Author Guidelines:
IEEE *Xplore* Immersive Articles v0.9

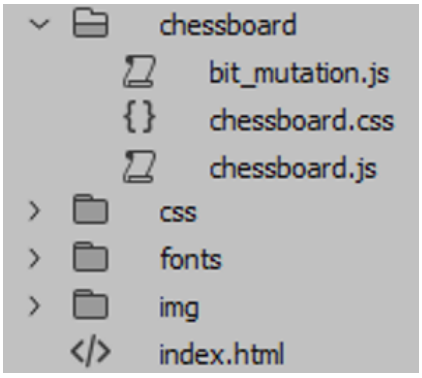
This document contains instructions on how to create immersive articles for inclusion in IEEE *Xplore* and is likely to be updated in the future.

Submission Guidelines:

- Immersive content will be sent to the IEEE as supplementary content for an article.
- A compressed zip file containing all of the necessary components required for the immersive article (HTML page and associated images, stylesheets, JavaScript, etc.) will be submitted along with the research article.

Content Development Guidelines:

- The immersive article HTML filename must be **index.html**.
- The immersive article should be able to function as stand-alone content.
- Contents of the immersive article will be embedded into the IEEE *Xplore* standard template (global header and footer applied) upon integration.
- References within the HTML to CSS, JavaScript, etc. will include a relative path such as:
    - <link rel="stylesheet" href="chessboard/chessboard.css">
    - <script type="text/javascript" src="chessboard/chessboard.js"></script>
- Sample directory structure for immersive article included below:



