

ABSTRAK

Salah satu fungsi dari pengklasifian data adalah untuk dapat mengenali objek baru. Sebuah sistem komputer yang berbentuk Multilayer Perceptron (MLP), dengan algoritma *backpropagation* mampu membantu mengenali objek tersebut secara otomatis. Algoritma ini berjalan dengan 3 fase. Fase pertama *feed forward*, memproses input-input yang diterima kemudian diteruskan ke bagian *hidden layer*, hingga akhirnya pemrosesan mencapai bagian *output layer*. Fase kedua *backpropagation*, akan menghitung nilai kesalahan dari output target dibandingkan dengan output yang ada; hasil dari perhitungan ini akan mempengaruhi nilai perubahan bobot pada layer sebelumnya. Fase ketiga adalah perubahan bobot yang akan memodifikasi nilai bobot-bobot sebelumnya dengan nilai bobot baru. Dengan bobot-bobot ini, kita dapat mengenali objek baru dan mengklasifikasikannya berdasarkan ciri-ciri yang dimiliki objek tersebut. Proses pengujian dataset dilakukan dengan menggunakan 1-3 *hidden layer*, (0.1, 0.5, 0.9) *learning rate*, (0.1, 0.5, 0.9) *momentum*, 1-5 node pada setiap *hidden layer*, serta (1000, 5000, 10000) *training time* pada dataset *iris* dan *three monks*, (10, 50, 100) pada dataset *mushroom*. Dari pengujian yang dilakukan pada dataset *mushroom* pada setting tertentu, seperti ketika klasifikasi diimplementasikan dengan menggunakan 1 *hidden layer* yang memiliki 4 node pada *hidden layer* tersebut, *learning rate* 0.1, *momentum* 0.1, *training time* 10, MLPs mampu melakukan klasifikasi secara sempurna dengan tingkat *error rate* 0%.

Kata kunci: *backpropagation*, *Multilayer Perceptron* (MLP), masalah klasifikasi

ABSTRACT

One of classification use cases is to recognize new objects. A computer system designed as a Multilayer Perceptron (MLP) with backpropagation algorithm can help recognize objects automatically. The algorithm works in three phases. The first phase is feed forward when the inputs are received and the forwarded to the hidden layer, until the inputs reach the output layer. The second phase is backpropagation where MLP calculates error values of the target output and compare them with existing outputs. The result of this calculation affects the values changed in weight on the previous layer. The third phase is updating the weights. MLP modifies the values of the previous weights with the new weights. With this new set of weights, we can recognize new objects and classify them based on their attributes. The experiment is set on 1-3 hidden layer, learning rate (0.1, 0.5, 0.9), momentum (0.1, 0.5, 0.9), from one to five nodes for each hidden layer, and also (1000, 5000, 10000) training time for iris and three monks dataset, (10, 50, 100) training time for mushroom dataset. Our experiment shows that with mushroom dataset when MLP is implemented on 1 hidden layer with 4 nodes, learning rate 0.1, momentum 0.1, 10 training time, MLPs able to classify perfectly with 0% error rate.

Keywords: backpropagation, classification problem, Multilayer Perceptron (MLP)



DAFTAR ISI

| | |
|--|-------|
| LEMBAR PENGESAHAN | i |
| PERNYATAAN ORISINALITAS LAPORAN PENELITIAN..... | ii |
| PERNYATAAN PUBLIKASI LAPORAN PENELITIAN..... | iii |
| PRAKATA..... | iv |
| ABSTRAK..... | v |
| ABSTRACT..... | vi |
| DAFTAR ISI..... | vii |
| DAFTAR GAMBAR..... | x |
| DAFTAR TABEL..... | xi |
| DAFTAR NOTASI/ LAMBANG..... | xvi |
| DAFTAR SINGKATAN..... | xvii |
| DAFTAR ISTILAH..... | xviii |
| BAB 1 PENDAHULUAN..... | 1 |
| 1.1 Latar Belakang..... | 1 |
| 1.2 Rumusan Masalah..... | 4 |
| 1.3 Tujuan Pembahasan..... | 4 |
| 1.4 Ruang Lingkup..... | 5 |
| 1.5 Sumber Data..... | 5 |
| 1.6 Sistematika Penyajian..... | 6 |
| BAB 2 KAJIAN TEORI..... | 7 |
| 2.1 <i>Artificial Intelligence (AI)</i> | 7 |
| 2.1.1 <i>Artificial Neural Network (ANN)</i> | 11 |
| 2.1.2 <i>Algoritma Backpropagation</i> | 14 |

