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Project CyberSym

Your wish is my command – if you fulfill mine.

A simulation approach to Stafford Beer's CyberSyn Project

Janosch Haber
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UNIVERSITY OF AMSTERDAM

CIVILIZATION ALPHA

Content

1) Historical Background
2) Research Relevance
3) Project Approach
4) Results
5) Future Work

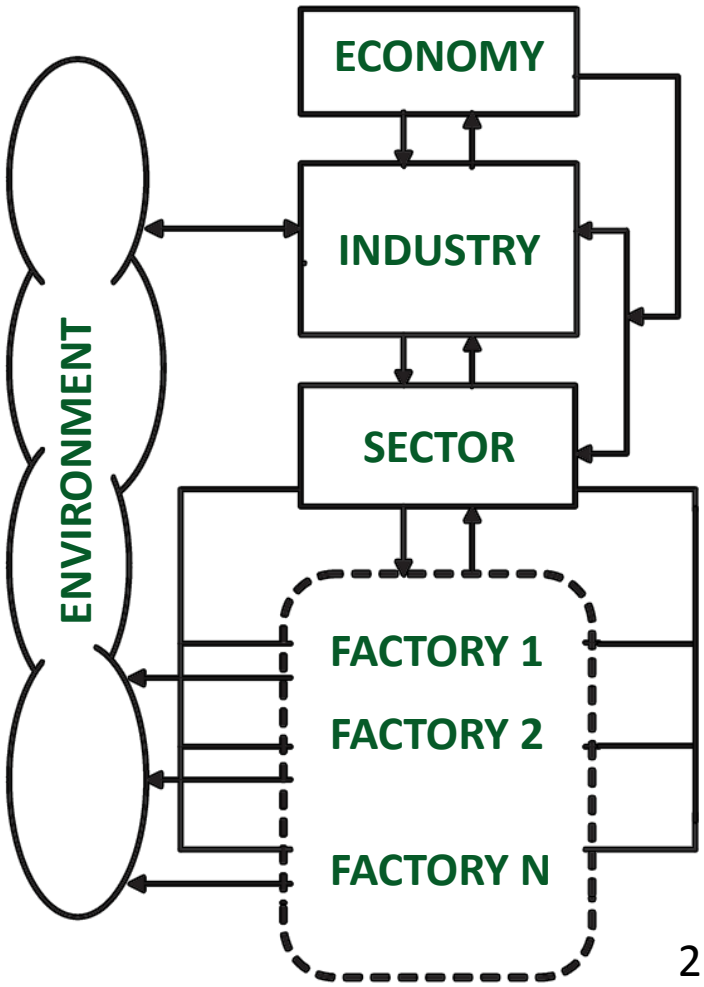
References

1

Project CyberSyn (1971)

Cybernetics and **Syn**ergy

Goal: Automatically controlling the Chilean industry based on Stafford Beer's **Viable Systems Model**



Project CyberSyn (1971)

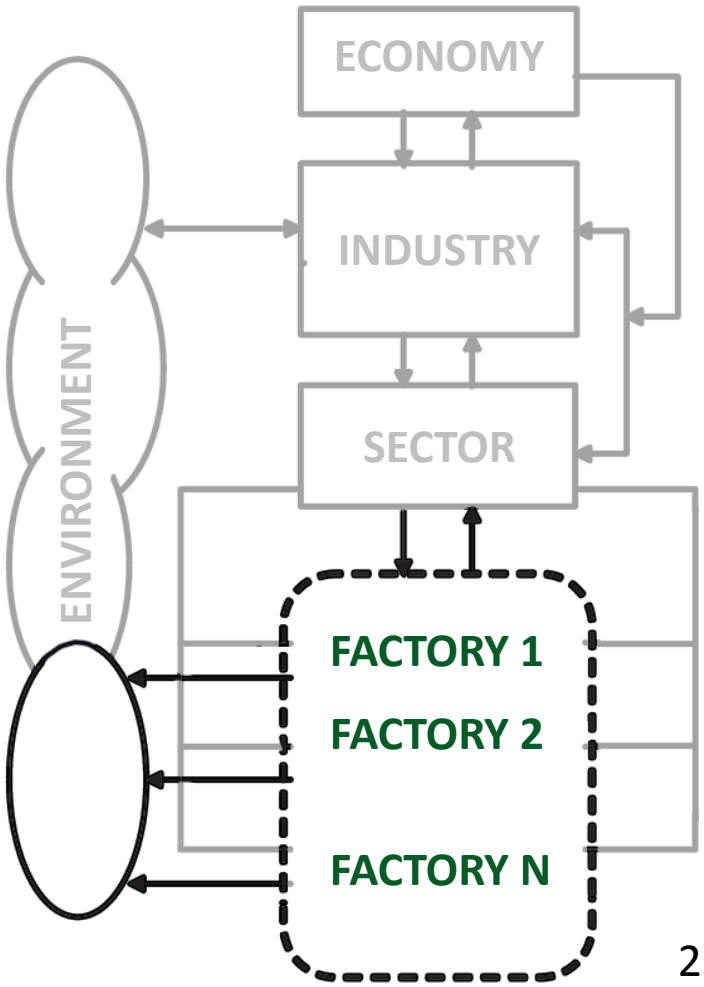
Cybernetics and **Syn**ergy

Goal: Automatically controlling the Chilean industry based on Stafford Beer's **Viable Systems Model**

Approach:

