

# Zastosowania R do analizy pracy robotów w inteligentnych hurtowniach

Filip Grotkowski

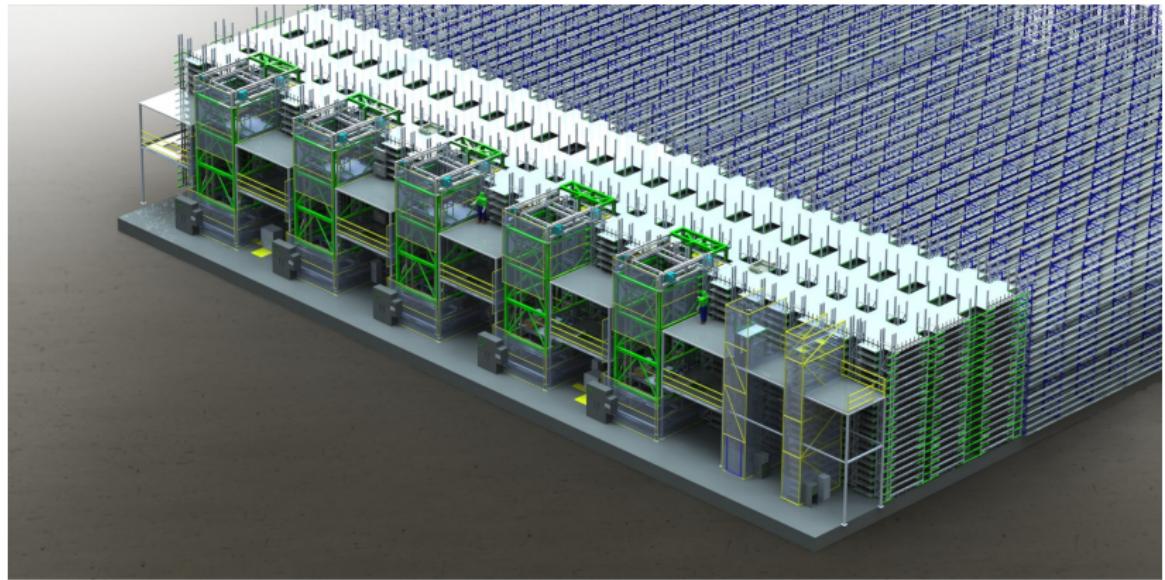
22 maja 2014



- 120kg wagi
- 1m długości
- maksymalna prędkość 10m/s

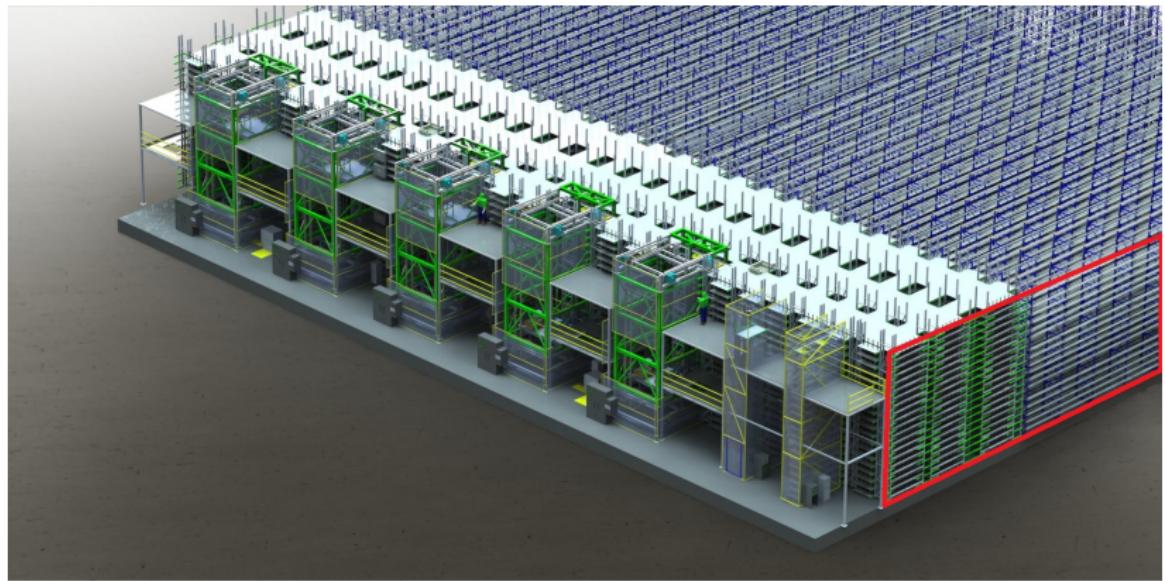
# Struktura hurtowni

## Plan ogólny



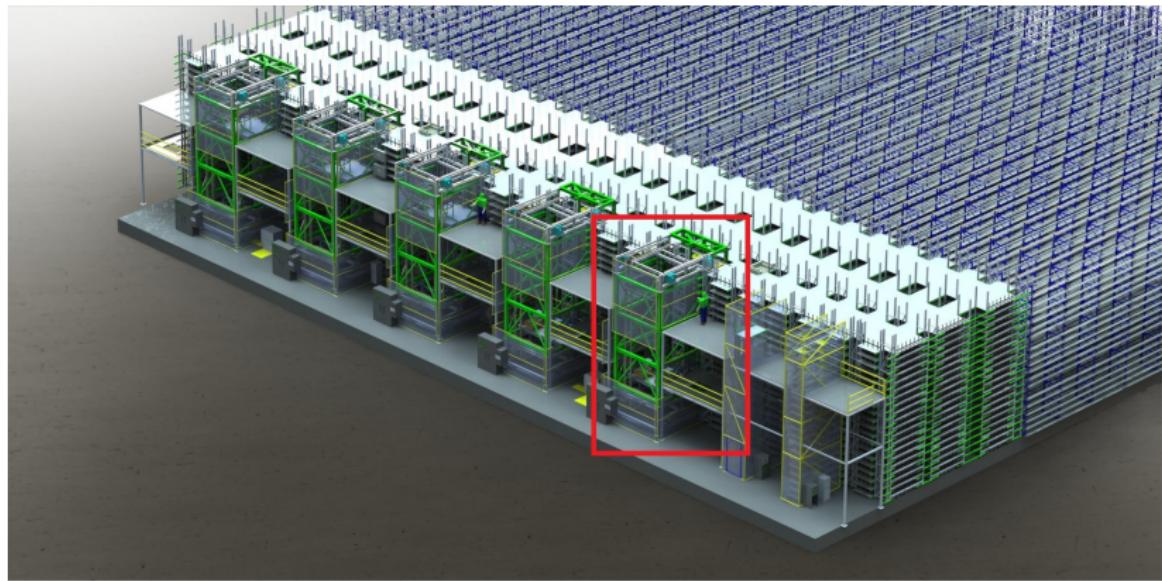
# Struktura hurtowni

## Poziomy



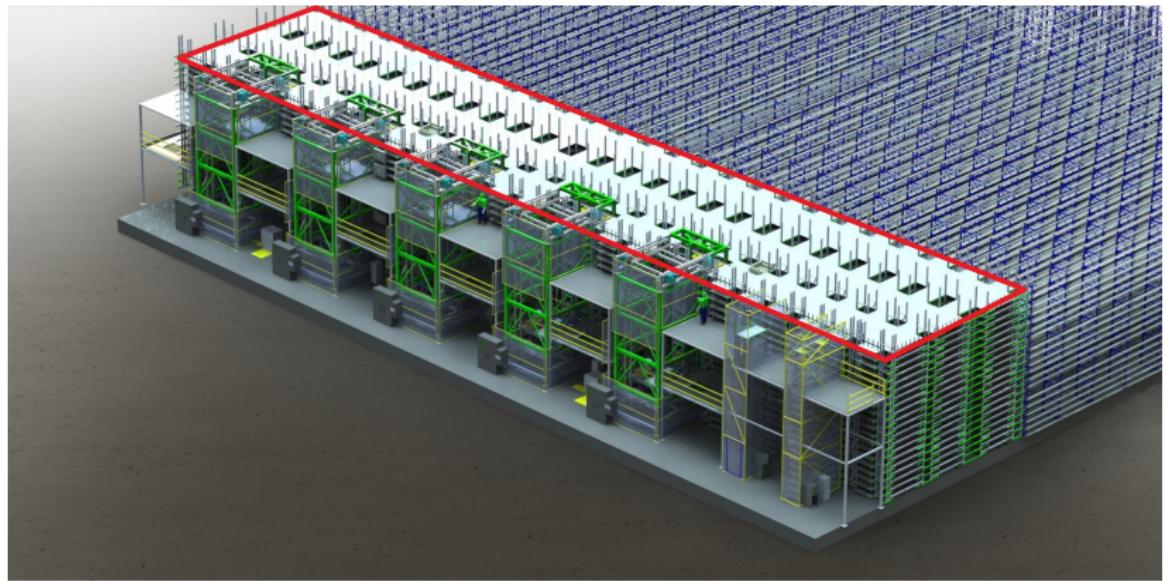
# Struktura hurtowni

MVC (winda)