| | |
|--|-----|
| 2.1.3 Model <i>Overfitting</i> | 19 |
| 2.1.4 <i>Waikato Environment for Knowledge Analysis (WEKA)</i> | 20 |
| BAB 3 ANALISIS DAN RANCANGAN SISTEM..... | 24 |
| 3.1 Analisis Kebutuhan Sistem | 24 |
| 3.2 Analisis Sistem..... | 24 |
| 3.2.1 Analisis Sumber Data..... | 25 |
| 3.2.2 Analisis Proses Klasifikasi <i>Backpropagation</i> | 26 |
| 3.2.3 Diagram <i>Use Case</i> | 26 |
| 3.2.4 <i>Activity Diagram</i> | 27 |
| 3.2.5 <i>User Interface</i> | 30 |
| BAB 4 IMPLEMENTASI..... | 32 |
| 4.1 Implementasi Sistem | 32 |
| 4.2 Implementasi Kode Program..... | 32 |
| 4.3 Implementasi Antarmuka | 35 |
| 4.3.1 Halaman Utama..... | 36 |
| 4.3.2 <i>Insert Dataset</i> | 36 |
| 4.3.3 Hasil Analisa | 37 |
| BAB 5 PENGUJIAN..... | 52 |
| 5.1 Pengujian Metode..... | 52 |
| 5.1.1 Pengujian Metode terhadap Dataset <i>Iris</i> | 53 |
| 5.1.2 Pengujian Metode terhadap Dataset <i>Mushroom</i> | 104 |
| 5.1.3 Pengujian Metode terhadap Dataset <i>Monks</i> | 156 |
| 5.2 Pengujian Kestabilan Numerik | 208 |
| 5.2.1 Kesimpulan | 269 |
| BAB 6 SIMPULAN DAN SARAN | 270 |
| 6.1 Simpulan | 270 |

| | |
|----------------------|-----|
| 6.2 Saran..... | 272 |
| DAFTAR PUSTAKA | 273 |



DAFTAR GAMBAR

| | |
|---|----|
| Gambar 1.1 : Ilustrasi jaringan syaraf manusia yang diadaptasi untuk ANN (Kriesel, 2011)..... | 1 |
| Gambar 1.2 : Ilustrasi retina mata manusia (Kriesel, 2011) | 2 |
| Gambar 1.3 : Ilustrasi SLP hyperplane (garis abu-abu)..... | 3 |
| Gambar 1.4 : Ilustrasi MLPs convex polygons (Kriesel, 2011)..... | 3 |
| Gambar 2.1 : Pohon keputusan dari sebuah training set (Kotsiantist, 2007) | 10 |
| Gambar 2.2 : Proses pengolahan informasi pada neuron (Kriesel, 2011)..... | 11 |
| Gambar 2.3 : SLP pada masalah XOR (Kriesel, 2011)..... | 12 |
| Gambar 2.4 : Struktur MLPs (Kriesel, 2011)..... | 13 |
| Gambar 2.5 : Arsitektur backpropagation pada jaringan MLP. (SIANG, 2009) .. | 14 |
| Gambar 2.6 : Arsitektur backpropagation untuk masalah XOR (SIANG, 2009) . | 15 |
| Gambar 2.7 Training dan Test error rate..... | 19 |
| Gambar 2.8 Pelatihan data iris menggunakan fungsi multilayer perceptron WEKA | 22 |
| Gambar 3.1 : Activity diagram proses klasifikasi dataset..... | 25 |
| Gambar 3.2 : Use Case Diagram..... | 26 |
| Gambar 3.3 Activity Diagram Input dataset | 27 |
| Gambar 3.4 : Activity Diagram Konfigurasi Jaringan..... | 28 |
| Gambar 3.5 : Activity Diagram analisa data..... | 29 |
| Gambar 3.6 : User Interface Halaman Analisis Algoritma | 30 |
| Gambar 4.1 Kode program menu insert dataset..... | 31 |
| Gambar 4.2 Kode program save seting jaringan MLPs | 32 |
| Gambar 4.3 Kode program pelatihan dataset..... | 33 |
| Gambar 4.4 Kode program write to excel..... | 34 |
| Gambar 4.5 Desain Antarmuka Halaman Utama..... | 35 |
| Gambar 4.6 Insert dataset..... | 36 |
| Gambar 4.7 Halaman hasil analisa pada dataset mushroom | 37 |