1) Autonomous Instances
2) Multi-level Control

   => Cybernetic self-regulation



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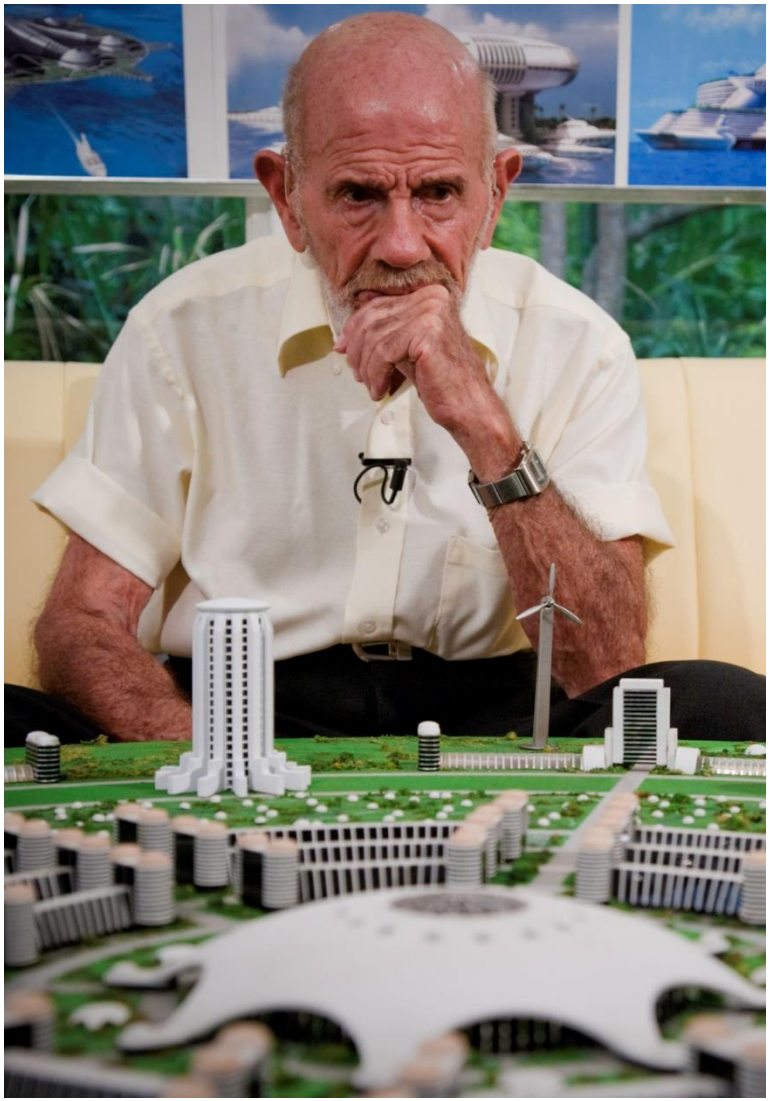
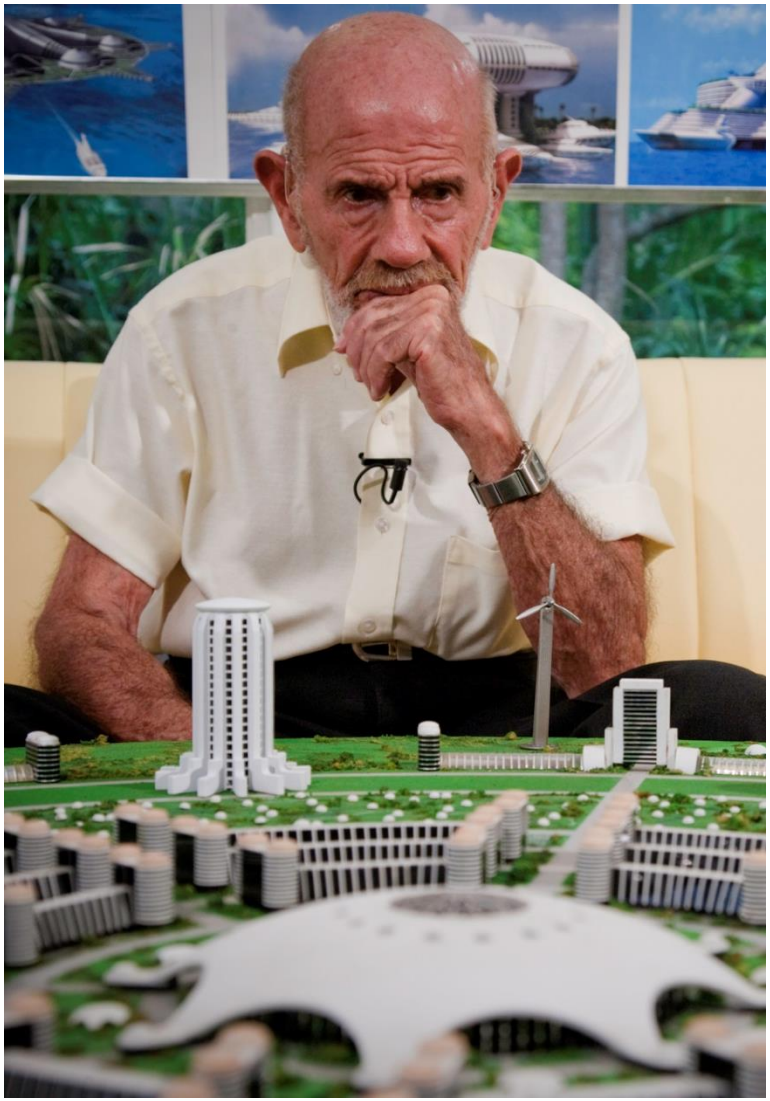


3

The Venus Project (1994)

Resource-Based Economy

Goal: " A system in which all goods and services are available without the use of money, credits, barter, or any other form of debt or servitude."



3

The Venus Project (1994)

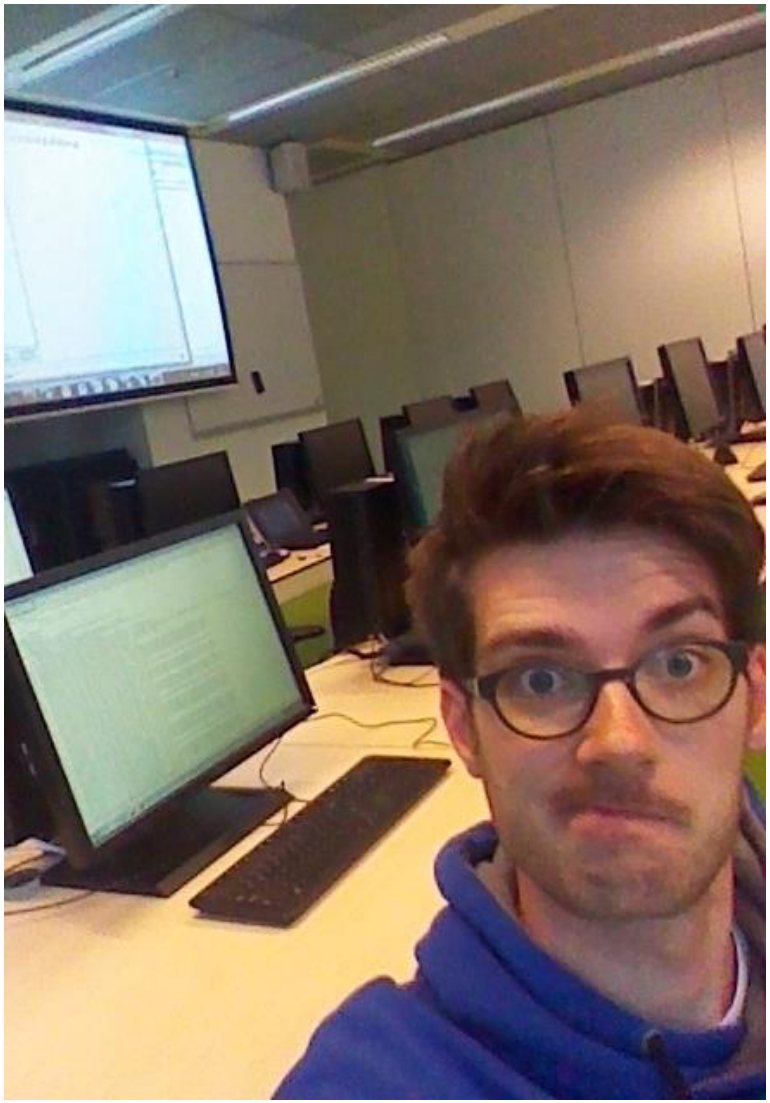
Resource-Based Economy

Goal: " A system in which all goods and services are available without the use of money, credits, barter, or any other form of debt or servitude."[4]