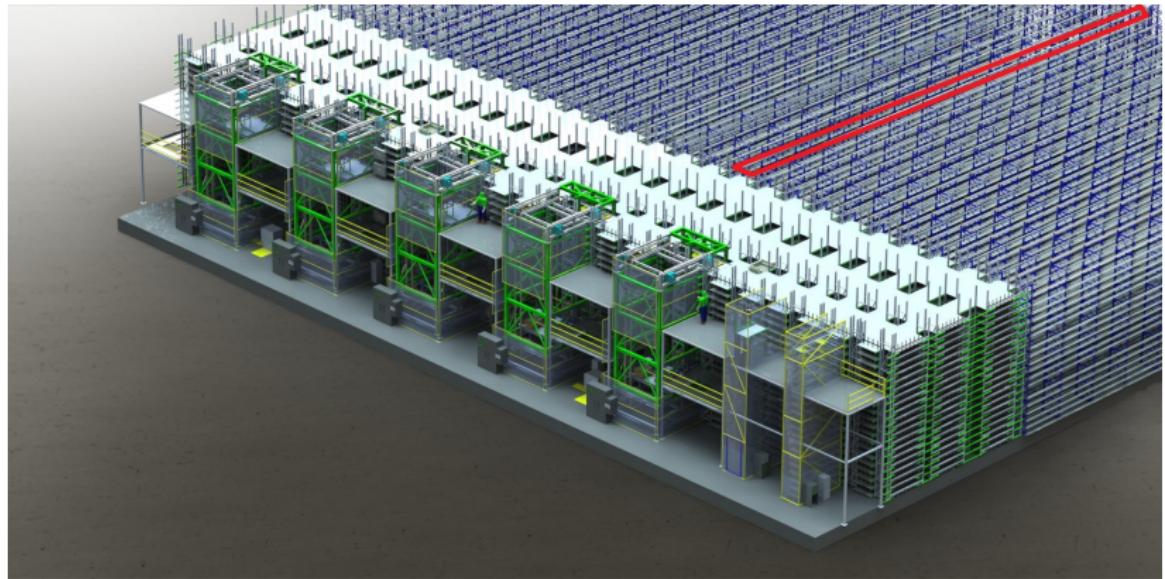
# Struktura hurtowni

## Transfer deck



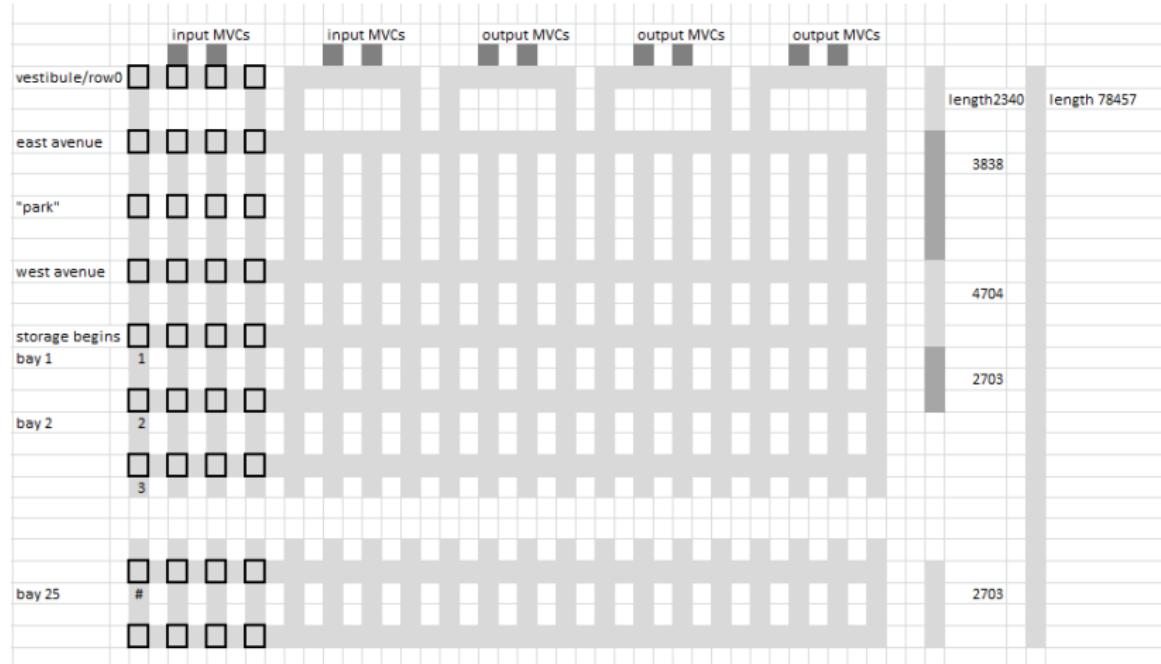
# Struktura hurtowni

Storage aisle



# Struktura hurtowni

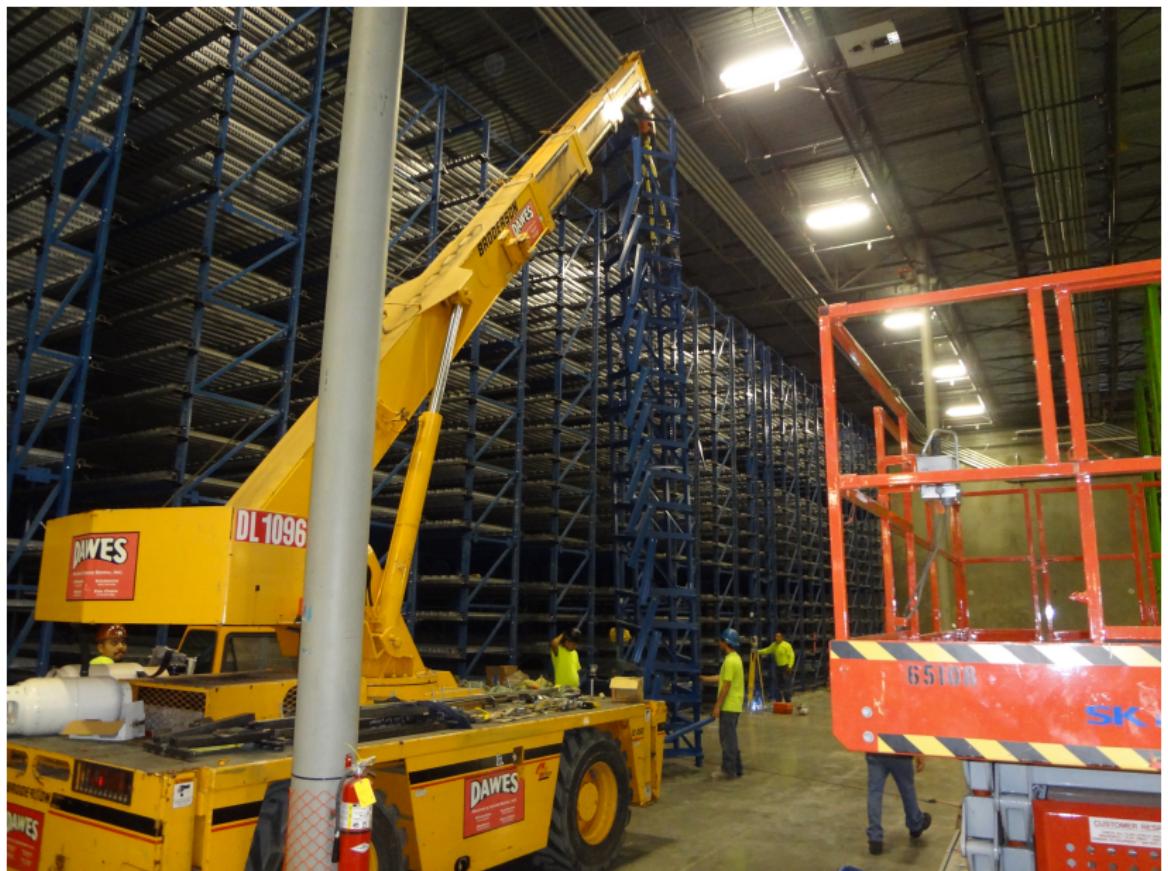
## Architektura jednego piętra



# Struktura hurtowni

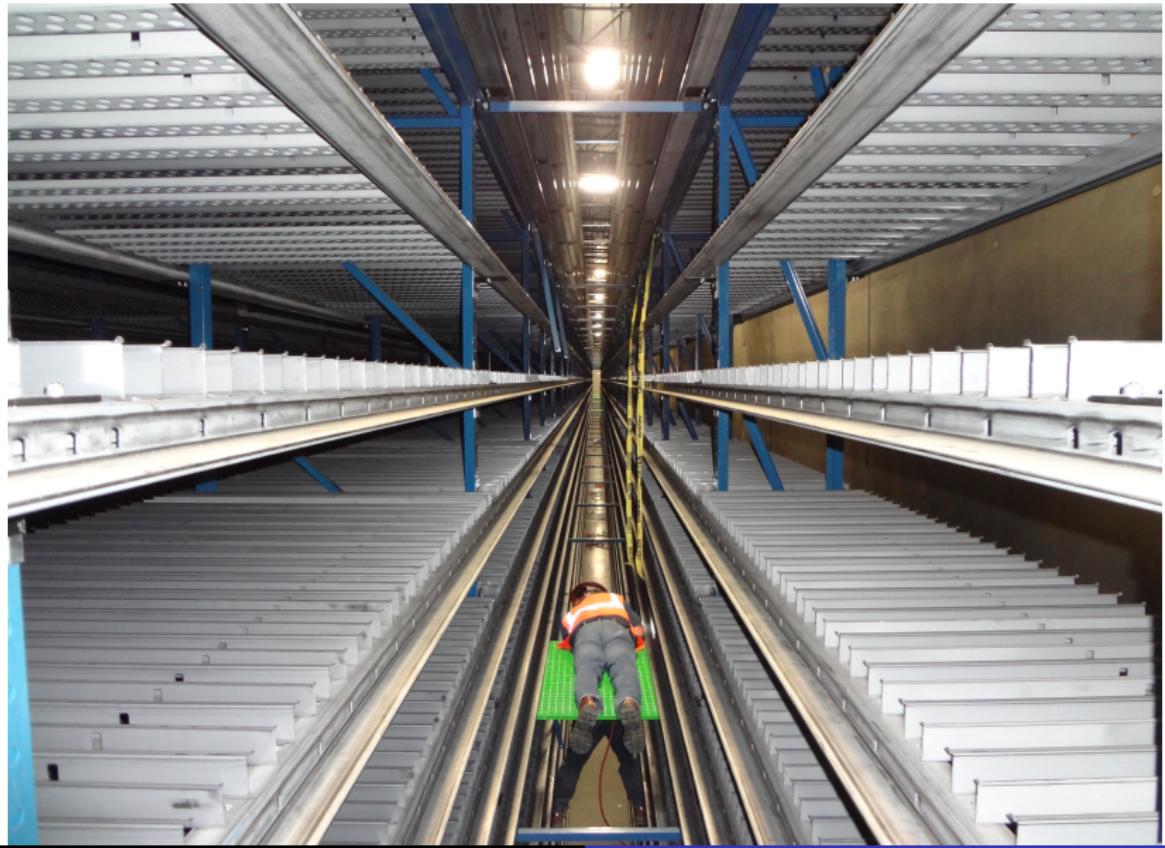


