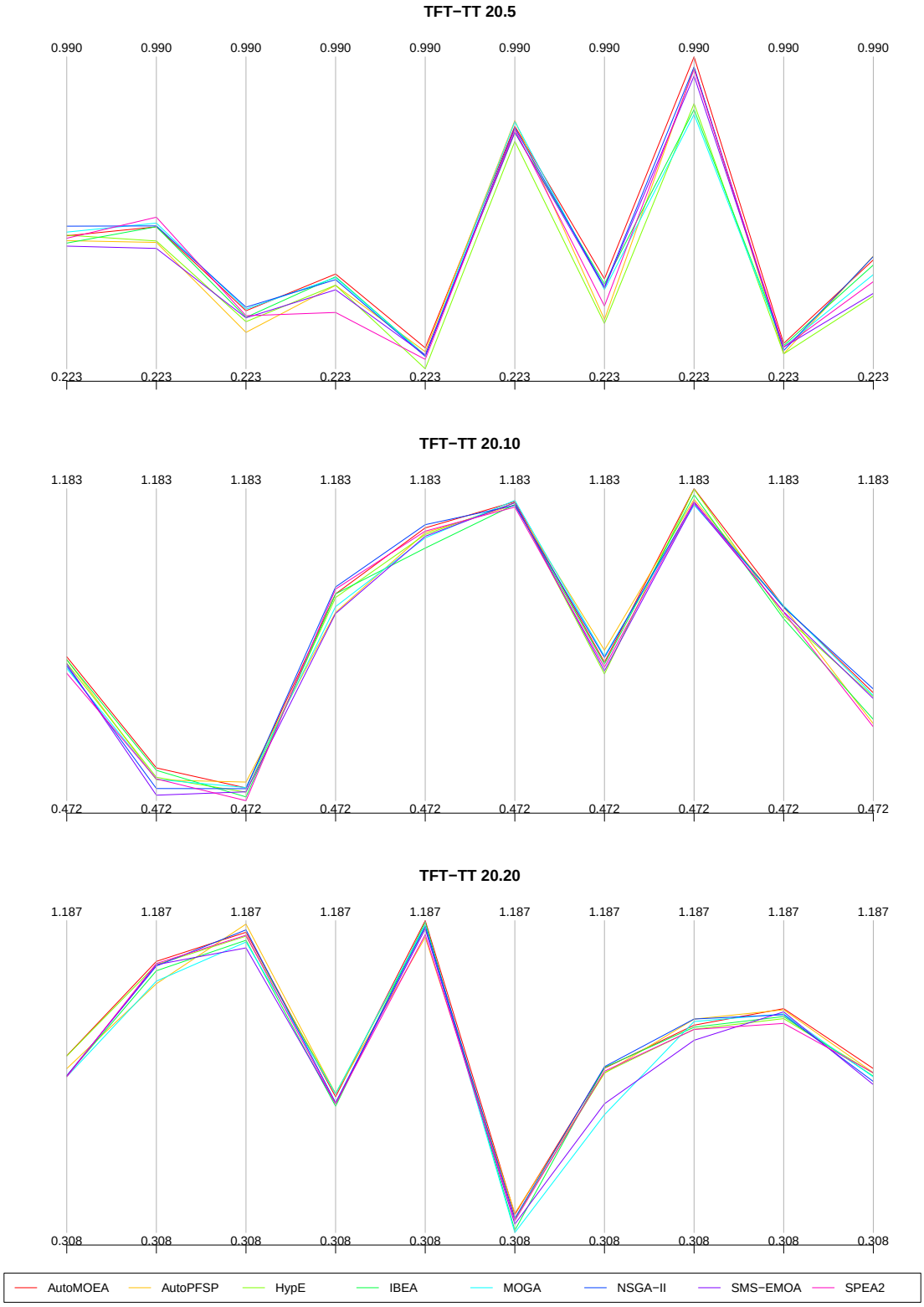

Fig. 9: Average hypervolume over 10 runs on 10 instances with 20 jobs each of TFT-TT.

