The Name of the Title is Hope

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ABSTRACT

A clear and well-documented LaTeX document is presented as an article formatted for publication by ACM in a conference proceedings or journal publication. Based on the "acmart" document class, this article presents and explains many of the common variations, as well as many of the formatting elements an author may use in the preparation of the documentation of their work.

CCS CONCEPTS

• **Theory of computation → Evolutionary algorithms**.

KEYWORDS

neural networks, gaze detection, text tagging

ACM Reference Format:
Ben Trovato, G.K.M. Tobin, Lars Thørväld, Valerie Béranger, Aparna Patel, Huifen Chan, Charles Palmer, John Smith, and Julius P. Kumquat. 2018. The Name of the Title is Hope. In *Woodstock '18: ACM Symposium on Neural Gaze Detection, June 03–05, 2018, Woodstock, NY*. ACM, New York, NY, USA, 8 pages. https://doi.org/10.1145/1122445.1122456

1 INTRODUCTION

Optimization problems involving multiple objectives arise in various fields such as engineering, economics, and logistics, to name a few. These problems, known as Multi-Objective Optimization (MOP) problems, involve the simultaneous optimization of more than one objective function. Formally, an MOP can be defined as follows:

Given a vector function $f(x) = [f_1(x), f_2(x), ..., f_m(x)]^T$, where $x \in \mathbb{R}^n$ and $f_i : \mathbb{R}^n \to \mathbb{R}$ for $i = 1, 2, ..., m$, the goal of an MOP is to find the set of all Pareto optimal solutions, where a solution x^* is Pareto optimal if there does not exist another solution x such that $f_i(x) \leq f_i(x^*)$ for all i and $f_j(x) < f_j(x^*)$ for at least one j.

However, in many real-world problems, the decision-making process is subject to various constraints. This leads to the Constrained Multi-Objective Optimization (CMOP) problem, which is an MOP with additional constraints. Formally, a CMOP can be defined as follows:

Given a vector function $f(x)$ and a set of constraint functions $g_j(x)$ and $h_k(x)$, where $g_j : \mathbb{R}^n \to \mathbb{R}$ for $j = 1, 2, ..., p$ and $h_k : \mathbb{R}^n \to \mathbb{R}$ for $k = 1, 2, ..., q$, the goal of a CMOP is to find the set of all feasible and Pareto optimal solutions, where a solution x^* is feasible if $g_j(x^*) \leq 0$ for all j and $h_k(x^*) = 0$ for all k, and Pareto optimal as defined above.

Outline

The algorithm proposed in this paper is introduced in Section 3.2. The experimental results are shown in Section **??**. The conclusion is drawn in Section **??**.

2 CURRENT RESEARCH SITUATION

The field of Constrained Multi-Objective Optimization (CMOP) has seen significant advancements in recent years. Researchers have proposed a variety of algorithms for solving CMOP problems, including evolutionary algorithms, swarm intelligence-based algorithms, and gradient-based methods.

Evolutionary algorithms, such as the Non-dominated Sorting Genetic Algorithm II[11] (NSGA-II) and the Multi-Objective Evolutionary Algorithm based on Decomposition (MOEA/D)[47], have

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Woodstock '18, June 03–05, 2018, Woodstock, NY

ACM ISBN 978-1-4503-XXXX-X/18/06…$15.00
https://doi.org/10.1145/1122445.1122456

been widely used due to their ability to handle complex optimization problems and generate a diverse set of Pareto-optimal solutions. But in order to handle optimization probmes with constraint some special adjustments is necessary before using those MOEA. Generally some constraint handling techniques (CHT) can be combined with different MOEAs in different cases, both are exchangleable, eg. NSGA-III[**?**] and C-MOEA/D[**?**].

Most CMOPEAs can be categorized into 7 groups [28]. The algorithms discussed here can be put into the

The difficulties brought by the constraints can be summarized as follows:

(1) The constraints make the feasible region of the problem smaller, which makes it harder to find feasible solutions.
(2) The inconsistency between the feasible region and the Pareto optimal region makes it harder to converge to the Pareto optimal solutions.
(3) The CPF (Constraint Pareto Front) is not smooth and more complex than the Pareto Front, which would make it harder to maintain the diversity of the final solutions.