# Struktura hurtowni



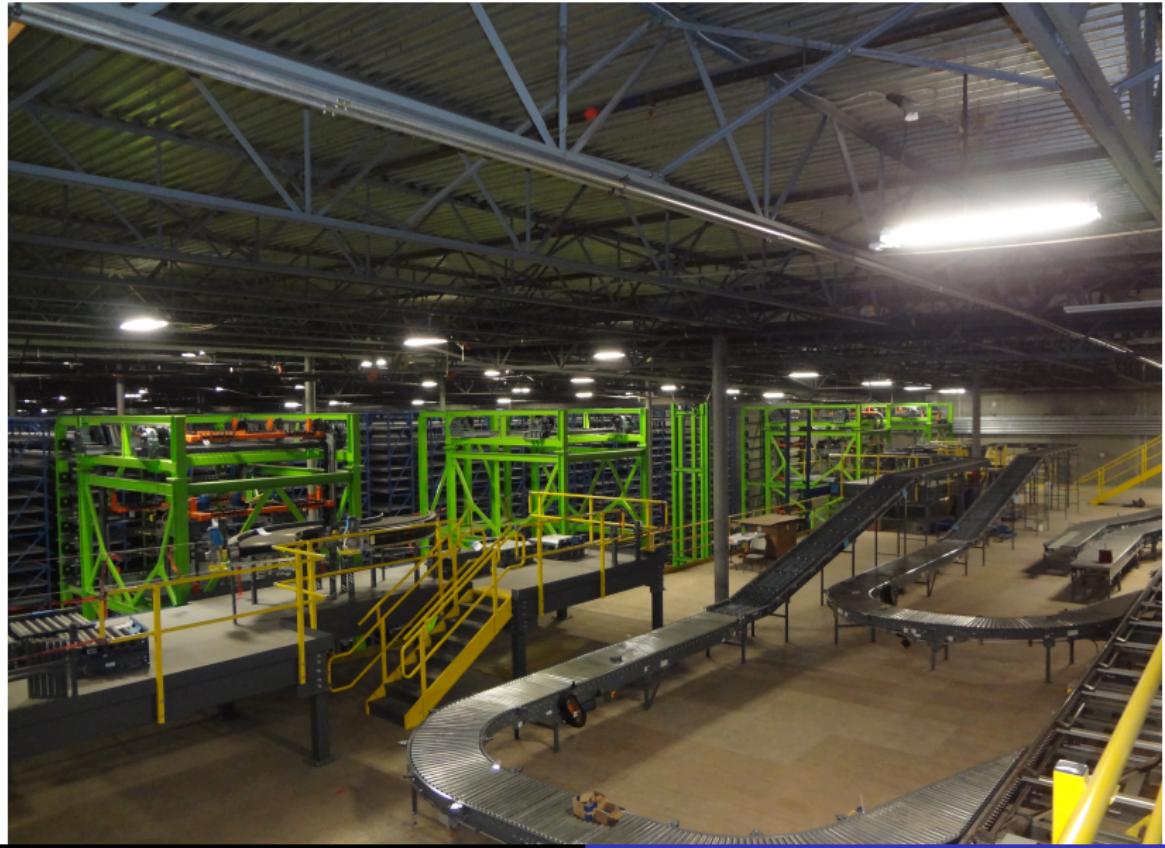
# Struktura hurtowni

## Storage aisle



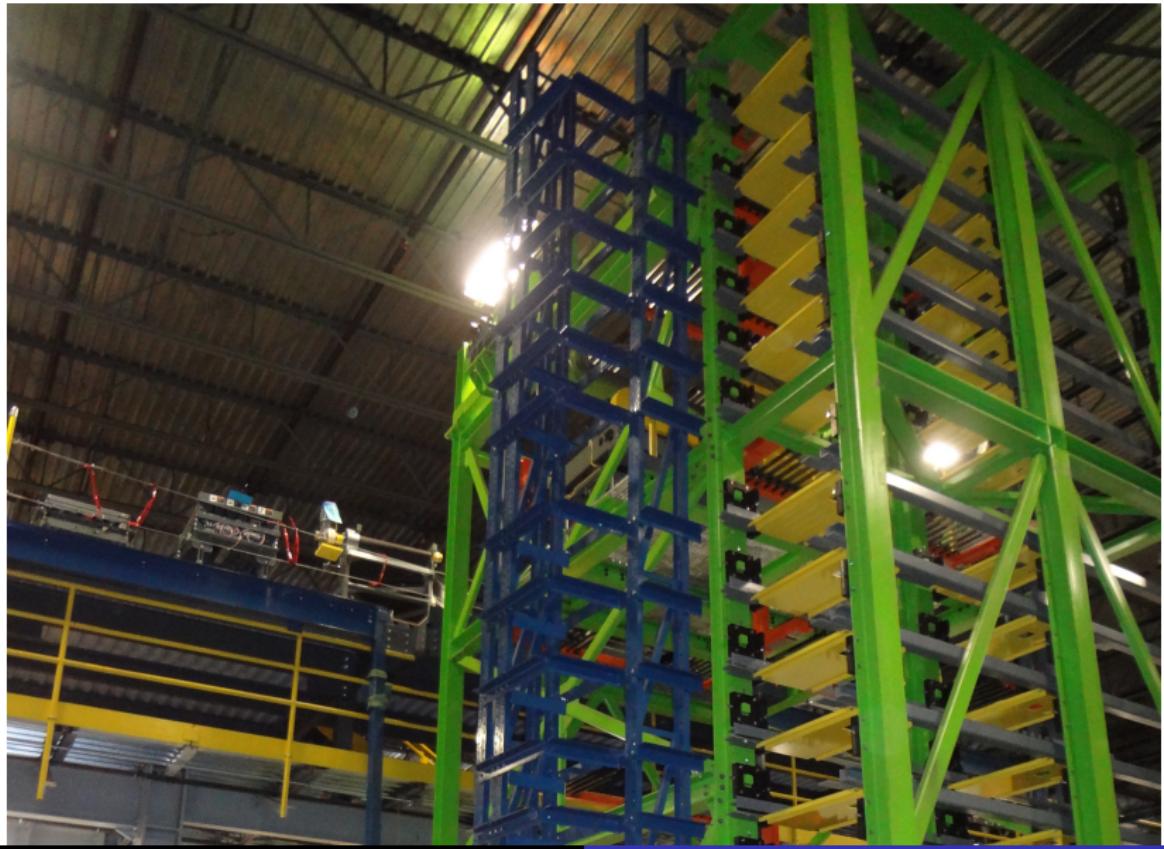
# Struktura hurtowni

Taśmociągi i MVC



# Struktura hurtowni

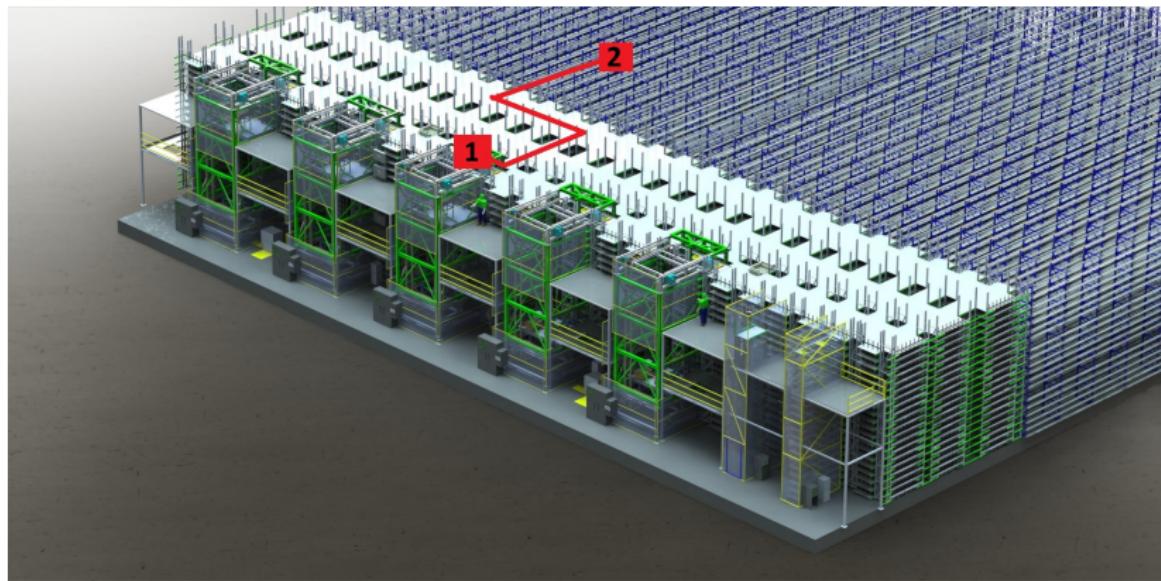
MVC



- Zadanie polega na jak najszybszym dodawaniu (input)/wyjmowaniu (output) produktów z hurtowni
- Maksymalizacja przepustowości przy użyciu jak najmniejszych zasobów (boty, windy, stal)
- Na wejściu mamy dwa strumienie: input i output
- Chcemy znaleźć takie przypisanie zadań dla botów wraz z ich realizacjami aby uzyskać największą średnią przepustowość w czasie