Approach:

1) Economy based on Resource Availability

   => Demand determines value



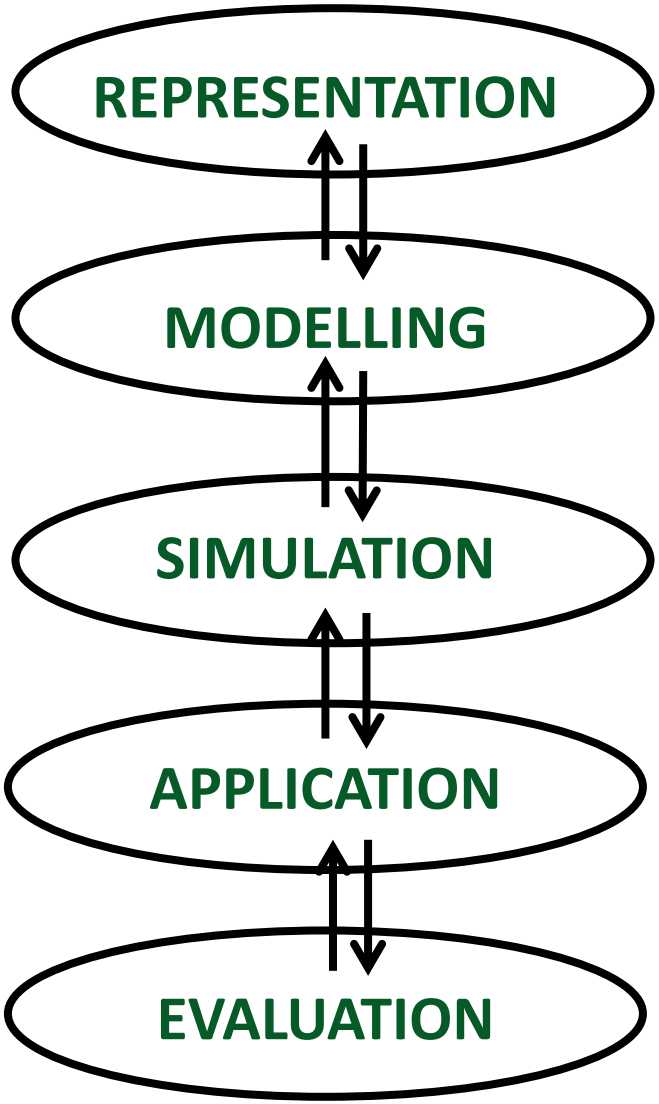
Project CyberSym (2015)

Cybernetics and **Sym**biosis

Goal: Provide a first assessment on whether Project CyberSyn's approach would have been feasible

Research Question:
Under which conditions can system self-sustainability emerge from within the autonomous collective?