There are some multiple-population based algorithms that can be used to solve CMOPs. The main idea of these algorithms is to use different populations to handle the objectives and constraints respectively. The main advantage of these algorithms is that they can handle the objectives and constraints separately, which makes it easier to maintain the diversity of the solutions.

There are another direction of research that is to use multi-stage, in multi-stage algorithms different goals are pursued at different stages, generally convergence and diversity are valued in early stages, feasiblility and convergence in later stages.

Some algorithms combine the above two directions to achieve better performance, eg EMCMO[34]. Although EMCMO is designed using the EMT[29] methods, it's still can be saw as a multi-population CMOPEA. In short, it create two populations in whihc one is evoluted towards the CPF while the other is directed towards the CPF, in each iteration some more adaptive individuals under the other populations' enviroment presure are incorperated into the latter population. This way two population coevolute quickly at the same pace, and the gap between them is controlled. The performance of EMCMO is unusual compared with other similar algorithms, this is beacuse of the offspring information is more exploited, the knowledge transfer between two population accelarate the evolution.

Recently another algorithms called MSCMO[30] are proposed, it's a multi-stage CMOPEA. It's based on the divide-and-conqury thought. At first, the constraints are sorted by the 'difficulties' which are measured by the ratio of feasible population in the end of an UPF stage. then in the order of from hard to simple constraints are added one by one. Everytime a new constraint is added, the initial population selected from a archive built in previous stages evolute from scratch. Alought the computation it requires is large, the results for some extream hard problems are exceptional. But MSCMO can't handle problems with few but extremly complex constraints.

3 NEO

3.1 Motivation

Although some algorithms introducted above are more competitive than others, there are still some paricular problems which are hard for them. One of them is from testsuit DASCOMP[15]. The EMCMO is run againest the DASCOMP1 on PlatEMO[43]. The final result are shown in Fig.1. It can be seen that the EMCMO can't find any feasible solutions in 50000 generations. Even if the constraints are removed.

After Further analysis, it's found that the problem is caused by the quick convergence in only one direction in Objective Space so that all the solutions in the population all have simlar gene, in another word the diversity is lost.

No single optimization algorithm can solve all the problems, not even the most of them , which is stated as the **No Free Launch Theorem**[46]. So it's necessary to design different algorithms for different problems. But some adaptive techniques can be utilize to adjust the algorithm online without the predesign or the interruption by the user.

The most used MOPEA in CMOPEA is Strength Pareto Evolutionary Algorithm 2(SPEA2)[**?**], which is a

So it's necessary to design a framework that can combine different algorithms to solve different problems. This is the idea of the **NEO**

The main contribution can be summarized as follows:

(1) A Tri-Population based CMOEA fit for various problems.
(2) A Dynamic method that adjust the relative size between the two auxiliary populations.
(3) The detailed explaination and analysis of the effectiveness of the algorithm.

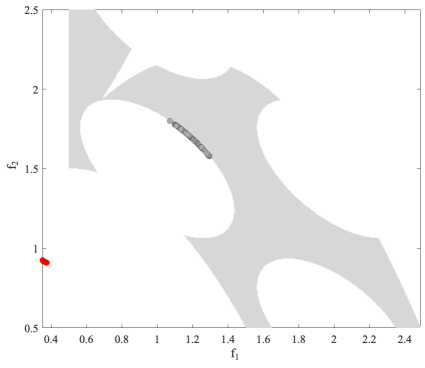

Figure 1: EMCMO on DASCOMP1 after 10000 function evaluations

3.2 Algorithm

3.2.1 Framework. This algorithm use three coevoled populations to solve the CMOPs.

At first, three populations is initialized, each of them has its own goal. The first one is the main population, which is used to approximate the constraint Pareto front. Both the second and the third population are auxiliary populations ignoring the constraints, while they each have different goals. The algorithm of mating, mutation enviroment selection for it is mainly based on the SPEA2 and CDP.