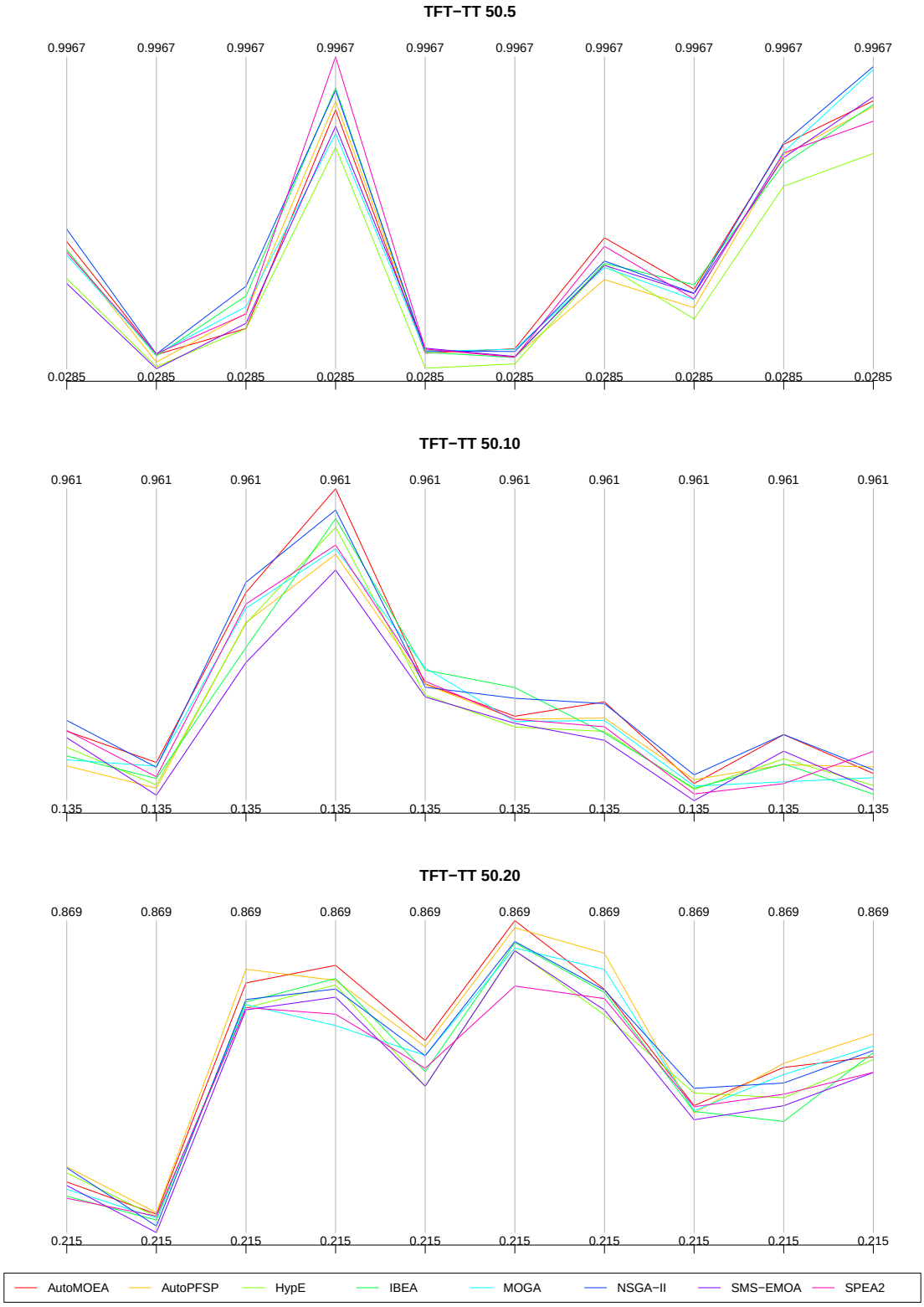

Fig. 10: Average hypervolume over 10 runs on 10 instances with 50 jobs each of TFT-TT.