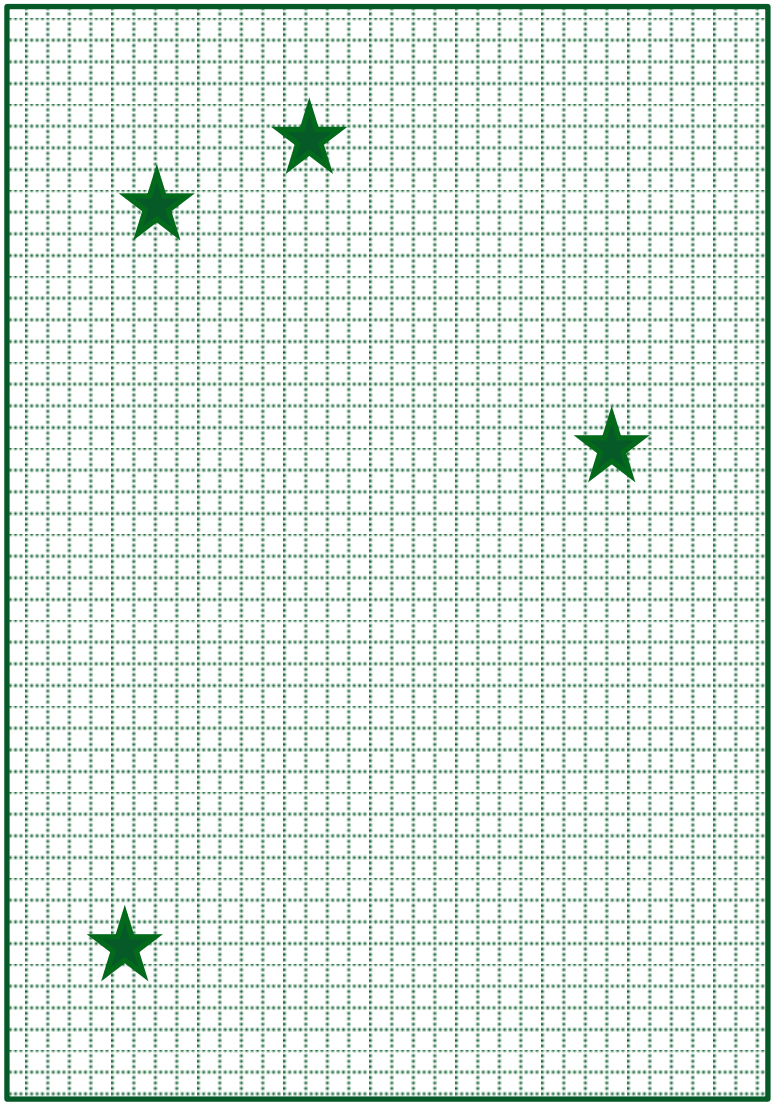
=> Simulation Approach



Method

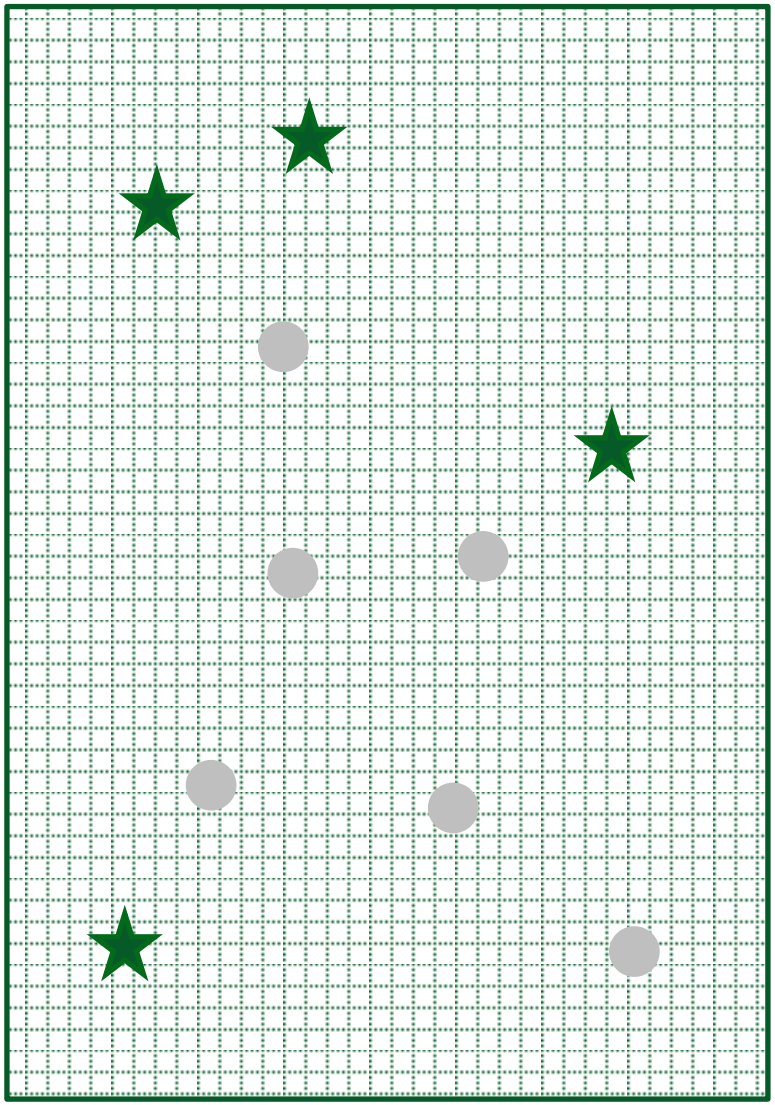
1) Determine the **most central features** of the system
2) Create an **abstract** representation
3) Implement the model in a **computer simulation**
4) Investigate different **parameters**
5) Evaluate **results**