The main function of the second population is to converge to the unconstrained Pareto front, it works as a pioneer to explore

the search space and lead the other two populations towars the pareto front. It also utilize SPEA2 as the backbone.

The third population is used to maintain the diversity of the solutions, it works as a exploration team to focus on the rare, novel and useful solutions to introduction new directions helping thee other two populations to escape from local optima and to cover more of whole Pareto front. Notably, this population directly use the algorithm called **MOEA/D-M2M**[**?** , m2m], which is a multi-objective evolutionary algorithm based on decomposition. The reason why it's chosen is that it's a very simple algorithm and it's very effective in maintaining the diversity of the solutions. It divde the objectives into several subproblems and optimize them separately, which is very similar to **MOEA/D**[47]. But it's different from MOEA/D in that it didn't try to some decomposition and aggregation methods to convert the multi-objective problem into a single-objective problem, instead it just divide evenly the objective space into several subspaces and optimize them separately using dominance relation.

This way it can maintain the diversity of the solutions very well, but it's not very effective in convergence. So it's just used to aid the other two populations.

3.2.2 Size Adjustment. One of the difficulties of three population approach is that more computation resource is required. So to alleviate this problem, a dynamic methods is design to adjust the relative size between the second and the third population. A running average of successful rate of each auxiliary population is recorded and used to achieve.

Algorithm 1: SPEA2 Main Loop

Input: N (population size), $\bar{N}$ (archive size), T (maximum number of generations)
Output: A (nondominated set)

`// SPEA2 Main Loop`

1 Initialization: Generate an initial population P_0 and create the empty archive (external set) $P_0 = \emptyset$. Set $t = 0$.
2 Fitness assignment: Calculate fitness values of individuals in P_t and P_t (cf. Section 3.1).
3 Environmental selection: Copy all nondominated individuals in P_t and P_t to P_{t+1}. If size of P_{t+1} exceeds N then reduce P_{t+1} by means of the truncation operator, otherwise if size of P_{t+1} is less than N then fill P_{t+1} with dominated individuals in P_t and P_t (cf. Section 3.2).
4 Termination: If $t \geq T$ or another stopping criterion is satisfied then set A to the set of decision vectors represented by the nondominated individuals in P_{t+1}. Stop.
5 Mating selection: Perform binary tournament selection with replacement on P_{t+1} in order to fill the mating pool.

3.2.3 Duplication Remoal. Beacuse of the inter-transfer of knowledge between three population

Transfer Scheme.

3.2.4 Stop Criterion.

Algorithm 2: Tournament Selection

Input: population $P(\tau)$, the tournament size $t \in \{1, 2, \ldots, N\}$
Output: The population after selection $P(\tau)'$

Function `tournament`$(t, J_1, \ldots, J_N)$**:**
  for $i \leftarrow 1$ **to** N **do**
    $J'_i \leftarrow$ best fit individual out of t randomly picked individuals from $\{J_1, \ldots, J_N\}$
  end
return $\{J'_1, \ldots, J'_N\}$

Algorithm 3: 遗传算法的伪代码

Result: 遗传算法找到的最佳解
Input: 适应度函数 f, 种群大小 N, 交叉率 p_c, 变异率 p_m

begin
  种群 ← 初始化种群 (N)
  foreach 个体 *in* 种群 **do**
    计算适应度 (个体, f)
  end
  while 未达到终止条件 **do**
    父代 ← 选择父代 (种群)
    子代 ← 交叉 (父代, p_c)
    变异 (子代, p_m)
    foreach 孩子 *in* 子代 **do**
      计算适应度 (孩子, f)
    end
    种群 ← 选择下一代种群 (种群, 子代)
  end
  return 获得最佳个体 *(种群)*
end

3.2.5 Stage Analysis.

3.3 Template Parameters

In addition to specifying the *template style* to be used in formatting your work, there are a number of *template parameters* which modify some part of the applied template style. A complete list of these parameters can be found in the *LaTeX User's Guide.*

Frequently-used parameters, or combinations of parameters, include:

- `anonymous,review`: Suitable for a "double-blind" conference submission. Anonymizes the work and includes line numbers. Use with the `\acmSubmissionID` command to print the submission's unique ID on each page of the work.
- `authorversion`: Produces a version of the work suitable for posting by the author.
- `screen`: Produces colored hyperlinks.