DAFTAR TABEL

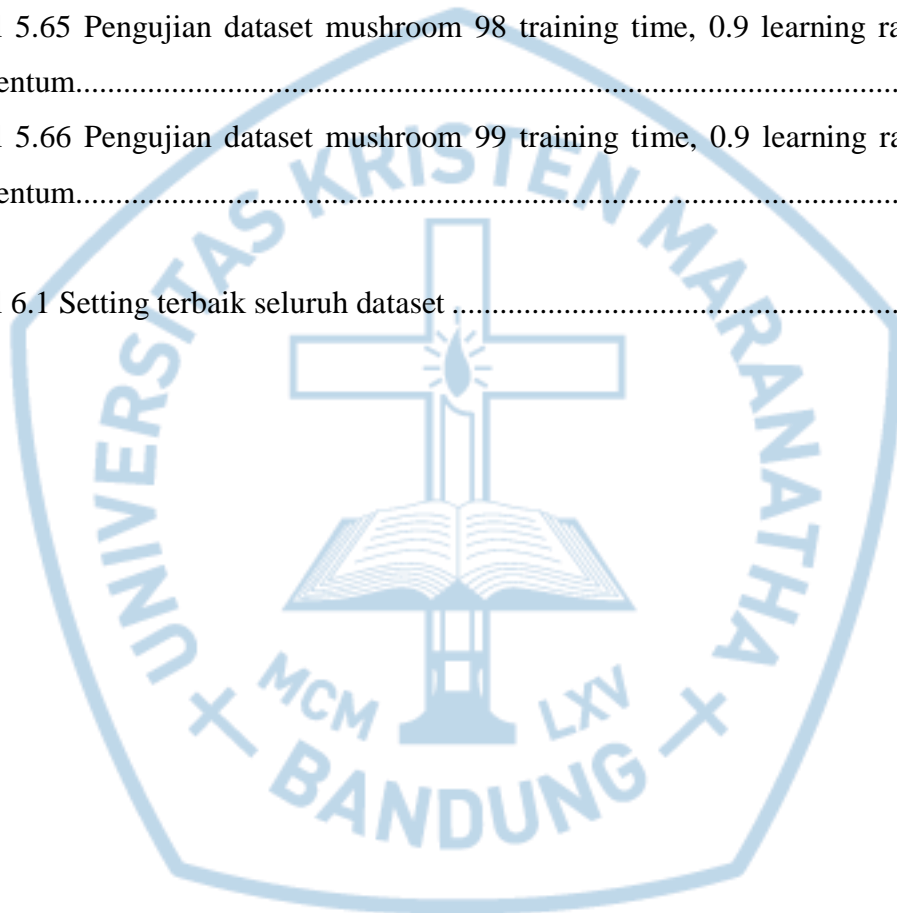
| | |
|--|----|
| Tabel 2.1 : Tabel Hubungan Perilaku Agen Kecerdasan dengan Lingkungannya (Russell & Norvig, 1995)..... | 8 |
| Tabel 2.2 : Contoh Dataset (Kotsiantist, 2007)..... | 9 |
| Tabel 2.3 : Tabel Contoh Training Set (Kotsiantist, 2007)..... | 10 |
| Tabel 2.4 : Tabel bobot koneksi ke layer tersembunyi | 15 |
| Tabel 2.5 : Tabel bobot koneksi ke output..... | 15 |
| Tabel 2.6 : Tabel perhitungan perubahan bobot ke unit tersembunyi..... | 17 |
| Tabel 2.7 : Hasil perhitungan perubahan bobot unit tersembunyi | 18 |
| Tabel 5.1 Pengujian dataset iris 1000 training time, learning rate 0.1, momentum 0.1..... | 52 |
| Tabel 5.2 Pengujian dataset iris 5000 training time, 0.1 learning rate, 0.1 momentum..... | 55 |
| Tabel 5.3 Pengujian dataset iris 10000 training time, 0.1 learning rate, 0.1 momentum..... | 58 |
| Tabel 5.4 Pengujian dataset iris 1000 training time, 0.5 learning rate, 0.1 momentum..... | 62 |
| Tabel 5.5 Pengujian dataset iris 1000 training time, 0.9 learning rate, 0.1 momentum..... | 65 |
| Tabel 5.6 Pengujian dataset iris 5000 training time, 0.5 learning rate, 0.1 momentum..... | 68 |
| Tabel 5.7 Pengujian dataset iris 5000 training time, 0.9 learning rate, 0.1 momentum..... | 72 |
| Tabel 5.8 Pengujian dataset iris 10000 training time, 0.5 learning rate, 0.1 momentum..... | 75 |
| Tabel 5.9 Pengujian dataset iris 10000 training time, 0.9 learning rate, 0.1 momentum..... | 78 |
| Tabel 5.10 Pengujian dataset iris 1000 training time, 0.1 learning rate, 0.5 momentum..... | 82 |
| Tabel 5.11 Pengujian dataset iris 1000 training time, 0.1 learning rate, 0.9 momentum..... | 85 |