5



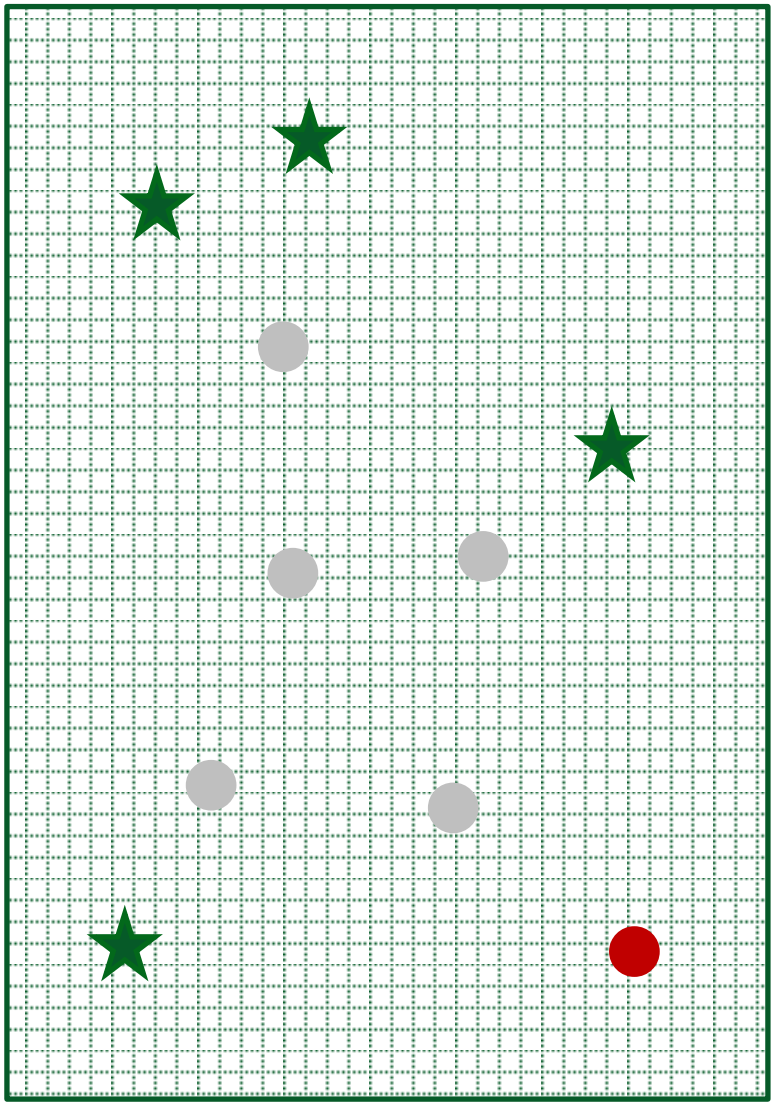
Model

1) Environment with Resources



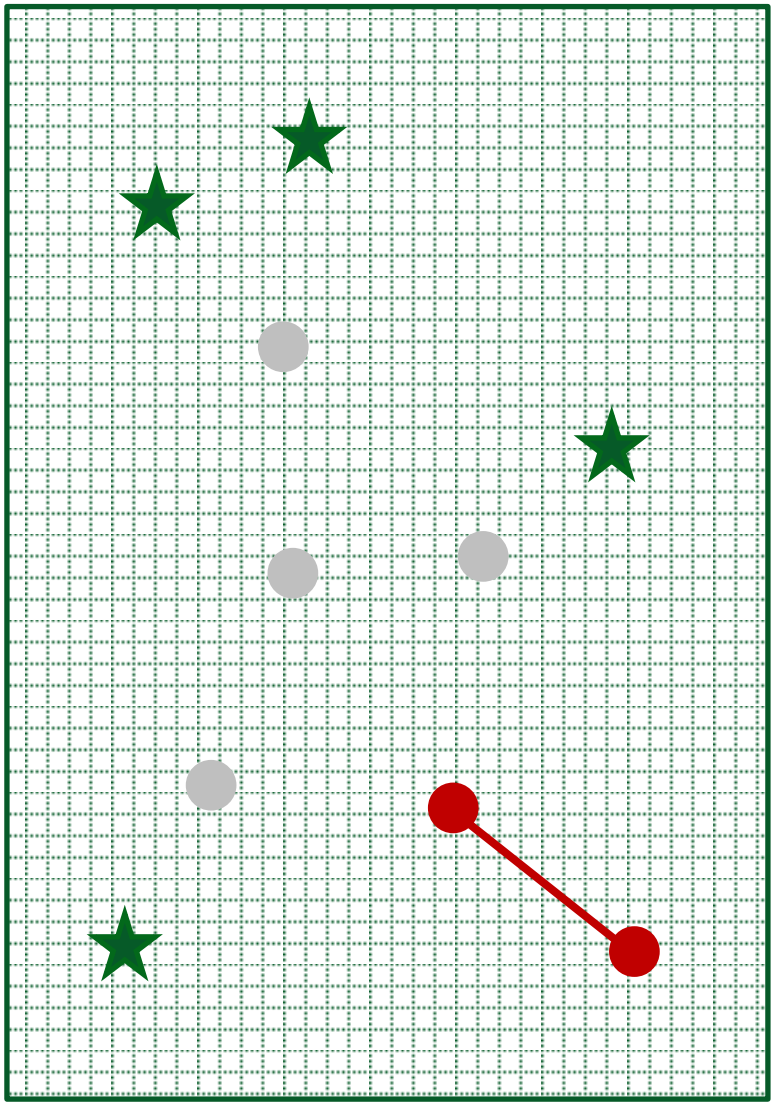
Model

1) Environment with Resources
2) Static Agents (limited Range)



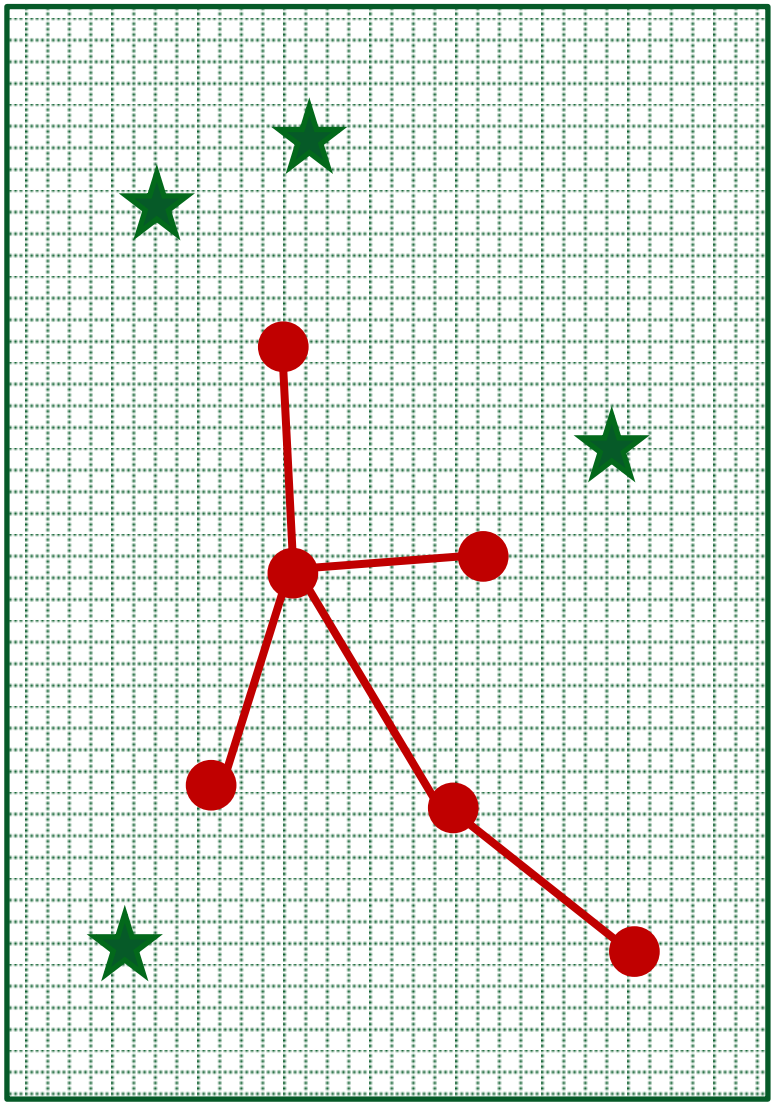
Model

1) Environment with Resources
2) Static Agents (limited Range)
3) Generation of Demand (Wishes)



Model

1) Environment with Resources
2) Static Agents (limited Range)
3) Generation of Demand (Wishes)
4) Distribution of Requests



