NEURAL NETWORKS

David Sánchez Artuñedo
07/06/2017
1. Preface
2. Machine learning
3. Examples
A neural network-based 2D/3D image registration quality evaluator for pediatric patient setup in external beam radiation therapy.

A Fast Neural Network Approach to Predict Lung Tumor Motion during Respiration for Radiation Therapy Applications

Anatomic Segmentation Improves Prostate Cancer Detection With Artificial Neural Networks Analysis of $^1$H Magnetic Resonance Spectroscopic Imaging

Utilisation d'un réseau de neurones artificiels pour la simulation des mouvements pulmonaires

Simulation of lung motions using an artificial neural network

Late rectal bleeding after 3D-CRT for prostate cancer: development of a neural-network-based predictive model

Beam orientation in stereotactic radiosurgery using an artificial neural network
1.0 RO: How data surrounds the patient

- DICOM
- RT Structure Set
- RT Plan
- RT Dose
- Dynalogs
- Aria
- SAP
- ...

2.0 Machine Learning definition

“A computer program is said to learn from experience \((E)\) with respect to some class of tasks \((T)\) and performance measure \((P)\), if its performance at tasks in \(T\), as measured by \(P\), improves with experience \(E\)”
Machine Learning

- Supervised Learning:
  - Classification
  - Regression

- Unsupervised learning
2.1 FFNN Design
\[ f(x) = v^T \omega^{(2)} + b^{(2)} \]

\[ v = s\left(x^T w_i^{(1)} + b^{(1)}\right) \]

\[ f(v) = \frac{1}{1 + e^{-v}} \]
2.2 Learning process

Weights randomly assigned

Neuron activated

Calculation of the output

Update weights

$x_i, y_d$

\[ y(j) = f\left(\sum_{i=1}^{R} w_{1,i}(j)x_i(j) + b\right) \]

\[ w_{1,i}(j + 1) = w_{1,i}(j) + \Delta w_{1,i}(j) \]

\[ \Delta w_{1,i}(j) = \alpha * x_i(j) * e(j) \]
2.3 Model Assessment and selection
### 2.2 Performance evaluation

<table>
<thead>
<tr>
<th>True Class</th>
<th>Pos</th>
<th>Neg</th>
</tr>
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<tbody>
<tr>
<td>Yes</td>
<td>TP</td>
<td>FP</td>
</tr>
<tr>
<td>No</td>
<td>FN</td>
<td>TN</td>
</tr>
<tr>
<td></td>
<td>P=TP+FN</td>
<td>N=FP+TN</td>
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</tbody>
</table>

- **Accuracy** = \( \frac{TP+TN}{P+N} \)
- **Precision** = \( \frac{TP}{TP+FP} \)
- **Sensitivity** = \( \frac{TP}{P} \)
- **Specificity** = \( \frac{TN}{N} \)
- **False positive rate** = \( \frac{FP}{N} \)
2.2.1 ROC curve
Stereotactic radiosurgery

Beam orientation in stereotactic radiosurgery using an artificial neural network

Agnieszka Skrobala*, Julian Malicki

Department of Electronradiology, University of Medical Science; and Department of Medical Physics, Greater Poland Cancer Centre, Poznan, Poland

![Graph showing beam orientation in stereotactic radiosurgery using an artificial neural network.](image)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MP</th>
<th>ANN1</th>
<th>ANN2</th>
<th>ANN3</th>
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<tr>
<td></td>
<td>Mean (%)</td>
<td>SD (%)</td>
<td>Mean (%)</td>
<td>SD (%)</td>
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<tr>
<td>Max body</td>
<td>107.4</td>
<td>3.0</td>
<td>106.9</td>
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<tr>
<td>Min PTV</td>
<td>92.6</td>
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<td>92.8</td>
<td>1.3</td>
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<td>8.6</td>
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<tr>
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<td>2.5</td>
<td>2.6</td>
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<tr>
<td>Max eye left</td>
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<td>4.1</td>
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<tr>
<td>Max optic nerve right</td>
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<tr>
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<tr>
<td>Max chiasm</td>
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<td>7.1</td>
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A Fast Neural Network Approach to Predict Lung Tumor Motion during Respiration for Radiation Therapy Applications

Ivo Bukovsky,¹ Noriyasu Homma,² Kei Ichiji,³ Matous Cejnek,¹ Matous Slama,¹ Peter M. Benes,¹ and Jiri Bila¹

<table>
<thead>
<tr>
<th>Architecture</th>
<th>Learning</th>
<th>N_{train}</th>
<th>n</th>
<th>n_{k}</th>
<th>μ</th>
<th>Epochs</th>
<th>Epochs</th>
<th>MAE [mm]</th>
<th>σ(MAE) [mm]</th>
<th>sps</th>
<th>Count of trials</th>
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Predicting Post-Treatment Survivability of Patients with Breast Cancer Using Artificial Neural Network Methods

Tan-Nai Wang, Chung-Hao Cheng, Hung-Wen Chiu, Member, IEEE

<table>
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<th>Prediction outcome</th>
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<td>Death</td>
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<tr>
<td>Survival</td>
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<td>66</td>
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<tr>
<td>Death</td>
<td>24</td>
<td>74</td>
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<td>Total</td>
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Accuracy=85.1%
Specificity= 52.86%
Sensitivity= 94.83%
Toward IMRT 2D dose modeling using artificial neural networks: A feasibility study
Knowledge-based prediction of three-dimensional dose distributions for external beam radiotherapy

Satomi Shiraishi and Kevin L. Moore
Department of Radiation Medicine and Applied Sciences, University of California, San Diego, La Jolla, California 92093

Fig. 1. Flowcharts describing (a) ANN training and (b) dose prediction steps.
### Calculating Tangential Collisions Internally

<table>
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<th>VERT</th>
<th>THETA</th>
<th>G</th>
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**Registrar**

Versión v1.1
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>> colision
introduzca la separación entre codos74

A =
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introduzca la altura del plano inclinado37

h =
    37

introduzca la coordenada lateral9

x =
    9

introduzca la coordenada vertical24

y =
    24

introduzca la angulación de gantry60

g =
    60

**ERROR: Colisión del tangencial interno**
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<th>G</th>
<th>d</th>
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**entrada =**

69  
36  
7   
26  
50

**salida =**

2.2488e-013

La configuración del campo no colisiona
thank you