| | |
|---|-----|
| Tabel 5.12 Pengujian dataset iris 5000 training time, 0.1 learning rate, 0.5 momentum..... | 88 |
| Tabel 5.13 Pengujian dataset iris 5000 training time, 0.1 learning rate, 0.9 momentum..... | 92 |
| Tabel 5.14 Pengujian dataset iris 10000 training time, 0.1 learning rate, 0.5 momentum..... | 95 |
| Tabel 5.15 Pengujian dataset iris 10000 training time, 0.1 learning rate, 0.9 momentum..... | 98 |
| Tabel 5.16 Rata-rata error rate dataset iris dengan berbagai setting | 102 |
| Tabel 5.17 Pengujian dataset mushroom 10 training time, 0.1 learning rate, 0.1 momentum..... | 103 |
| Tabel 5.18 Pengujian dataset mushroom 50 training time, 0.1 learning rate, 0.1 momentum..... | 106 |
| Tabel 5.19 Pengujian dataset mushroom 100 training time, 0.1 learning rate, 0.1 momentum..... | 110 |
| Tabel 5.20 Pengujian dataset mushroom 10 training time, 0.5 learning rate, 0.1 momentum..... | 113 |
| Tabel 5.21 Pengujian dataset mushroom 10 training time, 0.9 learning rate, 0.1 momentum..... | 116 |
| Tabel 5.22 Pengujian dataset mushroom 50 training time, 0.5 learning rate, 0.1 momentum..... | 120 |
| Tabel 5.23 Pengujian dataset mushroom 50 training time, 0.9 learning rate, 0.1 momentum..... | 123 |
| Tabel 5.24 Pengujian dataset mushroom 100 training time, 0.5 learning rate, 0.1 momentum..... | 126 |
| Tabel 5.25 Pengujian dataset mushroom 100 training time, 0.9 learning rate, 0.1 momentum..... | 130 |
| Tabel 5.26 Pengujian dataset mushroom 10 training time, 0.1 learning rate, 0.5 momentum..... | 133 |
| Tabel 5.27 Pengujian dataset mushroom 10 training time, 0.1 learning rate, 0.9 momentum..... | 137 |

| | |
|---|-----|
| Tabel 5.28 Pengujian dataset mushroom, 50 training time, 0.1 learning rate, 0.5 momentum..... | 140 |
| Tabel 5.29 Pengujian dataset mushroom 50 training time, 0.1 learning rate, 0.9 momentum..... | 143 |
| Tabel 5.30 Pengujian dataset mushroom 100 training time, 0.1 learning rate, 0.5 momentum..... | 147 |
| Tabel 5.31 Pengujian dataset mushroom 100 training time, 0.1 learning rate, 0.9 momentum..... | 150 |
| Tabel 5.32 Hasil pengujian dataset mushroom dengan berbagai setting | 153 |
| Tabel 5.33 Pengujian dataset monks 1000 training time, 0.1 learning rate, 0.1 momentum..... | 155 |
| Tabel 5.34 Pengujian dataset monks 5000 training time, 0.1 learning rate, 0.1 momentum..... | 158 |
| Tabel 5.35 Pengujian dataset monks 10000 training time, 0.1 learning rate, 0.1 momentum..... | 161 |
| Tabel 5.36 Pengujian dataset monks 1000 training time, 0.5 learning rate, 0.1 momentum..... | 166 |
| Tabel 5.37 Pengujian dataset monks 1000 training time, 0.9 learning rate, 0.1 momentum..... | 169 |
| Tabel 5.38 Pengujian dataset monks 5000 training time, 0.5 learning rate, 0.1 momentum..... | 172 |
| Tabel 5.39 Pengujian dataset monks 5000 training time, 0.9 learning rate, 0.1 momentum..... | 176 |
| Tabel 5.40 Pengujian dataset monks 10000 training time, 0.5 learning rate, 0.1 momentum..... | 179 |
| Tabel 5.41 Pengujian 10000 training time, 0.9 learning rate, 0.1 momentum.... | 182 |
| Tabel 5.42 Pengujian dataset monks 1000 training time, 0.1 learning rate, 0.5 momentum..... | 186 |
| Tabel 5.43 Pengujian dataset monks 1000 training time, 0.1 learning rate, 0.9 momentum..... | 189 |
| Tabel 5.44 Pengujian dataset monks 5000 training time, 0.1 learning rate, 0.5 momentum..... | 192 |