Model

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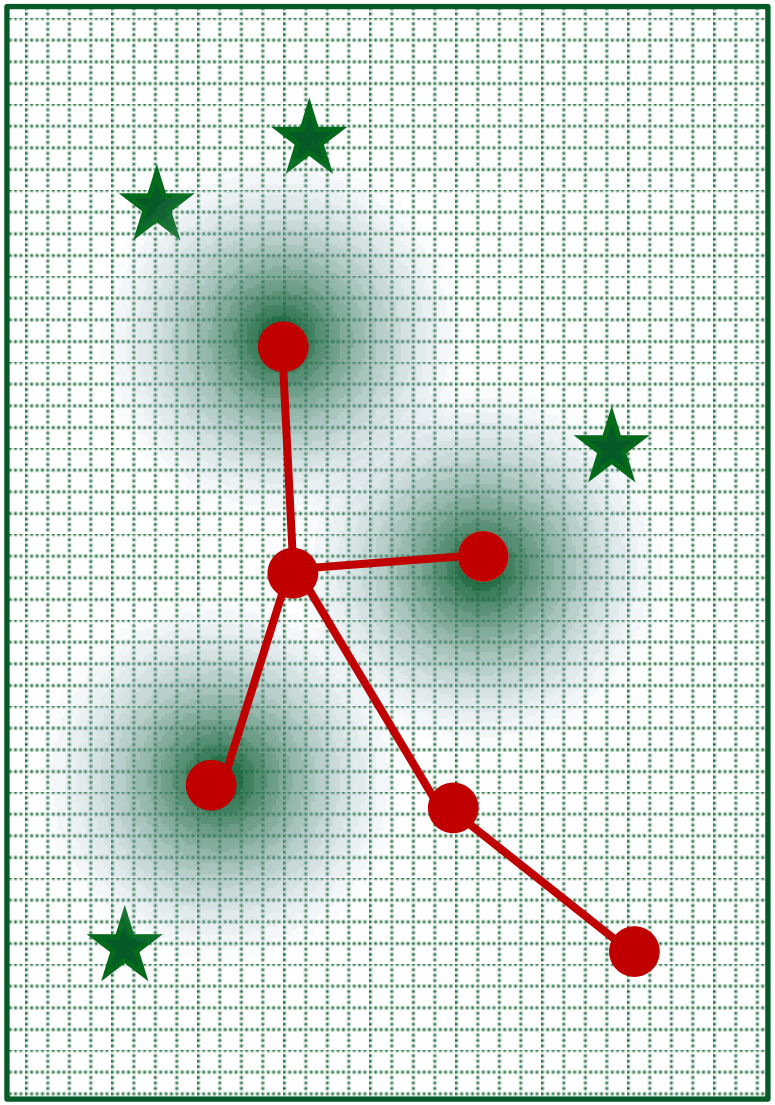
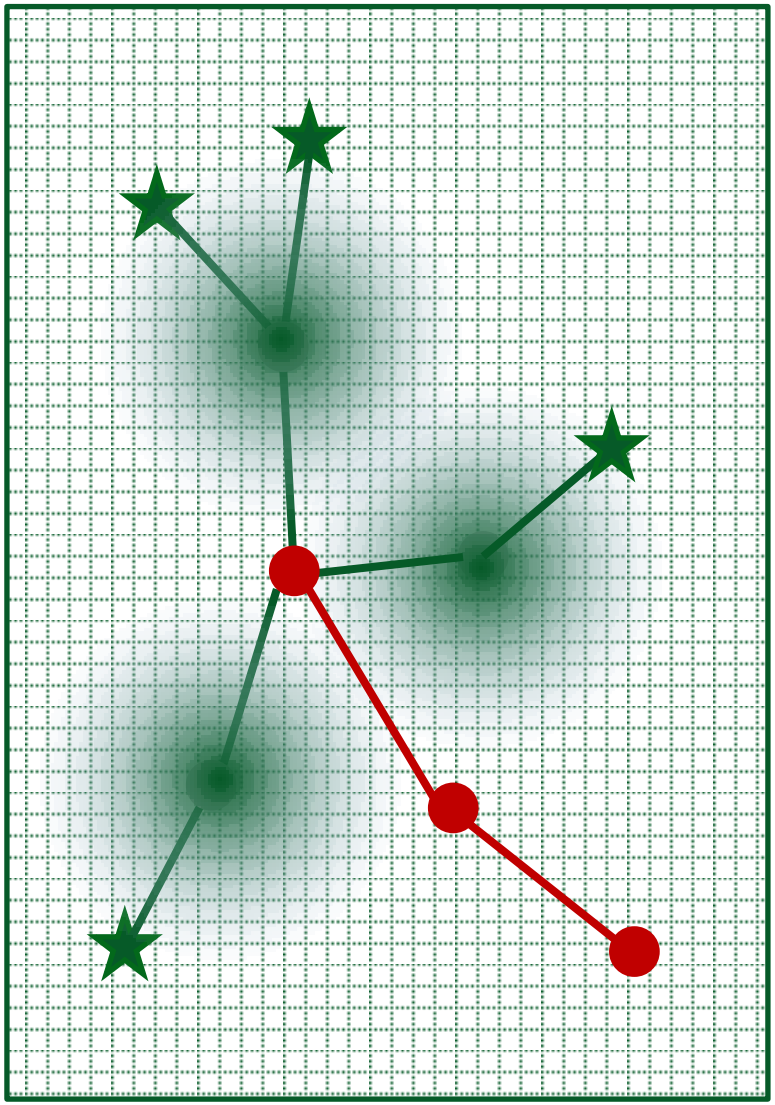
4) Distribution of Requests



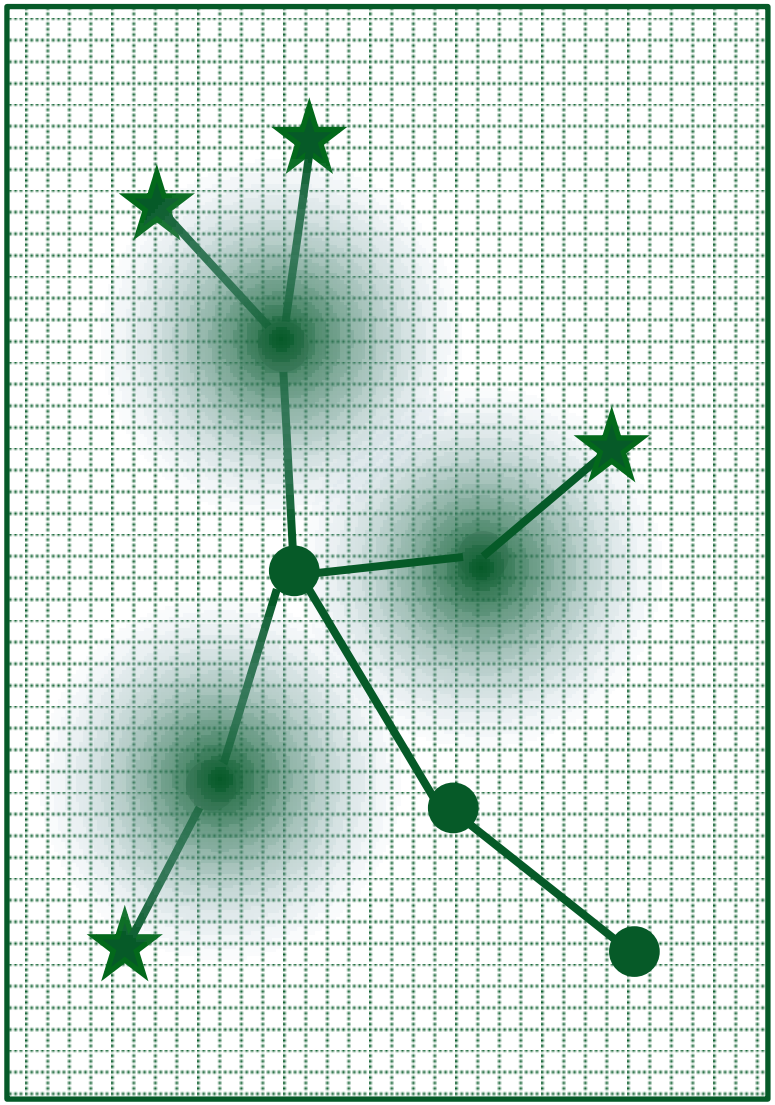
Model

1) Environment with Resources
2) Static Agents (limited Range)
3) Generation of Demand (Wishes)
4) Distribution of Requests
5) Evaluation of Availability