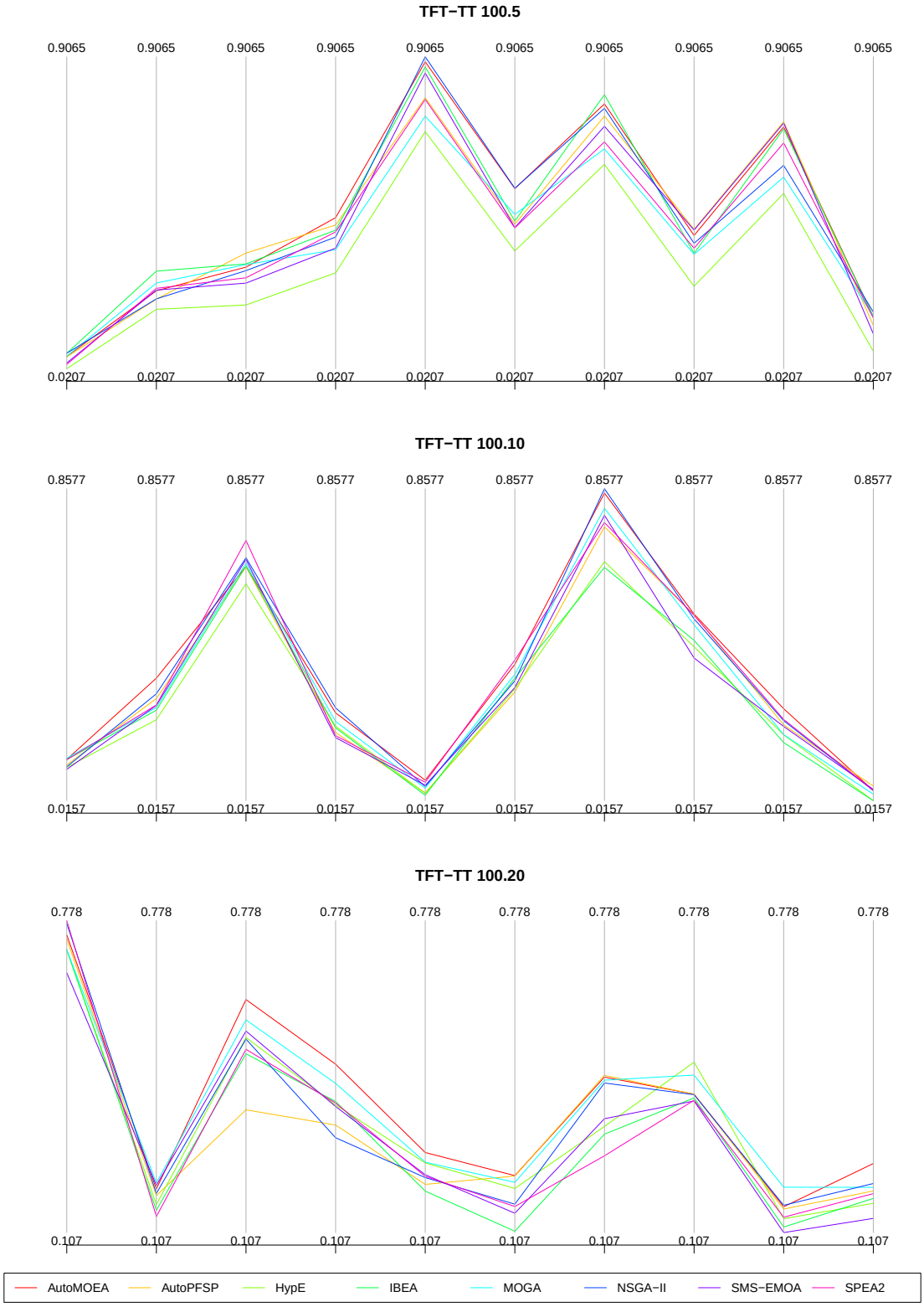

Fig. 11: Average hypervolume over 10 runs on 10 instances with 100 jobs each of TFT-TT.