| | |
|--|-----|
| Tabel 5.45 Pengujian dataset monks 5000 training time, 0.1 learning rate, 0.9 momentum..... | 195 |
| Tabel 5.46 Pengujian dataset monks 10000 training time, 0.1 learning rate, 0.5 momentum..... | 199 |
| Tabel 5.47 Pengujian dataset monks 10000 training time, 0.1 learning rate, 0.9 momentum..... | 202 |
| Tabel 5.48 Hasil pengujian dataset monks dengan berbagai setting..... | 206 |
| Tabel 5.49 Pengujian dataset iris 5001 training time, 0.9 learning rate, 0.1 momentum..... | 202 |
| Tabel 5.50 Pengujian dataset iris 5002 training time, 0.9 learning rate, 0.1 momentum..... | 211 |
| Tabel 5.51 Pengujian dataset iris 5003 training time, 0.9 learning rate, 0.1 momentum..... | 215 |
| Tabel 5.52 Pengujian dataset iris 5004 training time, 0.9 learning rate, 0.1 momentum..... | 218 |
| Tabel 5.53 Pengujian dataset iris 7500 training time, 0.9 learning rate, 0.1 momentum..... | 222 |
| Tabel 5.54 Pengujian dataset iris 9996 training time, 0.9 learning rate, 0.1 momentum..... | 225 |
| Tabel 5.55 Pengujian dataset iris 9997 training time, 0.9 learning rate, 0.1 momentum..... | 228 |
| Tabel 5.56 Pengujian dataset iris 9998 training time, 0.9 learning rate, 0.1 momentum..... | 232 |
| Tabel 5.57 Pengujian dataset iris 9999 training time, 0.9 learning rate, 0.1 momentum..... | 235 |
| Tabel 5.58 Pengujian dataset mushroom 51 training time, 0.9 learning rate, 0.1 momentum..... | 239 |
| Tabel 5.59 Pengujian dataset mushroom 52 training time, 0.9 learning rate, 0.1 momentum..... | 242 |
| Tabel 5.60 Pengujian dataset mushroom 53 training time, 0.9 learning rate, 0.1 momentum..... | 245 |

| | |
|--|-----|
| Tabel 5.61 Pengujian dataset mushroom 54 training time, 0.9 learning rate, 0.1 momentum..... | 249 |
| Tabel 5.62 Pengujian dataset mushroom 75 training time, 0.9 learning rate, 0.1 momentum..... | 252 |
| Tabel 5.63 Pengujian dataset mushroom 96 training time, 0.9 learning rate, 0.1 momentum..... | 256 |
| Tabel 5.64 Pengujian dataset mushroom 97 training time, 0.9 learning rate, 0.1 momentum..... | 259 |
| Tabel 5.65 Pengujian dataset mushroom 98 training time, 0.9 learning rate, 0.1 momentum..... | 262 |
| Tabel 5.66 Pengujian dataset mushroom 99 training time, 0.9 learning rate, 0.1 momentum..... | 266 |
| Tabel 6.1 Setting terbaik seluruh dataset | 275 |



DAFTAR NOTASI/ LAMBANG

| Jenis | Notasi/ Lambang | Nama | Arti |
|----------|-----------------------------|------|------|
| BPMN 2.0 | Isi dengan gambar notasinya | | |
| DFD | | | |
| ERD | | | |
| UML | | | |
| | | | |
| Dst. | | | |

Referensi:

Notasi/ Lambang BPMN 2.0 dari Object Management Group (Object Management Group, 2014)

Notasi/ Lambang DFD dari

Notasi/ Lambang ERD dari

Dst.



DAFTAR SINGKATAN

| | |
|-----|--------------------------|
| SLP | Singlelayered Perceptron |
| MLP | Multilayered Perceptron |



DAFTAR ISTILAH

| | | |
|-------------------------|-------|--|
| Audit | | Pemeriksaan dengan seksama pada sebuah organisasi dengan pencarian bukti nyata berupa dokumen fisik atau elektronik untuk pembuktiannya. |
| Supply Chain Management | Chain | “Manajemen pengelolaan bahan baku, dari industri hilir ke hulu “ [x] |
| | | |
| Dst. | | |

