----------------------- REVIEW 1 ---------------------
PAPER: 108
TITLE: Towards Large-Scale Multiobjective Optimization: Extremely Fast Hybrid Non-Dominated Sorting
AUTHORS: Margarita Markina and Maxim Buzdalov

Originality: 4 (good)
Relevance and significance: 5 (excellent)
Soundness: 4 (good)
Presentation quality: 5 (excellent)
Global evaluation: 2 (accept)
Best Paper Award: yes

----------- Comments for authors -----------
In this paper, the authors introduce a new algorithm for non-dominated sorting. The algorithm is a combination of two previously known algorithm: the divide-and-conquer algorithm of Jensen and an improvement version of the non-dominated tree algorithm (ENS-NDT) proposed by Gustavsson and Syberfeldt.
The paper is well-written, the motivations and contributions are clear (mainly a faster non-dominated sorting algorithm). Complexity results and experimental results are given. I think however that the instances used to compare the different algorithms could be improved: the authors have used instances composed of points generated inside a hypercube and instances composed of points generated inside a hyperplan (so every point is non-dominated if the hyperplan is not parallel to any objective axis). I would recommend to use instances of points presenting more similarities with real instances: like points contained in the interior of two hyperspheres (one small and the other a bit bigger) to have a distribution of points that mimic better the distribution of points obtained in a Pareto front.

Minor remarks

- In Section 1.1, you define the strict dominance relation, but in the paragraph just after you use "is not dominated", without using the word "strictly". I think that you can avoid the use of the word "strictly" in the dominance definition, as the strict dominance is generally used when a solution is strictly better on each objective (and not only for one for the simple dominance relation).

- Section 2.2: "it is deteremined whether..." -> reformulate

----------------------- REVIEW 2 ---------------------
PAPER: 108
TITLE: Towards Large-Scale Multiobjective Optimization: Extremely Fast Hybrid Non-Dominated Sorting
AUTHORS: Margarita Markina and Maxim Buzdalov

Originality: 4 (good)
Relevance and significance: 4 (good)

Soundness: 4 (good)
Presentation quality: 5 (excellent)
Global evaluation: 2 (accept)
Best Paper Award: no

----------- Comments for authors -----------
The authors take two algorithms for non-dominated sorting (i.e., computing ranks in a multi-objective optimsation), and combine them into a hybrid algorithm. They then test the hybrid algorithm on several benchmarks and find that it is often faster than either of the original algorithms. At the same time, the hybrid algorithm maintains the theoretical performance guarantees that are known for the parent algorithms.

Combining the algorithm requires some new twists, since application of one of the parent algorithms destroys the invariants that the other algorithm builds upon, as the authors demonstrate by examples.

The paper is very well-written and seems sound to me. The code is available at GitHub, and the experimental design is carefully described to enable reproducibility. I found only a very small number of typos.

Without being an expert on multi-objective optimisation, I think that the paper is worth publishing. The authors convincingly make the point that the problem of non-dominated sorting is rather central for multiobjective optimisation, both theoretically and practically, so improvements on this problem are welcome.
Combining the two known algorithms requires some new ideas, which renders the paper non-trivial (although the ideas do not seem to be overly deep to me).

MINOR COMMENTS:

page 2, line 10: "A set of points having the same rank ...". You introduce the rank only afterwards, so you may want to switch the order.
page 5, first sentence of the last paragraph: "Note that the HELPERA function solves ...". I was a bit confused by this sentence. Do you mean HELPERB instead of HELPERA?
page 6, middle: "deteremined" has an extra e.

----------------------- REVIEW 3 --------------------
PAPER: 108
TITLE: Towards Large-Scale Multiobjective Optimization: Extremely Fast Hybrid Non-Dominated Sorting
AUTHORS: Margarita Markina and Maxim Buzdalov

Originality: 3 (fair)
Relevance and significance: 5 (excellent)
Soundness: 4 (good)
Presentation quality: 5 (excellent)

Global evaluation: 2 (accept)
Best Paper Award: no

----------- Comments for authors -----------
Non-dominated sorting is at the heart of evolutionary multiobjective optimizers and it's a usually computationally very expensive operation when the problem size is large and the number of dimensions is larger than 2. The authors improve the best known algorithms for non-dominated sorting by tweaking and hybridising them. The hybrid uses the divide-and-conquer approach of one algorithm and then switches to another algorithms for smaller problems. Extensive large-scale experiments show that it outperforms the state-of-the-art in most considered settings when the population size is large.

The paper is very well written: the authors describe previous algorithms in very good detail, and also their ideas on how to improve them. The experiments show good improvements on two classes of random instances. Due to space restrictions, only parts of the results could be presented. I would have liked to see statistical tests to check for statistical significance as this would have made a much stronger statement.

- the definition of rank on page 2 says "solutions of rank at most i", which strictly speaking allows for all dominated solutions to be of smaller rank than i. You probably want to say that the maximum rank of all dominating solutions is precisely i?