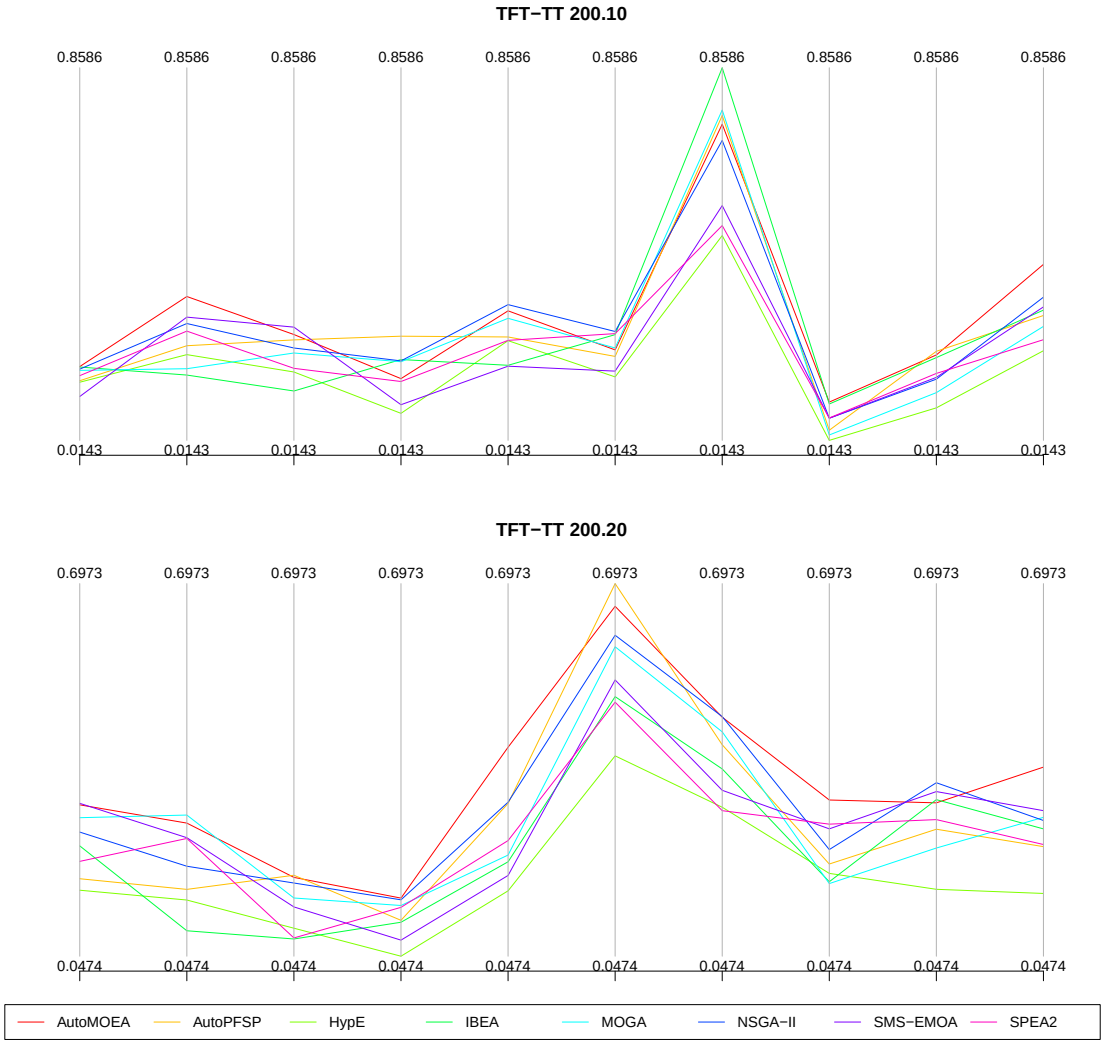

Fig. 12: Average hypervolume over 10 runs on 10 instances with 200 jobs each of TFT-TT.