Page title <h1>

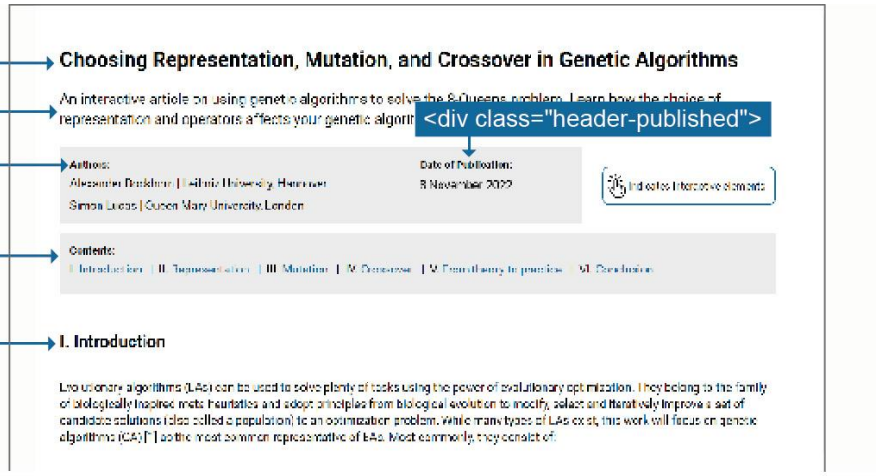
Subheading <p class="subhead">

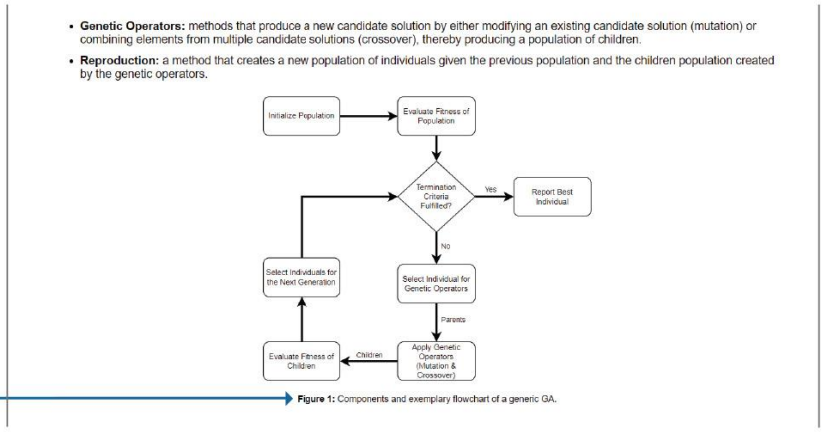
Authors grid

Table of contents

<section id="introduction">

Sections from table of contents
Allows for inclusion of
in line references



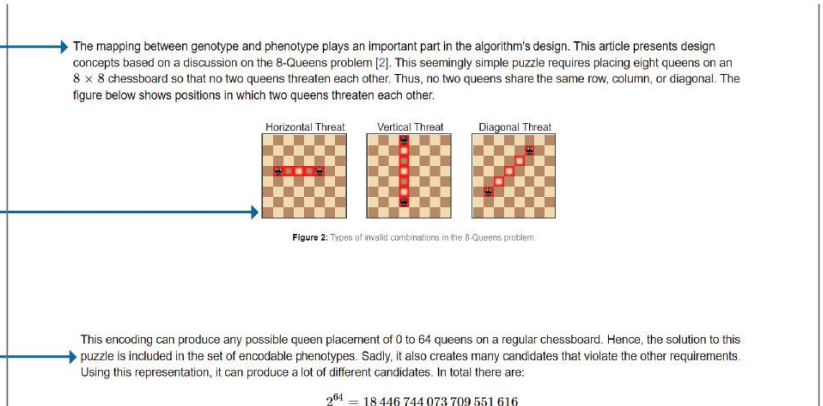


<figure class="text-center">

Tagging for images with caption

<p class="inline-math">

Allows for handling of MathJax
expressions Use $$ –
some equation here –
$$ to add an expression



Supports static illustrations
with caption

<p class="math-left">
and <p class="math-right">

Enables left/right alignment of
an expression

Each interactive element and scripts will be surrounded with this tagging

Constrained Matrix Representation

This might be a bit much to find one of the 92 solutions (including 12 unique solutions and all their rotations and reflections). But it can easily be improved by adding the second property to constrain the encoding, namely that no solution can have more or less than 8 queens. Therefore, it limits the number of queens in the matrix to exactly 8. This time, our genotype corresponds to moving a queen on the board because they can neither be spawned nor removed from the board. In case you tried to find a solution yourself at the beginning of this article, you have already used a similar phenotype representation above.

Drag and drop queens to change their position. See how the matrix changes according to the changes on the board.

Figure 5:
Pheno- and genotype constrained matrix representation of the 8-Queens problem.

Allows for handling of MathJax expressions
Use $$ – some equation here – $$ to add an expression

While this seems to be a small but intuitive change, it has a massive impact on the number of possible solutions. Instead of 2^{64}, it produces only: $\binom{64}{8} = 4\,426\,165\,368$ combinations.

$$ to add an expression

Allows for adding content into styled and responsive table

Representation	Size of an Individual	Size of the Search Space
Binary Matrix	$8 \times 8 = 64$	$2^{64} = 18\,446\,744\,073\,709\,551\,616$
Constrained Matrix	$8 \times 8 = 64$	$\binom{64}{8} = 4\,426\,165\,368$
Row Vector	8	$8^8 = 16\,777\,216$
Column Vector	8	$8^8 = 16\,777\,216$
Permutation	8	$8! = 40320$

Table 1: Comparison of genotype representations and their resulting size of the search space.

Allows for adding content into styled and responsive table

VI. Conclusion

This paper introduced several representations and their respective mutation and crossover operators for solving the 8-Queens Puzzle. It has been shown how the choice of representation impacts the size of the search space and imposes constraints on the choice of genetic operators. Special attention has been given to permutation-preserving mutation and crossover operators.

This overview has not covered all aspects of the algorithm's design process. Further elements such as initialization of the first population, fitness evaluation, selection, and reproduction should be well thought of when implementing an EA. For this purpose, please refer to introductory literature on EAs [3] as well as more detailed selections of mutation [4] and crossover operators [5], which can help to better understand the EA design process.

<section class="references">

Reference list

References

1. Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence
Holland, J.H., 1992. The MIT Press. DOI: 10.7551/mitpress/1090.001.0001