- page 2: "can be challenged" sounds odd.

- page 4, what do you mean by "the maximum objective in which the comparison still makes sense"?

- page 6, third paragraph "M-th" is missing "objective"

- please briefly explain k-d trees and recall/explain the parameters k and d.

- page 8: "the greater rank" should be "a greater rank". Three lines down: do you mean "refrain from" instead of "refuse from"?

- page 11: "of an interest": remove "an"

----------------------- REVIEW 4 --------------------
PAPER: 108
TITLE: Towards Large-Scale Multiobjective Optimization: Extremely Fast Hybrid Non-Dominated Sorting
AUTHORS: Margarita Markina and Maxim Buzdalov

Originality: 3 (fair)
Relevance and significance: 3 (fair)
Soundness: 3 (fair)
Presentation quality: 3 (fair)
Global evaluation: 0 (borderline paper)
Best Paper Award: no

----------- Comments for authors -----------
This paper proposes a new algorithm for the non-dominated sorting. The new algorithm consists of merging two known algorithms and with slight modifications to one of them.

In general, the paper is well-organized, the idea is interesting and the fact that the authors have the code available online is a positive aspect. My main criticisms are towards the results presented and the conclusions which seem biased.

Title:
- Describing the algorithm as "extremely fast" is exaggerated. The results presented show that when compared to the best alternative in the literature (ENS-NDT) the proposed algorithm achieves, at most, a speedup of 2, and only for some very large input sizes. Moreover, the algorithm is sometimes slightly slower than other from the state-of-the-art and the results are shown only for two data sets. In my opinion, the results do not support the title as is. My suggestion is to change it to something like "Towards Large-Scale Multiobjective Optimization with a Hybrid Algorithm for Non-dominated Sorting"

- Section 1: The authors should state more clearly what they refer as "large-scale" multiobjective problems as it is sometimes used in the literature to refer to problems with many decision variables. Be more specific on when a problem becomes "large-scale" (e.g., thousands of solutions, dozens of objectives).

- Page 2, Section 1.1: The sentence "A set of all points having the same rank is often called a front, a level or a layer" should appear only after "rank" is introduced. For example, in the third paragraph, after the description of non-dominated sorting.

- Page 3, first two sentences: Reference [15] is referred to as a paper but is not this a poster? If so, correct this.

- Section 1.2, 2nd paragraph: "disseration" must be replaced by "dissertation".

- Section 1.2, 5th paragraph: In order for the claims to be consistent to the results shown, it must be added that the observation that the hybrid algorithm tends to outperform the others is observed only for N >= 5 * 10^5.

- Section 2, 1st paragraph: The second sentence is unclear. My suggestion is to replace the "unlike [12]" and "unlike [10]" by something like "unlike the work in [12]" and "unlike the work in [10]".

- Section 2.1: I think the description is slightly confusing and should be made more clear.
   - For example, the second paragraph refers to the first and third operation stated above but it is unclear which are they. The first paragraph should clearly state which is the first, the second and the

third operation.

    - In the third paragraph, it should be made more clear what is meant with "the objective is always chosen to be the maximum objective in which the comparison still makes sense."

    - The pseudo code is useful, it helps understanding the algorithm but the text (especially the first 3 paragraphs) should make references to the pseudo code so that the description can be better understood.

- Section 4:

    - It should be made more clear why these two data sets (the uniform hypercube and hyperplane) were chosen and what are their characteristics with respect to the resulting number of layers.

    - I think it would be desirable to have comparisons on more benchmark data sets (such as the DTLZ fronts), but I understand that the space restrictions do not allow to show results on more data sets.

    - In the third paragraph, it should be made more clear what is meant with "switch-to-tree threshold", is it when it is decided to use ENS-NDT-ONE? If so, clearly state this. Also, specify what is 100 and 20000, for example "100 points".

    - In the third paragraph, it is said that for more than 3 objectives the threshold is 20000. Does this mean that for N <= 20 000 there is no divide-and-conquer and basically only the ENS-NDT-ONE is used? If so, clearly state this.

    - Table 1 must also include the standard deviation (the text should discuss that as well), and I believe there is space for that.

    - It is good that more results were made available online. However, it is important that Table 1 resumes all that information. From what I observed, there is no advantage of using the Hybrid Algorithm (nor the ENS-NDT-ONE) for N <= 10^5. This should be clearly stated in the text and Table 1 should reflect this. For example, instead of showing the results for N in {5 * 10^5, 10^6} it should show results also for lower values of N, for example: {10^4, 10^5, 10^6}

- Section 5:
- Describing the new algorithm as "highly efficient" is debatable as the runtime is reduced only for N > 5* 10^5 and the speedup is only at most of 2. This paragraph should be changed. The paragraph should state that the algorithm outperforms ENS-NDT (the best available algorithm) only for N >= 5 * 10^5 (specify the input size instead of saying that outperforms except in certain ranges).