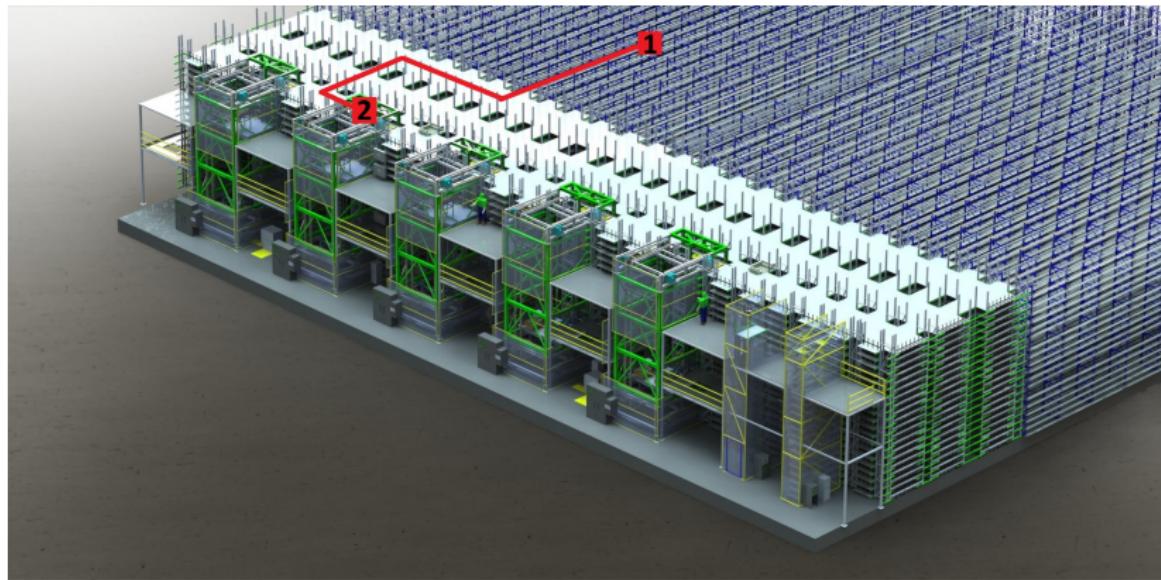
# Definicja problemu

Input task



# Definicja problemu

Output task



# Video demo

Podsumowanie pierwszej części

# Raport

## Podsumowanie testu

### Test summary Fri Apr 05 04:31:10 EDT 2013

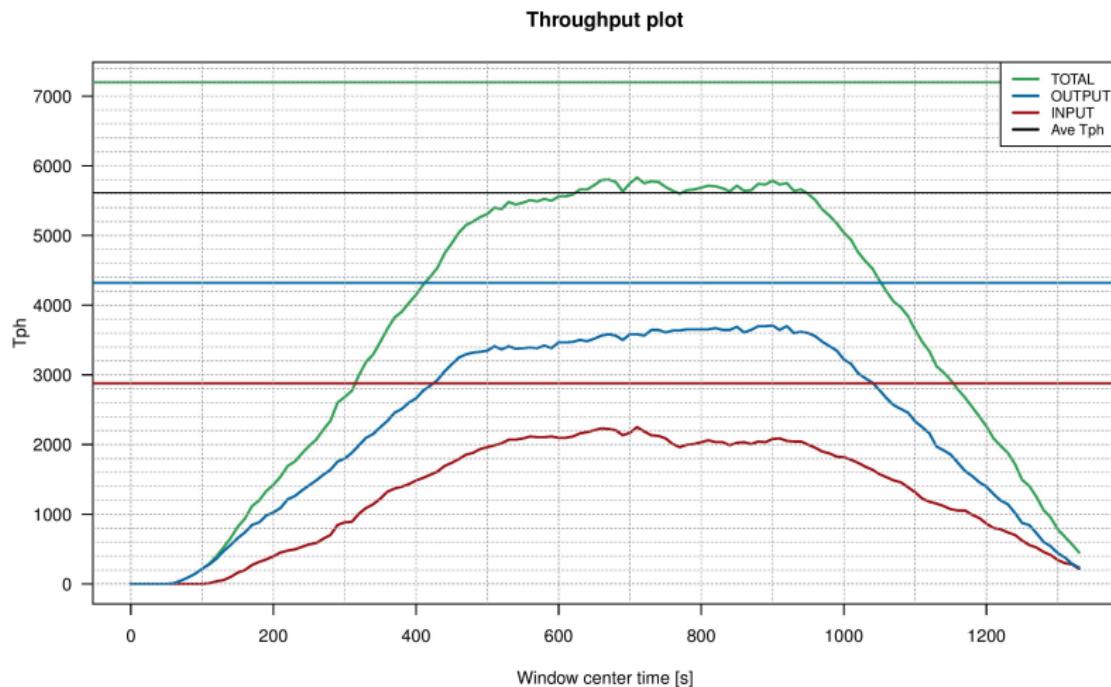
```
Number of tasks: 1344
Number of levels: 21
Number of INPUT tasks: 487
Number of OUTPUT tasks: 857
Number of bots: 168
Number of bots per level: 8
Pickface ratio: 1.76
Computation time: 0[h] 5[min] 21.31[s]
Computation time (plan): 0[h] 0[min] 32.23[s]
Computation time (realize): 0[h] 4[min] 49.08[s]
Move BLOCKER: 134
Move BLOCKER INPUT: 33
Move BLOCKER OUTPUT: 101
```

### Throughput stats

```
Simulation start time: 70.21 [s]
Simulation end time: 1333.81 [s] = 0[h] 22[min] 13.81[s]
Throughput: 1.56 [tasks/s]
Tph: 5616 [tasks/h] (theoretical limit = 7200[tasks/h])
Tph INPUT: 2079 [tasks/h] (theoretical limit = 2880[tasks/h])
Tph OUTPUT: 3537 [tasks/h] (theoretical limit = 4320[tasks/h])
Tpb: 33.43 [tasks/h] (theoretical limit = 42.85[tasks/h])
Tpb INPUT: 12.38 [tasks/h] (theoretical limit = 17.14[tasks/h])
Tpb OUTPUT: 21.05 [tasks/h] (theoretical limit = 25.71[tasks/h])
```

# Raport

## Throughput plot – wykres przepustowości



# Raport

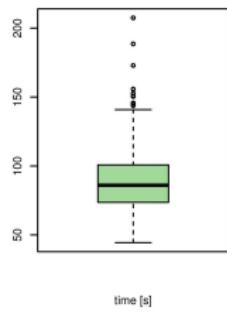
## Czasy cyklu

Cycle time [s]					
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
44.52	73.63	86.06	88.31	100.8	207.5

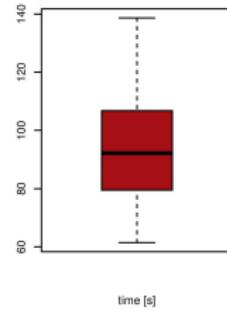
Cycle time INPUT [s]					
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
61.47	79.49	92.16	93.98	106.7	138.7

Cycle time OUTPUT [s]					
Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
44.52	69.61	83.16	84.84	96.01	207.5

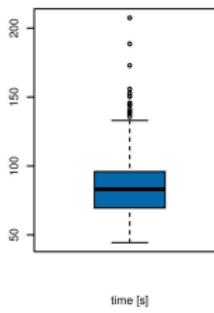
Boxplot for cycle time



Boxplot for cycle time INPUT



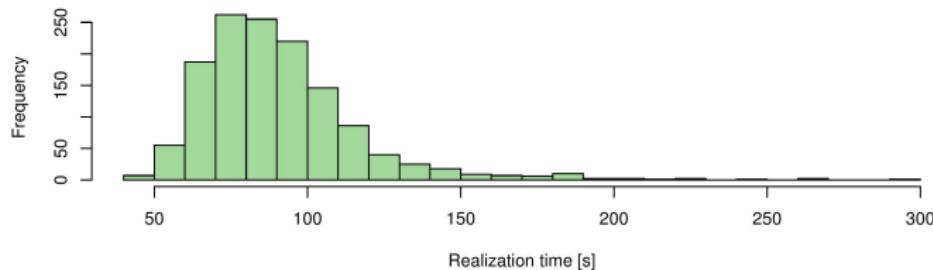
Boxplot for cycle time OUTPUT



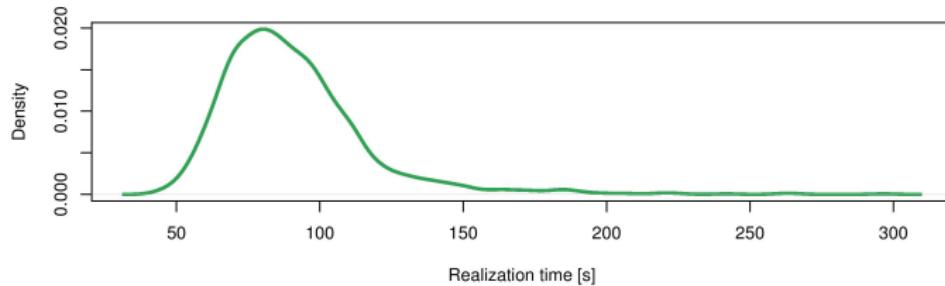
# Raport

## Rozkład czasu cyklu

Cycle time (1344 tasks)

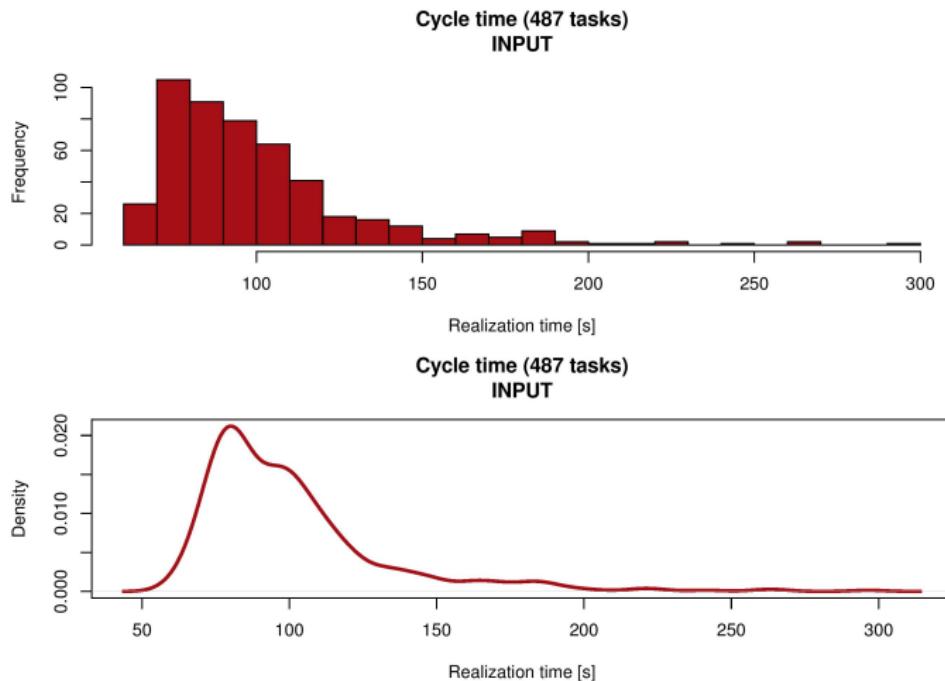


Cycle time (1344 tasks)



