Modeling of angle ply laminates using artificial neural network

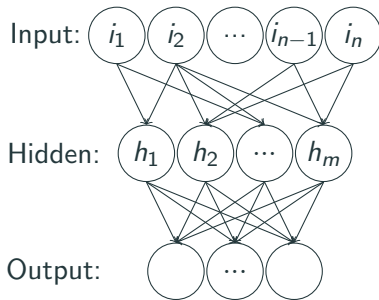Huiyao Zhang

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Kyoto Institue of Technology

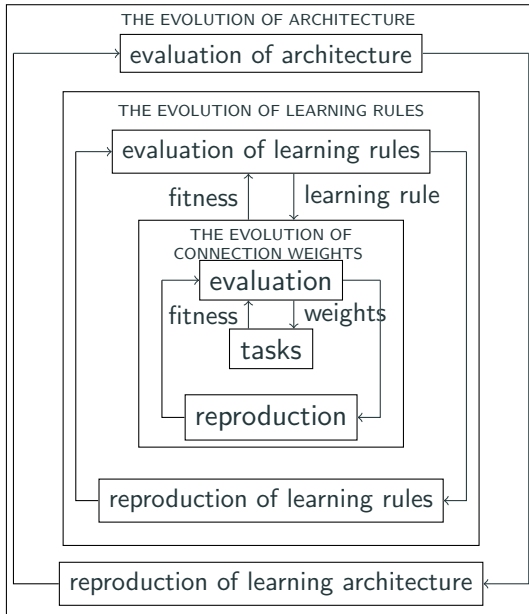**Content**

1. Neural Network
2. Genetic Algorithm
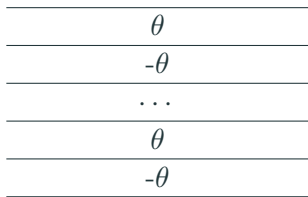3. Classic Lamination Theory

2. Neural Work

Input: i_1 i_2 $\cdots$ i_{n-1} i_n

Hidden: h_1 h_2 $\cdots$ h_m

Output: $\cdots$

Figure 1: Neural Network Model

2. Genetic Algorithm

THE EVOLUTION OF ARCHITECTURE

evaluation of architecture

THE EVOLUTION OF LEARNING RULES

evaluation of learning rules

fitness   learning rule

THE EVOLUTION OF
CONNECTION WEIGHTS

evaluation

fitness   weights

tasks

reproduction

reproduction of learning rules

reproduction of learning architecture

2. Classic Lamination Theory

Figure 3: Model for Angle ply laminate

$$
\begin{bmatrix} N_x \\ N_y \\ N_{xy} \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{16} \\ A_{12} & A_{22} & A_{26} \\ A_{16} & A_{26} & A_{66} \end{bmatrix} \begin{bmatrix} \varepsilon_x^0 \\ \varepsilon_y^0 \\ \gamma_{xy}^0 \end{bmatrix}
$$
$$
+ \begin{bmatrix} B_{11} & B_{12} & B_{16} \\ B_{11} & B_{12} & B_{16} \\ B_{16} & B_{26} & B_{66} \end{bmatrix} \begin{bmatrix} k_x \\ k_y \\ k_{xy} \end{bmatrix}
$$

$$
\begin{bmatrix} M_x \\ M_y \\ M_{xy} \end{bmatrix} = \begin{bmatrix} B_{11} & B_{12} & B_{16} \\ B_{12} & B_{22} & B_{26} \\ B_{16} & B_{26} & B_{66} \end{bmatrix} \begin{bmatrix} \varepsilon_x^0 \\ \varepsilon_y^0 \\ \gamma_{xy}^0 \end{bmatrix}
$$
$$
+ \begin{bmatrix} D_{11} & D_{12} & D_{16} \\ D_{11} & D_{12} & D_{16} \\ D_{16} & D_{26} & D_{66} \end{bmatrix} \begin{bmatrix} k_x \\ k_y \\ k_{xy} \end{bmatrix}
$$

(1)

2. Methdology
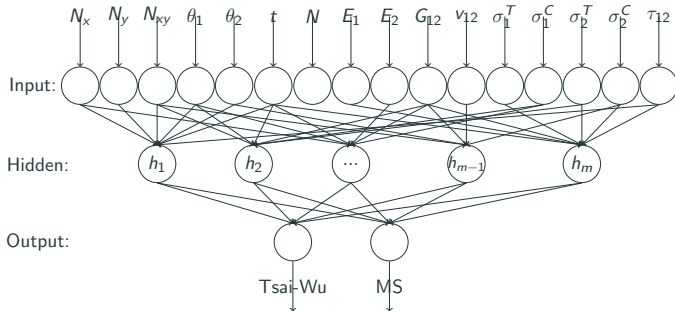
Figure 4: Neural Network Model

3. Implementation: Data Preparation

	Input			Output	
Load	Laminate Structure	Material Property	Failure Property	MS	Tsai-Wu
120,5,0	10,-10,8,1.27	38.6,8.27,0.26,4.14	1062.0,610.0,31,118,72	0.068	0.062
120,5,0	10,-10,2,1.27	38.6,8.27,0.26,4.14	1062.0,610.0,31,118,72	1.69	2.18
...	...	...	...	...	...
120,5,0	10,-10,134,1.27	38.6,8.27,0.26,4.14	1062.0,610.0,31,118,72	1.70	1.56
120,5,0	10,-10,8,1.27	181,10.3,0.28,7.17	1500.0,1500.0,40,246,68	0.072	0.024

4. Implementation: Neural Network