

## DAFTAR ISI

|                                                                                      |             |
|--------------------------------------------------------------------------------------|-------------|
| <b>ABSTRAK.....</b>                                                                  | <b>vii</b>  |
| <b>ABSTRACT .....</b>                                                                | <b>viii</b> |
| <b>KATA PENGANTAR .....</b>                                                          | <b>ix</b>   |
| <b>DAFTAR ISI .....</b>                                                              | <b>xi</b>   |
| <b>DAFTAR TABEL .....</b>                                                            | <b>xiv</b>  |
| <b>DAFTAR GAMBAR .....</b>                                                           | <b>xv</b>   |
| <b>DAFTAR LAMPIRAN .....</b>                                                         | <b>xvii</b> |
| <b>BAB I PENDAHULUAN .....</b>                                                       | <b>1</b>    |
| 1.1 Latar Belakang Masalah .....                                                     | 1           |
| 1.2 Rumusan Masalah .....                                                            | 3           |
| 1.3 Batasan Masalah .....                                                            | 3           |
| 1.4 Tujuan Penelitian .....                                                          | 4           |
| 1.5 Manfaat Penelitian .....                                                         | 4           |
| 1.6 Tahapan Penelitian .....                                                         | 4           |
| 1.7 Sistematika Penulisan .....                                                      | 5           |
| <b>BAB II TINJAUAN LITERATUR .....</b>                                               | <b>7</b>    |
| 2.1 Penyakit Tuberkulosis .....                                                      | 7           |
| 2.2 Jaringan Interaksi Protein (PPI).....                                            | 8           |
| 2.3 Maximum Clique Problem (MCP) .....                                               | 9           |
| 2.4 Pangkalan Data UniProt (Universal Protein Resource).....                         | 11          |
| 2.5 Algoritma CliSAT .....                                                           | 12          |
| 2.5.1 Representasi Logika dan Formulasi Masalah .....                                | 14          |
| 2.5.2 Mekanisme <i>Branch-and-Bound</i> (Pencarian Pohon) .....                      | 15          |
| 2.5.3 Perhitungan Batas Atas Berbasis Pewarnaan ( <i>Coloring-Based Bound</i> )..... | 15          |
| 2.5.4 Penalaran MaxSAT (Infrastructure-Based Reasoning) .....                        | 16          |
| 2.6 Teknik Pemangkasan Berbasis Batas Derajat ( <i>Degree Bounding</i> ) .....       | 17          |
| 2.7 Analisis Pengayaan Fungsional ( <i>Functional Enrichment Analysis</i> ) .....    | 18          |
| 2.7.1 <i>Gene Ontology</i> (GO) .....                                                | 19          |
| 2.7.2 <i>KEGG Pathway</i> .....                                                      | 19          |
| 2.8 Penelitian Terdahulu.....                                                        | 19          |
| <b>BAB III METODOLOGI PENELITIAN.....</b>                                            | <b>22</b>   |
| 3.1 Pengumpulan Data.....                                                            | 22          |

|                                                   |                                                                |           |
|---------------------------------------------------|----------------------------------------------------------------|-----------|
| 3.2                                               | <i>Data Preprocessing</i> .....                                | 24        |
| 3.2.1                                             | <i>Data Selection</i> .....                                    | 24        |
| 3.2.2                                             | <i>Data Deduplication</i> .....                                | 25        |
| 3.2.3                                             | <i>Network Construction</i> .....                              | 26        |
| 3.2.4                                             | <i>Data Filtering</i> .....                                    | 27        |
| 3.2.5                                             | Konversi Format Data .....                                     | 29        |
| 3.3                                               | Deteksi <i>Maximum Clique</i> menggunakan CliSAT .....         | 29        |
| 3.3.1                                             | Inisialisasi & Penetapan Rekor Awal .....                      | 31        |
| 3.3.2                                             | Pencarian cabang ( <i>Branching</i> ) .....                    | 33        |
| 3.3.3                                             | Pemangkasan berbasis pewarnaan ( <i>Coloring Bound</i> ) ..... | 37        |
| 3.3.4                                             | Penalaran logika konflik ( <i>MaxSAT Reasoning</i> ) .....     | 41        |
| 3.3.5                                             | Pembaruan rekor solusi ( <i>Backtrack &amp; Update</i> ) ..... | 44        |
| 3.4                                               | Evaluasi .....                                                 | 46        |
| 3.4.2                                             | Evaluasi Perbandingan Performa ( <i>Benchmarking</i> ) .....   | 49        |
| 3.5                                               | <i>Deployment</i> .....                                        | 50        |
| 3.5.1                                             | Analisis Kebutuhan .....                                       | 50        |
| 3.5.2                                             | Membuat <i>User Interface</i> .....                            | 52        |
| 3.5.3                                             | Integrasi Sistem .....                                         | 55        |
| 3.5.4                                             | Pengujian Sistem .....                                         | 56        |
| 3.6                                               | Analisis Fungsional <i>Maximum Clique</i> .....                | 56        |
| 3.6.1                                             | <i>Functional Enrichment Analysis</i> .....                    | 56        |
| <b>BAB IV HASIL PENGUJIAN DAN PEMBAHASAN.....</b> |                                                                | <b>60</b> |
| 4.1                                               | Implementasi .....                                             | 60        |
| 4.1.1                                             | Deskripsi Alat dan Lingkungan Implementasi .....               | 60        |
| 4.1.2                                             | Tahapan Implementasi .....                                     | 61        |
| 4.2                                               | Hasil .....                                                    | 67        |
| 4.2.1                                             | Hasil Pengumpulan Data .....                                   | 67        |
| 4.2.2                                             | Hasil <i>Preprocessing Data</i> .....                          | 67        |
| 4.2.3                                             | Hasil Penentuan <i>Maximum Clique</i> (CliSAT) .....           | 72        |
| 4.2.4                                             | Hasil Evaluasi .....                                           | 75        |
| 4.2.5                                             | Hasil Pengembangan Sistem Antarmuka Web .....                  | 78        |
| 4.2.6                                             | Hasil Analisis Fungsional .....                                | 80        |
| 4.3                                               | Pembahasan .....                                               | 83        |

|                             |                                              |           |
|-----------------------------|----------------------------------------------|-----------|
| 4.3.1                       | Efisiensi Komputasi Algoritma CliSAT.....    | 83        |
| 4.3.2                       | Peran Fungsional <i>Maximum Clique</i> ..... | 84        |
| <b>BAB V PENUTUP .....</b>  |                                              | <b>85</b> |
| 5.1                         | Kesimpulan.....                              | 85        |
| 5.2                         | Saran .....                                  | 85        |
| <b>DAFTAR PUSTAKA .....</b> |                                              | <b>87</b> |
| <b>LAMPIRAN .....</b>       |                                              | <b>91</b> |