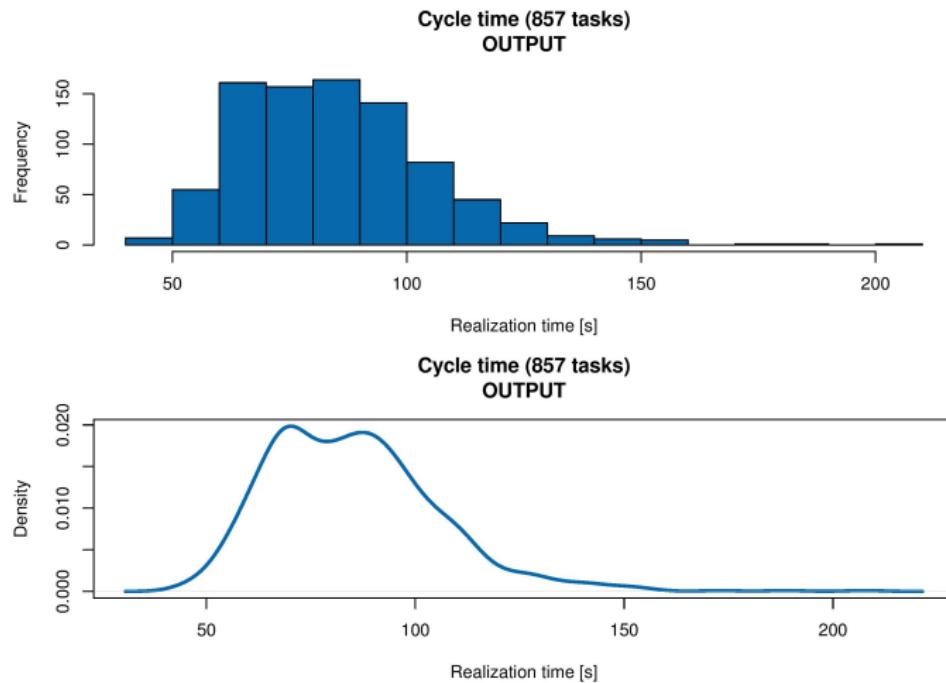
# Raport

## Rozkład czasu cyklu. Zadania wejściowe (Input)



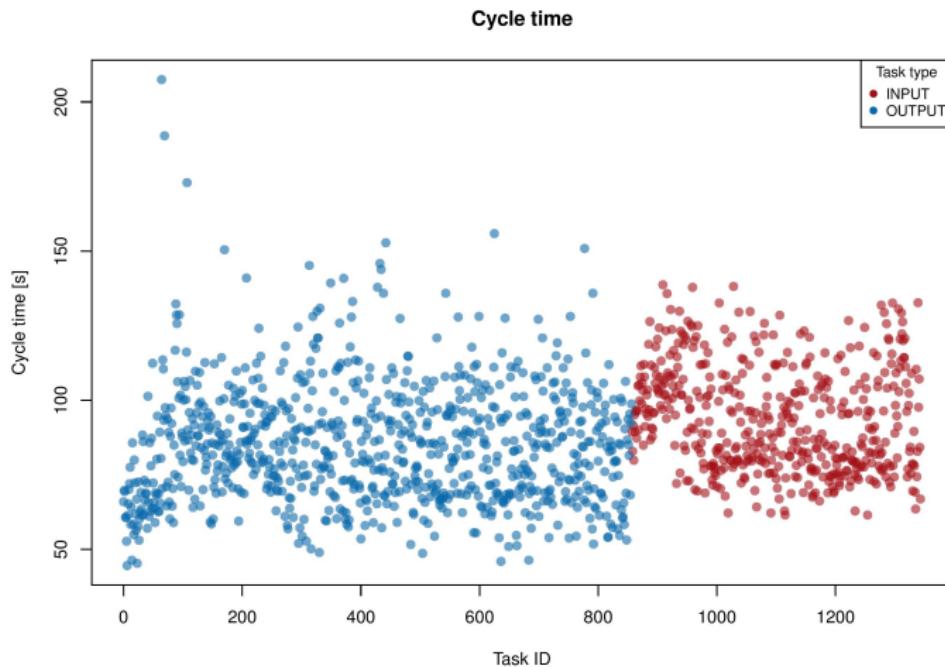
# Raport

## Rozkład czasu cyklu. Zadania wyjściowe (Output)



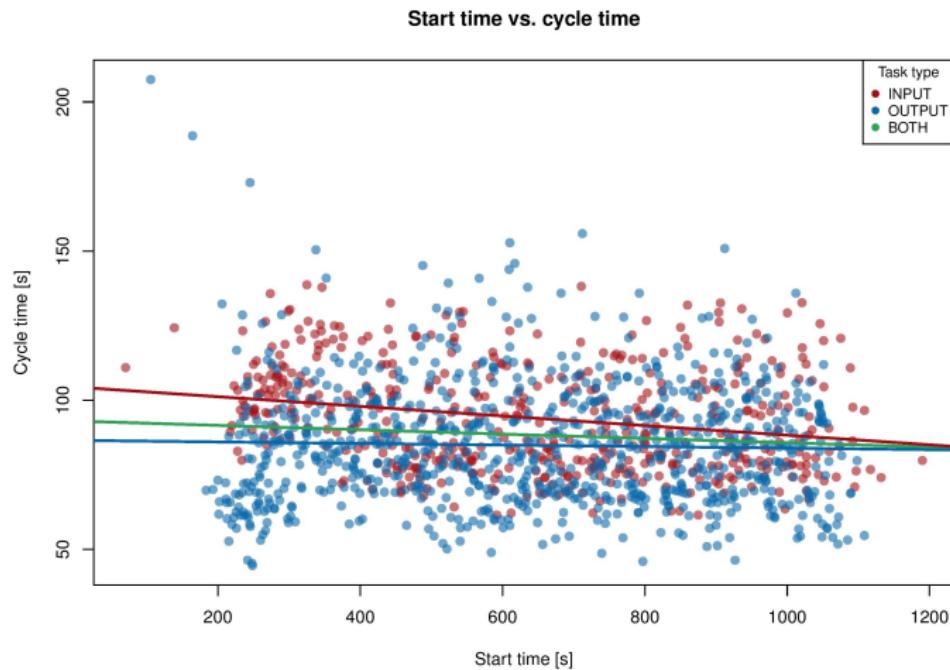
# Raport

## Czas cyklu



# Raport

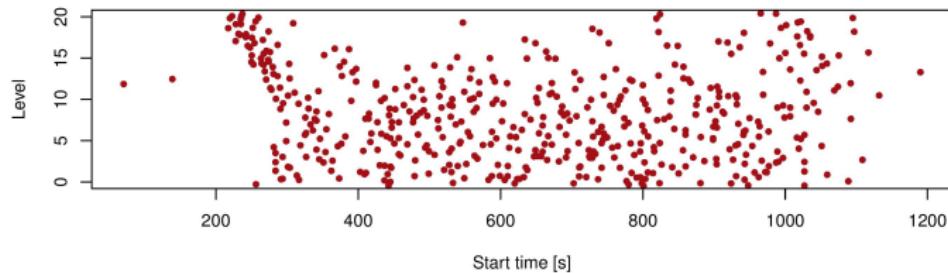
## Zmienność czasu cyklu w czasie



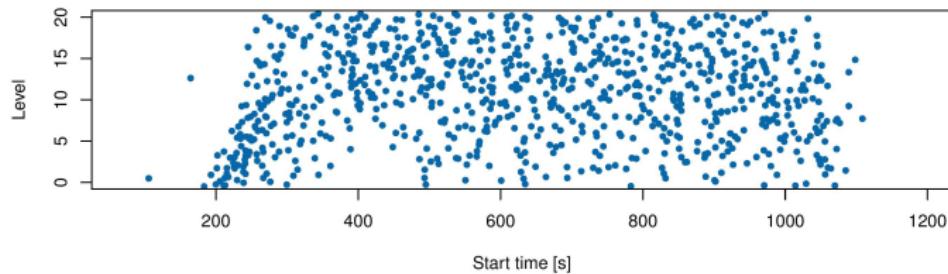
