Akademia Górniczo-Hutnicza

Głębokie uczenie i inteligencja obliczeniowa

Automatyka i Robotyka II Stopień

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Optymalizacja fabryki z wykorzystaniem algorytmu immunologicznego (selekcji klonalnej)

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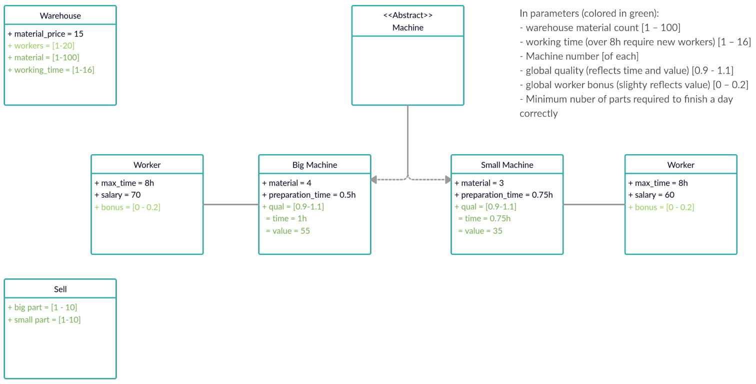
Spis treści

1 Wstęp

1.1 Factory model



Rysunek 1: Factory scheme

1.1.1 Factory main goal function:

$$Income = \sum_{i=1}^{n_p}(p_i * (v_i - m_i * m_p)) - (1 + b_i) * \sum_{i=1}^{n_w}(w_i * s_i * t_{wi}) - m_r * m_p - punish$$

Where:

- n_p – number of item types (param)
- $p_i(n_m)$ – number of manufactured i-type items
- $v_i(v_{bi}, t_{wi}, t_{bi}, w_q)$ – value of the i-type items
- m_i – number of material needed to manufacture the i-type item (param)
- m_p – material price (param)
- n_w – number of types of employees (param)
- w_i – number of i-type employees (param)
- s_i – the salary of i-type employees
- b – the bonus for employees (param)
- t_{wi} – real working time of the i-type machine/employee for one product
- $m_r(p_i, n_m)$ – material remains, unused material
- $p_{i_{min}}$ – minimum number of i-type items that must be manufactured to avoid punishment (param)
- $p_{i_{max}}$ – maximum number of items that can be manufactured
- n_m – number of materials in the warehouse at the beginning of the day (param)
- $punish(p_{un}, p_{num_i}, v_i)$ – punishment for not produced required item number

1.1.2 Punish

$punish = p_{un} * \sum_{i=1}^{n_p}(p_{num_i}) * v_i$

$$p_{num_i} = \begin{cases} 0 & \text{if} \quad p_{i_{min}} - p_i \leqslant 0 \\ p_{i_{min}} - p_i & \text{if} \quad p_{i_{min}} - p_i > 0 \end{cases}$$

Where:

- p_{un} – punishment rate
- $p_{num_i}(p_{i_{min}}, p_i)$ – number of i-type items for which a punishment will be charged

1.1.3 Number of types

Number of types of employees and machines should be the same:

$n_p = n_w$

1.1.4 Max number of items

Numbers of i-type items must meet:

$\sum_{i=1}^{n_p} p_{i_{max}} * m_i < n_m$

1.1.5 Real working time of the i-type machine/employee for one product

$t_{wi} = t_{pi} + p_i * t_{bi}$

1.2 Model assumption

Parameter	mark	value
Material number	n_m	[x - 100]
Material cost	m_p	15
Working time	?	[1 - 16]
Minimal number of big parts	$p_{0_{min}}$	[0 - 10]
Minimal number of small parts	$p_{1_{min}}$	[0 -10]
Big machine worker salary	s_0	70
Big machine material requirements	m_0	4
Big machine preparation time	t_{p0}	30 min
Base big machine item value	v_{b0}	50
Base big machine working time per item	t_{b0}	1h
Number of big machines	?	[0 - 10]
Small machine worker salary	s_1	60
Small machine material requirements	m_1	3
Small machine preparation time	t_{p1}	45 min
Base small machine item value	v_{b1}	35
Base small machine working time per item	t_{b1}	45 min
Number of small machines	?	[0 - 10]
Max working time per worker	?	8h
Worker bonus	b	[0.0 - 0.2]
Punishment rate	p_{un}	1.5

Where:

- x – number of required parts * cost of part
- Input parameters are given in square brackets
- Worker is hired on full time. Must work 8h
- First and second shift are equal in machine and worker count and type
- We reserve materials for a require items
- Any item manufactured over require number is a profit

2 Badany problem

2.1 Przegląd literatury

This article is about the artificial immune system in industrial application. Basing on cutting parameters (force, vibrations, torque etc.) they try to detect tool brake using a negative-selection algorithm [1].

This article is about the artificial immune system in industrial application. Authors compare AIS with Social Learning Mechanisms to few others AIS which use cloning alghoritm. Basing on proportional–/integral–/derivative-time they try to tune a PID [2].

Bibliografia

[1] Dipankar Dasgupta i Stephanie Forrest. “Artificial immune systems in industrial applications”. W: *Proceedings of the Second International Conference on Intelligent Processing and Manufacturing of Materials. IPMM’99 (Cat. No. 99EX296).* T. 1. IEEE. 1999, s. 257–267.

[2] Mingan Wang i in. “An Artificial Immune System Algorithm with Social Learning and Its Application in Industrial PID Controller Design”. en. W: *Mathematical Problems in Engineering* 2017 (2017), s. 1–13. ISSN: 1024-123X, 1563-5147. DOI: 10.1155/2017/3959474. URL: https://www.hindawi.com/journals/mpe/2017/3959474/ (term. wiz. 25. 03. 2020).