This document uses the following string as the first command in the source file:

```
\documentclass[sigconf]{acmart}
```

4 MODIFICATIONS

Modifying the template — including but not limited to: adjusting margins, typeface sizes, line spacing, paragraph and list definitions, and the use of the `\vspace` command to manually adjust the vertical spacing between elements of your work — is not allowed.

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5 TYPEFACES

The "`acmart`" document class requires the use of the "Libertine" typeface family. Your TEX installation should include this set of packages. Please do not substitute other typefaces. The "`lmodern`" and "`ltimes`" packages should not be used, as they will override the built-in typeface families.

6 TITLE INFORMATION

The title of your work should use capital letters appropriately - https://capitalizemytitle.com/ has useful rules for capitalization. Use the `title` command to define the title of your work. If your work has a subtitle, define it with the `subtitle` command. Do not insert line breaks in your title.

If your title is lengthy, you must define a short version to be used in the page headers, to prevent overlapping text. The `title` command has a "short title" parameter:

```
\title[short title]{full title}
```

7 AUTHORS AND AFFILIATIONS

Each author must be defined separately for accurate metadata identification. Multiple authors may share one affiliation. Authors' names should not be abbreviated; use full first names wherever possible. Include authors' e-mail addresses whenever possible.

Grouping authors' names or e-mail addresses, or providing an "e-mail alias," as shown below, is not acceptable:

```
\author{Brooke Aster, David Mehldau}
\email{dave,judy,steve@university.edu}
\email{firstname.lastname@phillips.org}
```

The `authornote` and `authornotemark` commands allow a note to apply to multiple authors — for example, if the first two authors of an article contributed equally to the work.

If your author list is lengthy, you must define a shortened version of the list of authors to be used in the page headers, to prevent overlapping text. The following command should be placed just after the last `\author{}` definition:

```
\renewcommand{\shortauthors}{McCartney, et al.}
```

Omitting this command will force the use of a concatenated list of all of the authors' names, which may result in overlapping text in the page headers.

The article template's documentation, available at https://www.acm.org/publications/proceedings-template, has a complete explanation of these commands and tips for their effective use.

Note that authors' addresses are mandatory for journal articles.

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- the "ACM Reference Format" text on the first page.
- the "rights management" text on the first page.
- the conference information in the page header(s).

Rights information is unique to the work; if you are preparing several works for an event, make sure to use the correct set of commands with each of the works.

The ACM Reference Format text is required for all articles over one page in length, and is optional for one-page articles (abstracts).

9 CCS CONCEPTS AND USER-DEFINED KEYWORDS

Two elements of the "acmart" document class provide powerful taxonomic tools for you to help readers find your work in an online search.

The ACM Computing Classification System — https://www.acm.org/publications/class-2012 — is a set of classifiers and concepts that describe the computing discipline. Authors can select entries from this classification system, via https://dl.acm.org/ccs/ccs.cfm, and generate the commands to be included in the LATEX source.

User-defined keywords are a comma-separated list of words and phrases of the authors' choosing, providing a more flexible way of describing the research being presented.

CCS concepts and user-defined keywords are required for for all articles over two pages in length, and are optional for one- and two-page articles (or abstracts).

10 SECTIONING COMMANDS

Your work should use standard LATEX sectioning commands: `section`, `subsection`, `subsubsection`, and `paragraph`. They should be numbered; do not remove the numbering from the commands.

Simulating a sectioning command by setting the first word or words of a paragraph in boldface or italicized text is **not allowed.**

11 TABLES

The "`acmart`" document class includes the "`booktabs`" package — https://ctan.org/pkg/booktabs — for preparing high-quality tables.