# Raport

## Dystrybucja zadań między poziomy w czasie

**Distribution of tasks between levels in time (INPUT)**

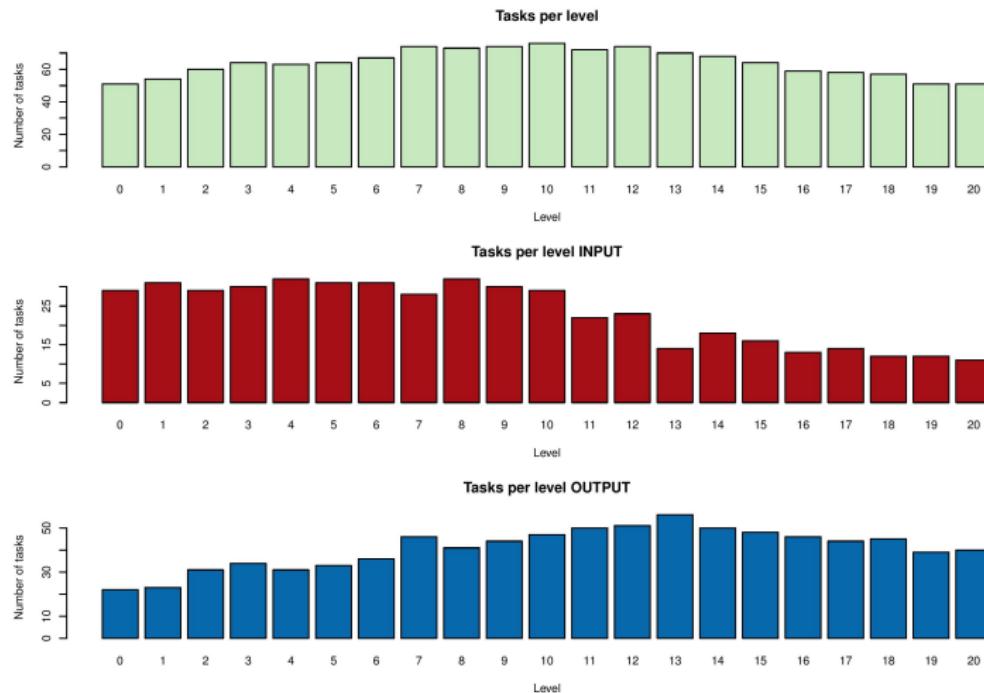


**Distribution of tasks between levels in time (OUTPUT)**



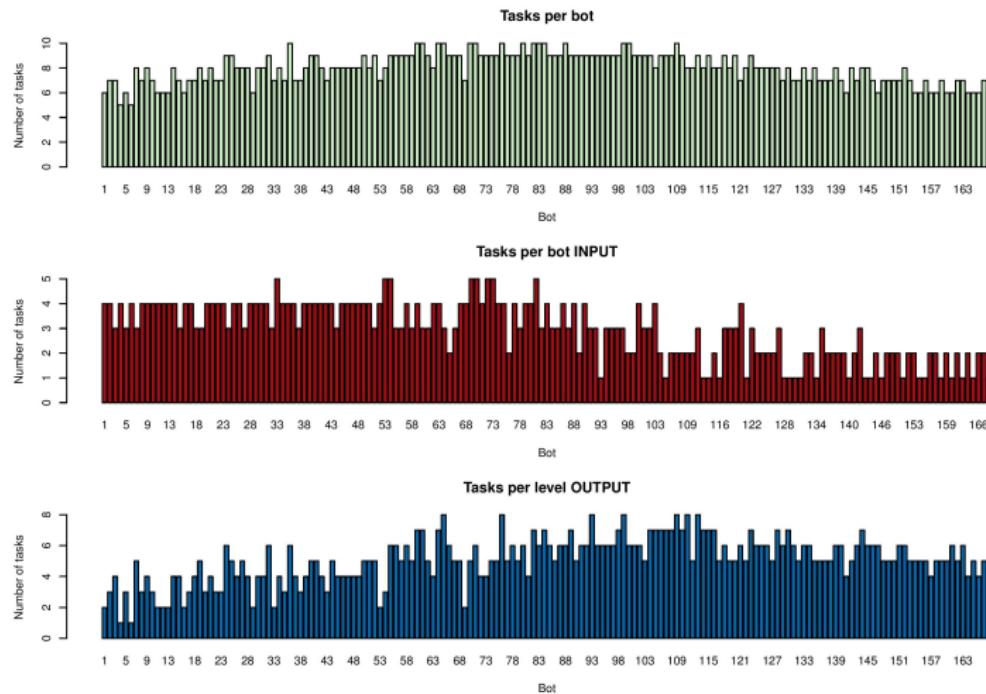
# Raport

## Dystrybucja zadań między poziomy



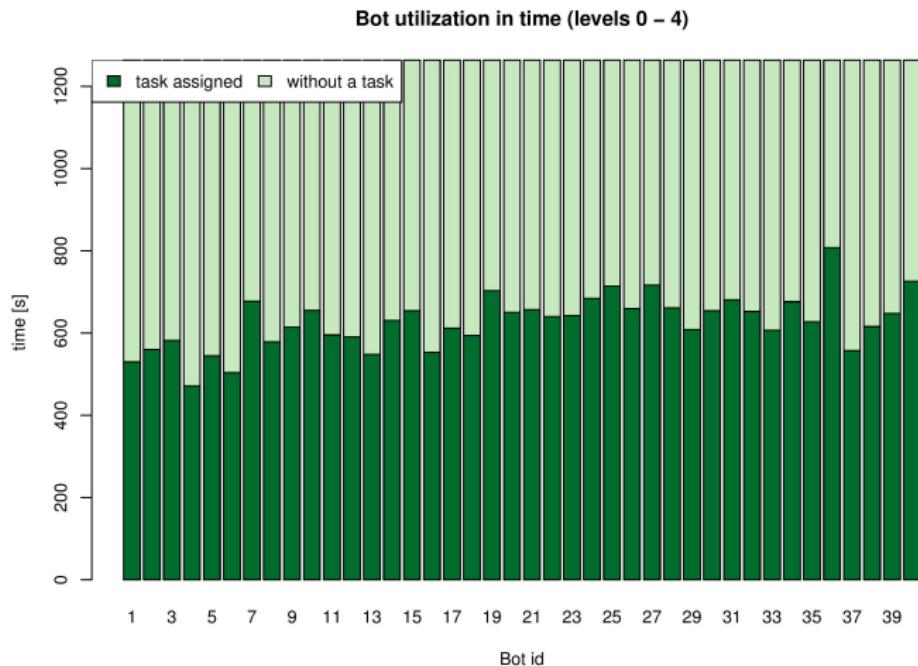
# Raport

## Dystrybucja zadań między boty



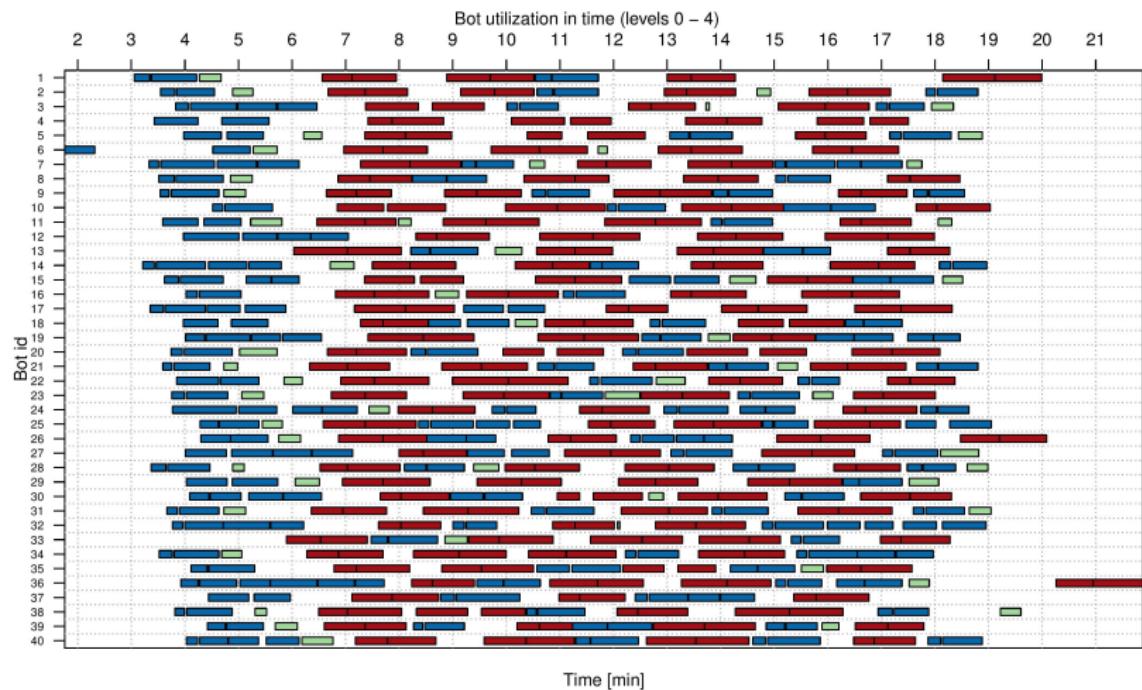
# Raport

## Utylizacja botów



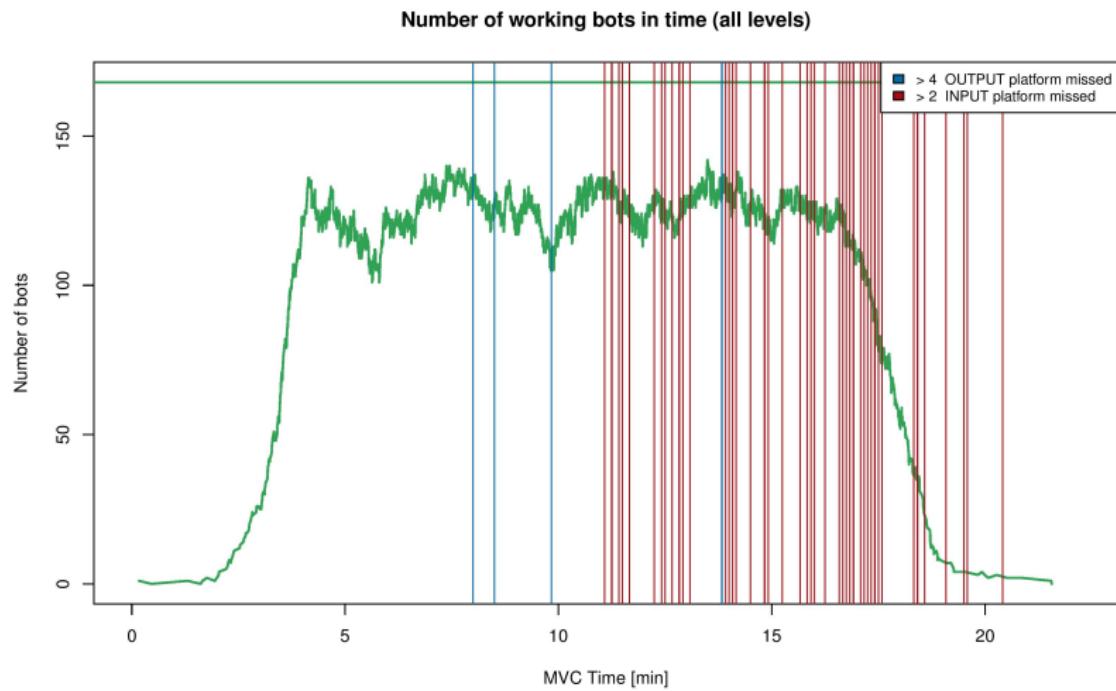