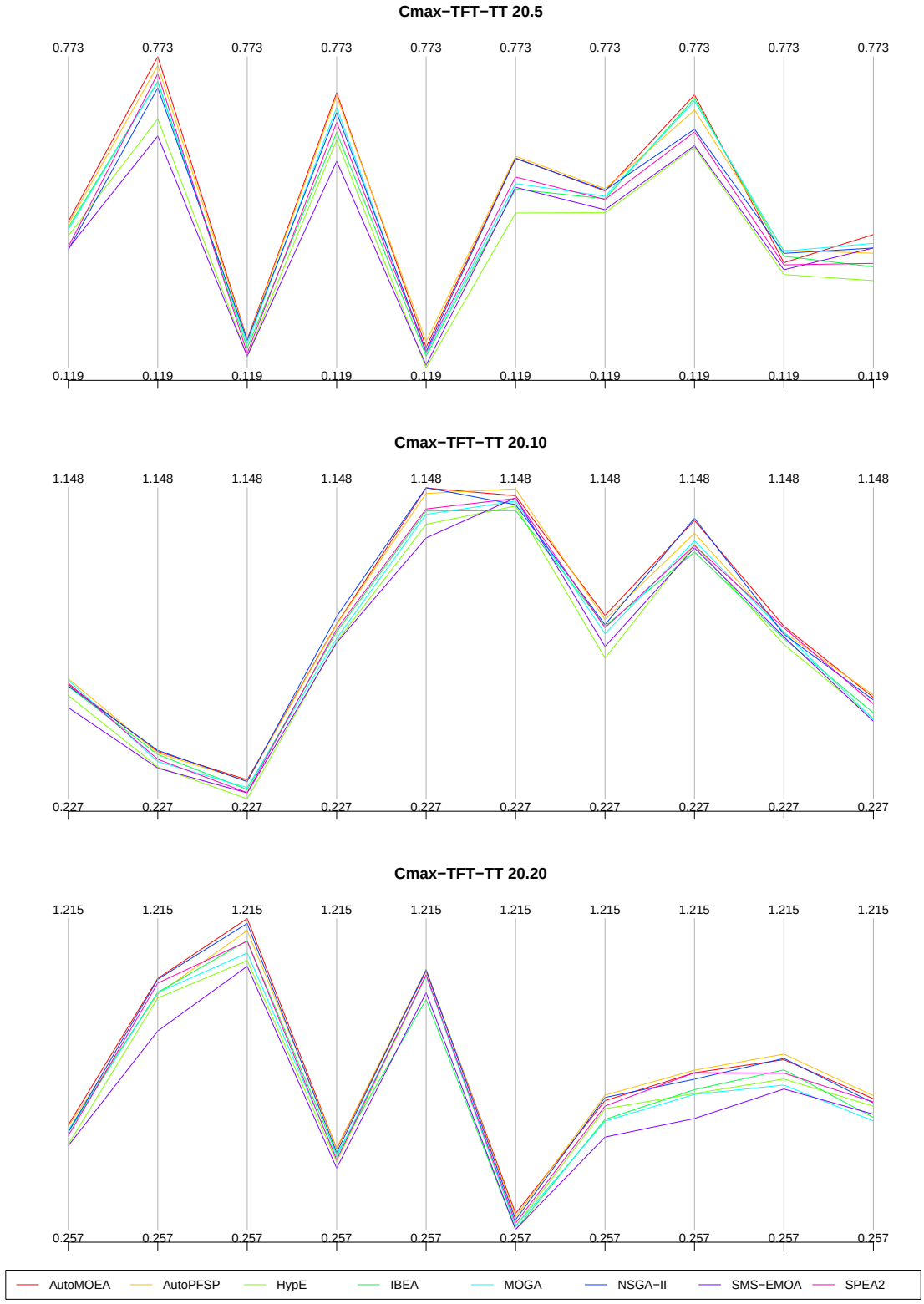

Fig. 13: Average hypervolume over 10 runs on 10 instances with 20 jobs each of Cmax-TFT-TT.

Fig. 14: Average hypervolume over 10 runs on 10 instances with 50 jobs each of Cmax-TFT-TT.