Table captions are placed *above* the table.

Because tables cannot be split across pages, the best placement for them is typically the top of the page nearest their initial cite. To ensure this proper "floating" placement of tables, use the environment **table** to enclose the table's contents and the table caption. The contents of the table itself must go in the **tabular** environment,

Table 1: Frequency of Special Characters

Non-English or Math	Frequency	Comments
Ø	1 in 1,000	For Swedish names
π	1 in 5	Common in math
\$	4 in 5	Used in business
Ψ_1^2	1 in 40,000	Unexplained usage

to be aligned properly in rows and columns, with the desired horizontal and vertical rules. Again, detailed instructions on **tabular** material are found in the *LaTeX User's Guide*.

Immediately following this sentence is the point at which Table 1 is included in the input file; compare the placement of the table here with the table in the printed output of this document.

To set a wider table, which takes up the whole width of the page's live area, use the environment **table*** to enclose the table's contents and the table caption. As with a single-column table, this wide table will "float" to a location deemed more desirable. Immediately following this sentence is the point at which Table 2 is included in the input file; again, it is instructive to compare the placement of the table here with the table in the printed output of this document.

Always use midrule to separate table header rows from data rows, and use it only for this purpose. This enables assistive technologies to recognise table headers and support their users in navigating tables more easily.

12 MATH EQUATIONS

You may want to display math equations in three distinct styles: inline, numbered or non-numbered display. Each of the three are discussed in the next sections.

12.1 Inline (In-text) Equations

A formula that appears in the running text is called an inline or in-text formula. It is produced by the **math** environment, which can be invoked with the usual `\begin…\end` construction or with the short form `$…$`. You can use any of the symbols and structures, from α to ω, available in LaTeX [26]; this section will simply show a few examples of in-text equations in context. Notice how this equation: $\lim_{n\to\infty} x = 0$, set here in in-line math style, looks slightly different when set in display style. (See next section).

12.2 Display Equations

A numbered display equation—one set off by vertical space from the text and centered horizontally—is produced by the **equation** environment. An unnumbered display equation is produced by the **displaymath** environment.

Again, in either environment, you can use any of the symbols and structures available in LaTeX; this section will just give a couple of examples of display equations in context. First, consider the equation, shown as an inline equation above:

$$\lim_{n\to\infty} x = 0 \tag{1}$$

Notice how it is formatted somewhat differently in the **displaymath** environment. Now, we'll enter an unnumbered equation:

$$\sum_{i=0}^{\infty} x + 1$$

and follow it with another numbered equation:

$$\sum_{i=0}^{\infty} x_i = \int_0^{\pi+2} f \tag{2}$$

just to demonstrate LaTeX's able handling of numbering.

13 FIGURES

The "`figure`" environment should be used for figures. One or more images can be placed within a figure. If your figure contains third-party material, you must clearly identify it as such, as shown in the example below.

Figure 2: 1907 Franklin Model D roadster. Photograph by Harris & Ewing, Inc. [Public domain], via Wikimedia Commons. (https://goo.gl/VLCRBB).

Your figures should contain a caption which describes the figure to the reader.

Figure captions are placed *below* the figure.

Every figure should also have a figure description unless it is purely decorative. These descriptions convey what's in the image to someone who cannot see it. They are also used by search engine crawlers for indexing images, and when images cannot be loaded.

A figure description must be unformatted plain text less than 2000 characters long (including spaces). **Figure descriptions should not repeat the figure caption – their purpose is to capture important information that is not already provided in the caption or the main text of the paper.** For figures that convey important and complex new information, a short text description may not be adequate. More complex alternative descriptions can be placed in an appendix and referenced in a short figure description. For example, provide a data table capturing the information in a bar chart, or a structured list representing a graph.

Table 2: Some Typical Commands

Command	A Number	Comments
\author	100	Author
\table	300	For tables
\table*	400	For wider tables

For additional information regarding how best to write figure descriptions and why doing this is so important, please see https://www.acm.org/publications/taps/describing-figures/.