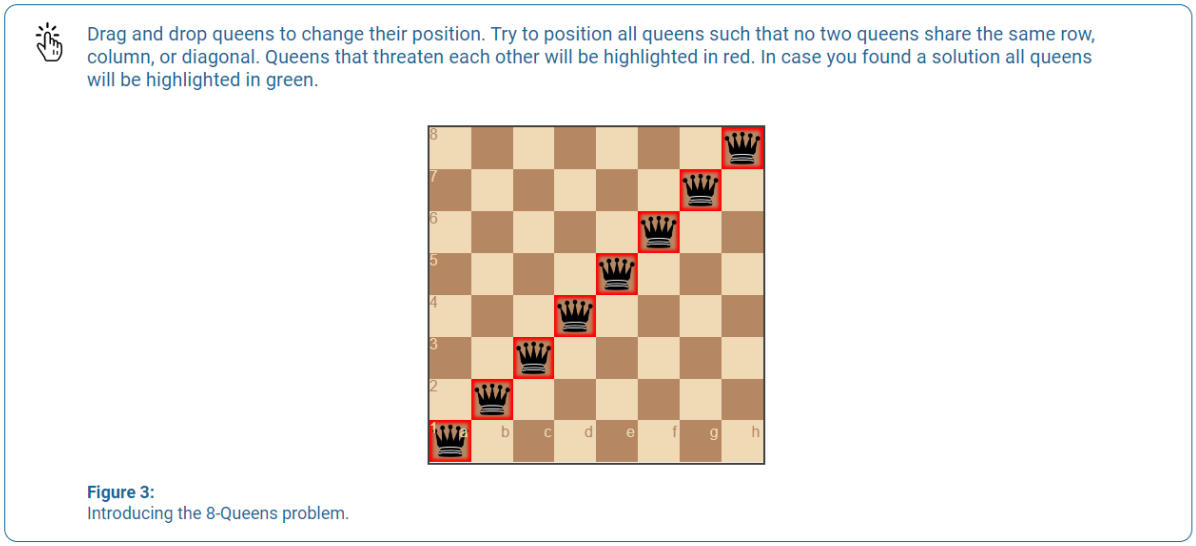
2. The n-Queens Problem
Rivin, I., Vardi, I. and Zimmermann, P., 1994. The American Mathematical Monthly, Vol 101(7), pp. 629–639. Informa UK Limited. DOI: 10.1080/00029890.1994.11997004

3. Computational Intelligence
Kruse, R., Borgelt, C., Braune, C., Mostaghim, S. and Steinbrecher, M., 2016. Springer London. DOI: 10.1007/978-1-4471-7296-3

</section>

Additional Guidelines

- **Metadata Section**:
  - **Authors**: Author names to be shown in the firstname lastname format followed by a pipe delimiter (|) and then the author affiliation.
  - **Date of Publication**: Indicates date article was published in IEEE *Xplore*.
  - **Table of Contents**: Includes each of the main sections of the article numbered by roman numerals using title case capitalization.
- **Interactive Elements:**
  - Any sections of the immersive article that are interactive will be embedded into a framed interface component to make it easy for users to determine which portions are interactive. This component will include clear instructions to the users on how to interact with the content.



  - **Border**: : Will surround the content with a blue border.
  - **Instructions**: : Each interactive element will need some instructions to the user on how to interact with.
  - **Figure Caption**: ”: Each interactive element will need to contain a figure caption.

Tagging Structure

- **<h1> :**
  Page title
- **<p class="subhead"> :**
  Subheading
- ** :**
  Authors grid
- ** :**
  Published date information
- ** :**
  Table of contents
- **<section id="introduction"> :**
  Sections from table of contents
  Allows for inclusion of in line references
- **<figure class="text-center"> :**
  Tagging for images with caption
- **<p class="inline-math"> :**
  Allows for handling of MathJax expressions
  Use $$ – some equation here – $$ to add an expression
- **<p class="math-left"> and <p class="math-right"> :**
  Enables left/right alignment of an expression
- ** :**
  Supports static illustrations with caption
- ** :**
  Each interactive element and scripts will be surrounded with this tagging
- ** :**
  Allows for adding content into styled and responsive table
- **<section class="references"> :**
  Reference list

HTML Examples:

Header and Sub-Head

```
<h1>
  Choosing Representation, Mutation, and Crossover in Genetic Algorithms
</h1>
<!-- Subheading -->
<p class="subhead">
  An interactive article on using genetic algorithms to solve the
  8-Queens problem. Learn how the choice of representation and operators
  affects your genetic algorithm.
</p>
```

Authors and Publication Date

```
<div class="header-authors">
  <h2>Authors:</h2>
  <ul>
    <li>Alexander Dockhorn | Leibniz University, Hannover</li>
    <li>Simon Lucas | Queen Mary University, London</li>
  </ul>
</div>
<!-- Published info section -->
<div class="header-published">
  <h2>Date of Publication:</h2>
  <p>Nov. 26, 2021</p>
</div>
```