Fig. 15: Average hypervolume over 10 runs on 10 instances with 100 jobs each of Cmax-TFT-TT.

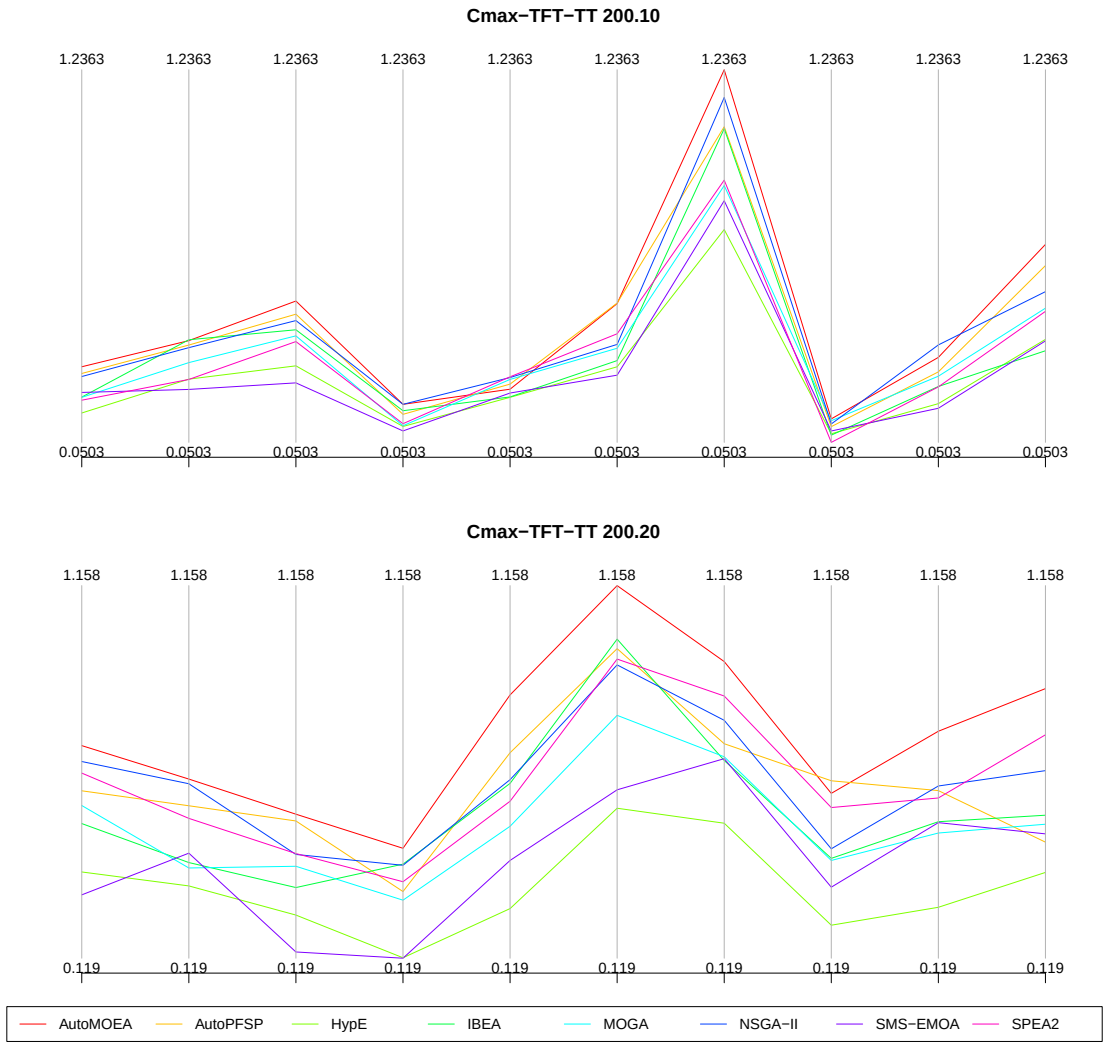

Fig. 16: Average hypervolume over 10 runs on 10 instances with 200 jobs each of Cmax-TFT-TT.