# Raport

## Utylizacja botów. Diagram Gantta



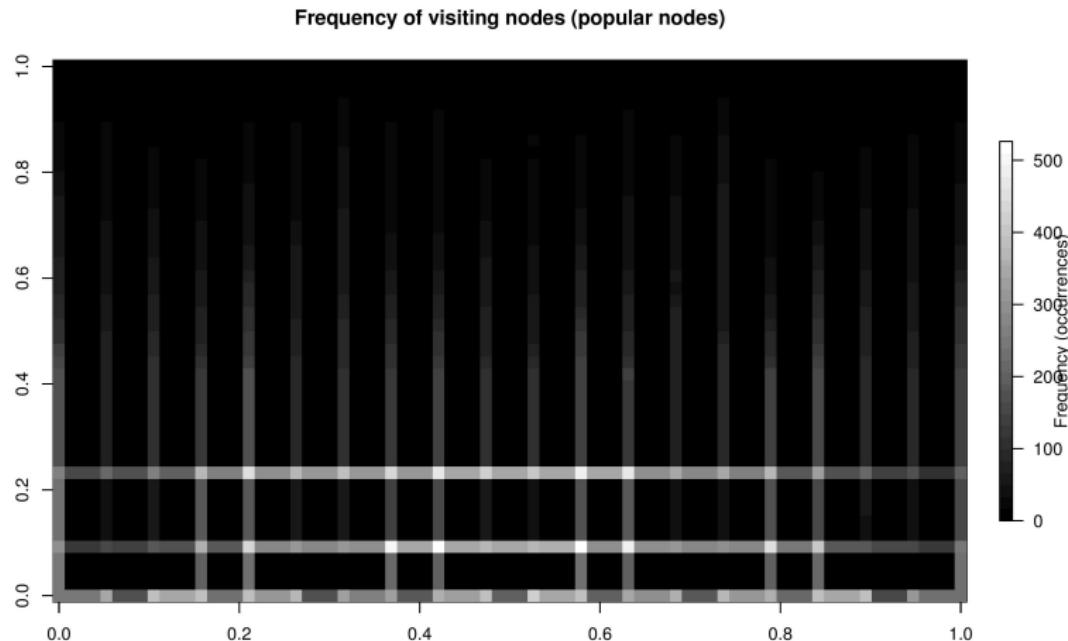
# Raport

## Liczba pracujących botów w czasie



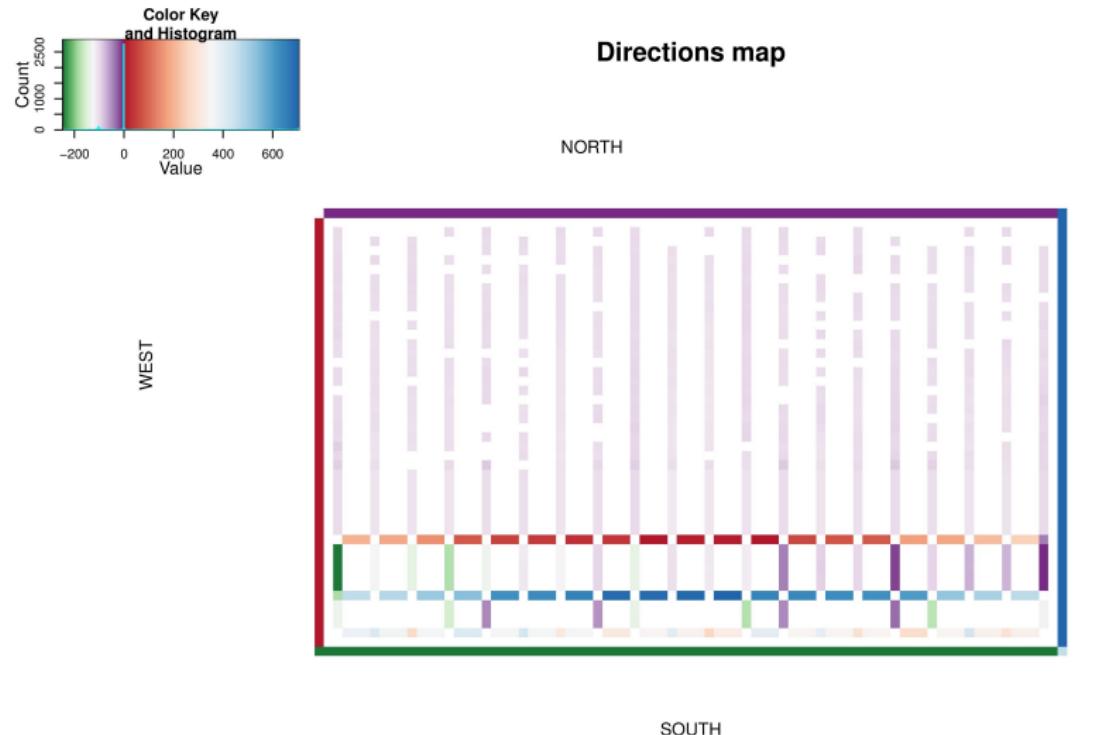
# Raport

## Częstotliwość odwiedzania poszczególnych pozycji



# Raport

## Wykres orientacji dróg



# Restauracja Gessler "U Kucharzy" Toruń

Rynek Staromiejski 21



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