Model

1) Environment with Resources
2) Static Agents (limited Range)
3) Generation of Demand (Wishes)
4) Distribution of Requests
5) Evaluation of Availability
6) Distribution of Resources



Model

1) Environment with Resources
2) Static Agents (limited Range)
3) Generation of Demand (Wishes)
4) Distribution of Requests
5) Evaluation of Availability
6) Distribution of Resources
7) Assembly of partial Products + Transport

Simulation Run

1) EVALUATE ENVIRONMENT

Simulation Run

1) EVALUATE ENVIRONMENT

2) GENERATE JOB LIST

Simulation Run

1) EVALUATE ENVIRONMENT

2) GENERATE JOB LIST

3) DETERMINE POSSIBLE ACTIONS

A) Resource Extraction
B) Product Assembly
C) Delivery

Simulation Run

1) EVALUATE ENVIRONMENT

2) GENERATE JOB LIST

3) DETERMINE POSSIBLE ACTIONS

A) Resource Extraction
B) Product Assembly
C) Delivery

4) RATE OPTIONS

A) Request Urgency
B) Resource Availability
C) Requester Distance

Simulation Run

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5) PERFORM BEST ACTION

Simulation Run

1) EVALUATE ENVIRONMENT

2) GENERATE JOB LIST

3) DETERMINE POSSIBLE ACTIONS

A) Resource Extraction
B) Product Assembly
C) Delivery

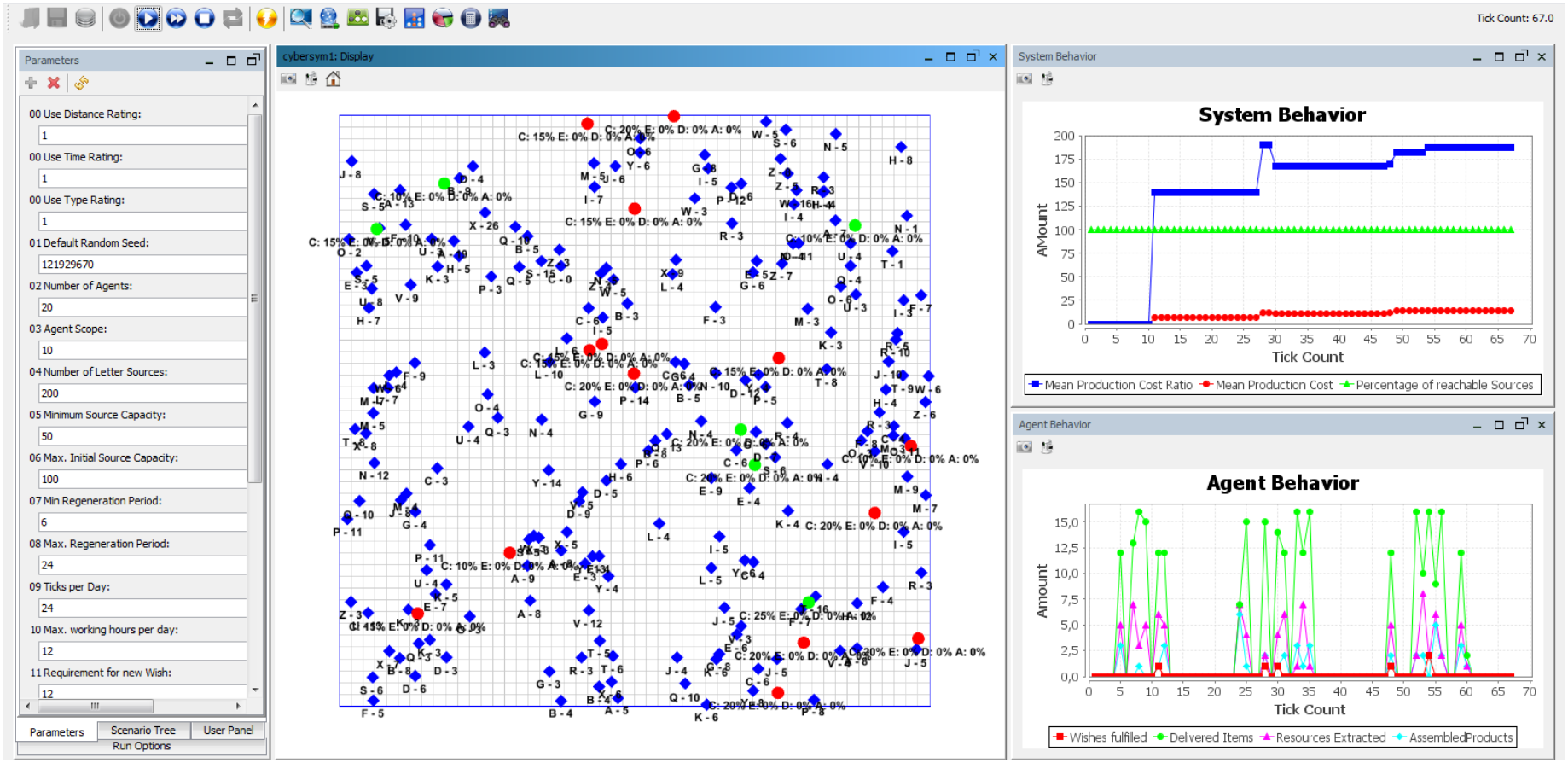
4) RATE OPTIONS

A) Request Urgency
B) Resource Availability
C) Requester Distance

5) PERFORM BEST ACTION

Computer Simulation (Repast Simphony)