13.1 The "Teaser Figure"

A "teaser figure" is an image, or set of images in one figure, that are placed after all author and affiliation information, and before the body of the article, spanning the page. If you wish to have such a figure in your article, place the command immediately before the \maketitle command:

```
\begin{teaserfigure}
  \includegraphics[width=\textwidth]{sampleteaser}
  \caption{figure caption}
  \Description{figure description}
\end{teaserfigure}
```

14 CITATIONS AND BIBLIOGRAPHIES

The use of BibTeX for the preparation and formatting of one's references is strongly recommended. Authors' names should be complete — use full first names ("Donald E. Knuth") not initials ("D. E. Knuth") — and the salient identifying features of a reference should be included: title, year, volume, number, pages, article DOI, etc.

The bibliography is included in your source document with these two commands, placed just before the \end{document} command:

```
\bibliographystyle{ACM-Reference-Format}
\bibliography{bibfile}
```

where "bibfile" is the name, without the ".bib" suffix, of the BibTeX file.

Citations and references are numbered by default. A small number of ACM publications have citations and references formatted in the "author year" style; for these exceptions, please include this command in the **preamble** (before the command "\begin{document}") of your LaTeX source:

```
\citestyle{acmauthoryear}
```

Some examples. A paginated journal article [2], an enumerated journal article [10], a reference to an entire issue [9], a monograph (whole book) [25], a monograph/whole book in a series (see 2a in spec. document) [19], a divisible-book such as an anthology or compilation [13] followed by the same example, however we only output the series if the volume number is given [14] (so Editor00a's series should NOT be present since it has no vol. no.), a chapter in a divisible book [41], a chapter in a divisible book in a series [12], a multi-volume work as book [24], a couple of articles in a proceedings (of a conference, symposium, workshop for example) (paginated proceedings article) [3, 17], a proceedings article with all possible elements [40], an example of an enumerated proceedings article [16], an informally published work [18], a couple of preprints [6, 7], a doctoral dissertation [8], a master's thesis: [4], an online document / world wide web resource [1, 33, 42], a video game (Case 1) [32] and (Case 2) [31] and [27] and (Case 3) a patent [39], work accepted for publication [36], 'YYYYb'-test for prolific author [37] and [38]. Other cites might contain 'duplicate' DOI and URLs (some SIAM articles) [23]. Boris / Barbara Beeton: multi-volume works as books [21] and [20]. A couple of citations with DOIs: [22, 23]. Online citations: [42, 44, 45]. Artifacts: [35] and [5].

15 ACKNOWLEDGMENTS

Identification of funding sources and other support, and thanks to individuals and groups that assisted in the research and the preparation of the work should be included in an acknowledgment section, which is placed just before the reference section in your document.

This section has a special environment:

```
\begin{acks}
...
\end{acks}
```

so that the information contained therein can be more easily collected during the article metadata extraction phase, and to ensure consistency in the spelling of the section heading.

Authors should not prepare this section as a numbered or unnumbered \section; please use the "acks" environment.

16 APPENDICES

If your work needs an appendix, add it before the "\end{document}" command at the conclusion of your source document.

Start the appendix with the "appendix" command:

```
\appendix
```

and note that in the appendix, sections are lettered, not numbered. This document has two appendices, demonstrating the section and subsection identification method.

17 SIGCHI EXTENDED ABSTRACTS

The "sigchi-a" template style (available only in LaTeX and not in Word) produces a landscape-orientation formatted article, with a wide left margin. Three environments are available for use with the "sigchi-a" template style, and produce formatted output in the margin:

- sidebar: Place formatted text in the margin.
- marginfigure: Place a figure in the margin.
- margintable: Place a table in the margin.

ACKNOWLEDGMENTS

To Robert, for the bagels and explaining CMYK and color spaces.

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A RESEARCH METHODS

A.1 Part One

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A.2 Part Two

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B ONLINE RESOURCES

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