Table of Contents

```
<div class="contents box">
  <h2>Contents:</h2>
  <ul>
    <li>
      <a href="#introduction">Introduction</a>
      <span class="separator">  |  </span>
    </li>
    <li>
      <a href="#representation">Representation</a>
      <span class="separator">  |  </span>
    </li>
    <li>
      <a href="#mutation">Mutation</a>
      <span class="separator">  |  </span>
    </li>
    <li>
      <a href="#crossover">Crossover</a>
      <span class="separator">  |  </span>
    </li>
    <li>
      <a href="#fttp">From theory to practice</a>
      <span class="separator">  |  </span>
    </li>
    <li><a href="#conclusion">Conclusion</a></li>
  </ul>
</div>
```

Article Sections

```
<section id="introduction">
  <!-- Section title -->
  <h2>I. Introduction</h2>
  <p>
    Evolutionary algorithms (EAs) can be used to solve plenty of tasks
    using the power of evolutionary optimization.
    They belong to the family of biologically inspired meta-heuristics and
    adopt principles from biological evolution to modify, select and
    iteratively improve a set of candidate solutions (also called a
    population) to an optimization problem.
    While many types of EAs exist, this work will focus on genetic
    algorithms (GA) [<a href="#ref_1">1</a>] as the most common
    representative of EAs. Most commonly, they consist of:
  </p>
```

- Include name of section in Section ID value.
- Surround section header in <h2> tag.

Framed Element

```
▼<div class="framed" style="margin-bottom: 20px"> flex
   <!-- Additional class for responsiveness -->
  ▼<div class="inside">
     <!-- Frame top blue text -->
    ▼<div class="eyebrow"> == $0
       " Drag and drop queens to change their position. Try to position all queens such that no two queens
       share the same row, column, or diagonal. Queens that threaten each other will be highlighted in red.
       In case you found a solution all queens will be highlighted in green. "
      </div>
    ▼<div id="board-letsplay" style="width: 320px; margin: auto auto 10px;">
      ▶<div class="chessboard-63f37">…</div>
      </div>
      <!-- Frame caption -->
    ▼<div class="caption">
        <b>Figure 3:</b>
        " Introducing the 8-Queens problem."
      </div>
      <script type="module" src="chessboard/chessboard_lets_play.js"></script>
    </div>
  </div>
</section>
```

Math

```
<!-- Class for math expession inside content -->
<p class="inline-math">The mapping between genotype and phenotype plays
  an important part in
  the algorithm's design. This article presents design concepts based on
  a discussion on the 8-Queens problem [<a href="#ref_2">2</a>]. This
  seemingly simple puzzle
  requires placing eight queens on an
  <!-- Mathjax expression -->$$8\times8$$ chessboard so that no two
  queens threaten each other. Thus, no two queens share the same row,
  column, or diagonal. The figure below shows positions in which two
  queens threaten each other.
</p>
```

References

Inline References

The inline references will be tagged using the following format: **[1]** as outlined below:

```
algorithms (GA) [<a href="#ref_1">1</a>] as the most common
representative of EAs. Most commonly, they consist of:
```

Reference List

```
<!-- References section -->
<section class="references">
  <h2>References</h2>
  <ol>
    <li id="ref_1">
      ::marker
      " Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence "
      <br>
      <span>
        " Holland, J.H., 1992. The MIT Press. DOI: "
        <a href="https://direct.mit.edu/books/book/2574/Adaptation-in-Natural-and-Artificial-SystemsAn" target="_blank"> 10.7551/mitpress/1090.001.0001
        </a>
      </span>
    </li>
    <li id="ref_2">
      ::marker
      " The n-Queens Problem "
      <br>
      <span>
        " Rivin, I., Vardi, I. and Zimmermann, P., 1994. The American Mathematical Monthly, Vol 101(7), pp. 629--639. Informa UK Limited. DOI: "
        <a href="https://www.tandfonline.com/doi/abs/10.1080/00029890.1994.11997004" target="_blank"> 10.1080/00029890.1994.11997004</a>
      </span>
    </li>
    <li id="ref_3">…</li>
    <li id="ref_4">…</li>
    <li id="ref_5">…</li>
    <li id="ref_6">…</li>
    <li id="ref_7">…</li>
    <li id="ref_8">…</li>
  </ol>
</section>
```