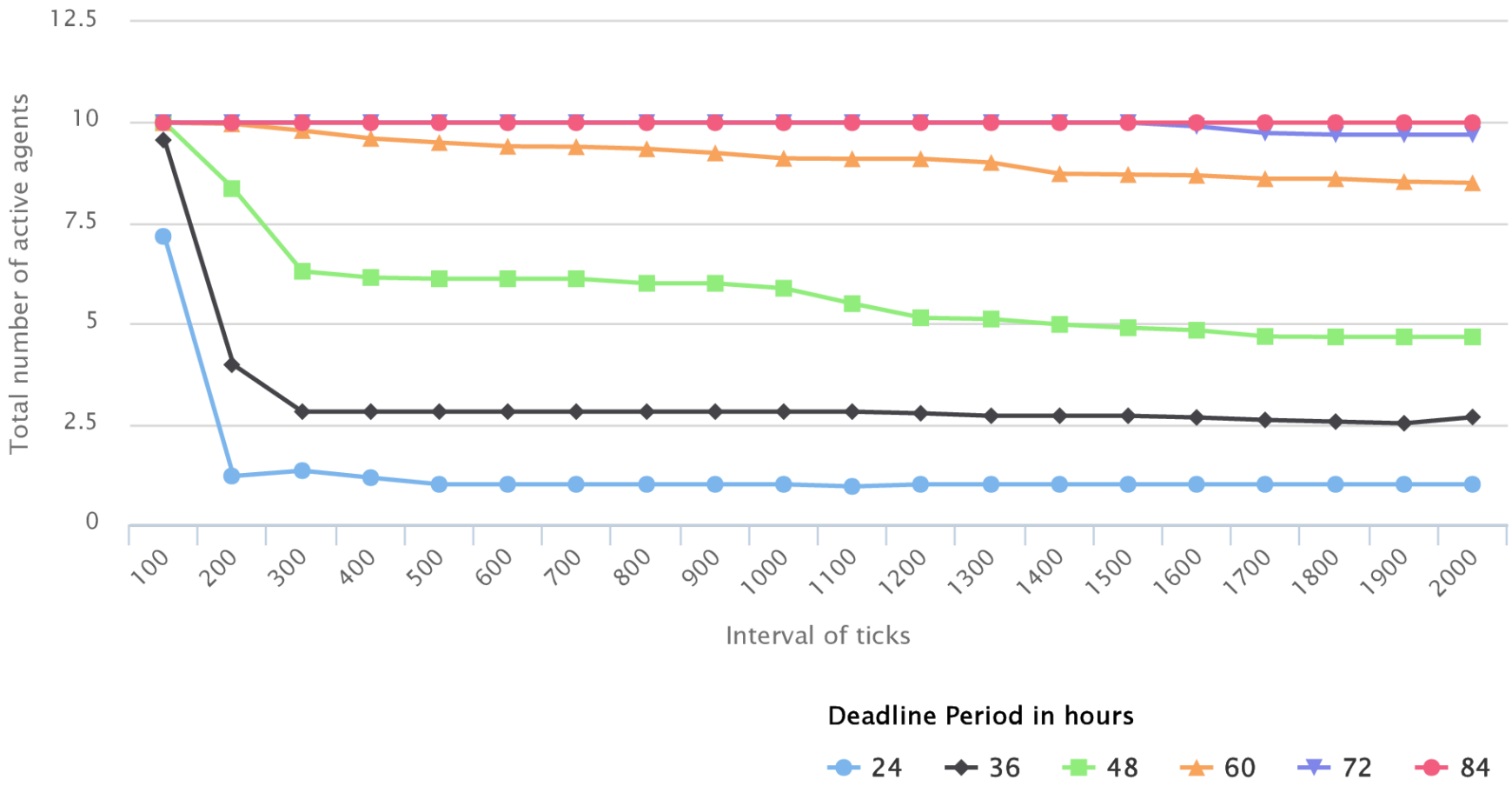
repast



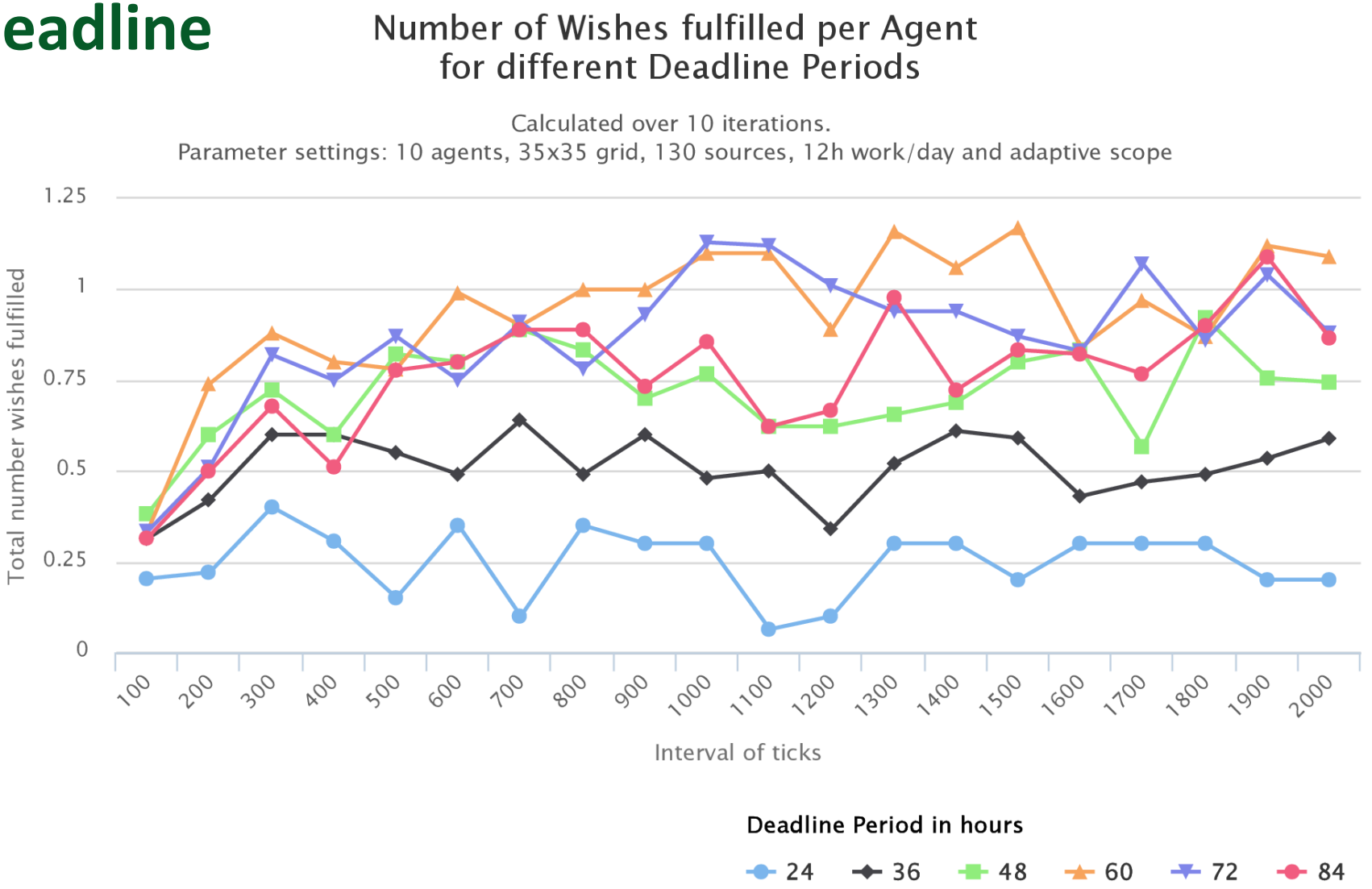
Deadline

Number of active Agents for different Deadline Periods

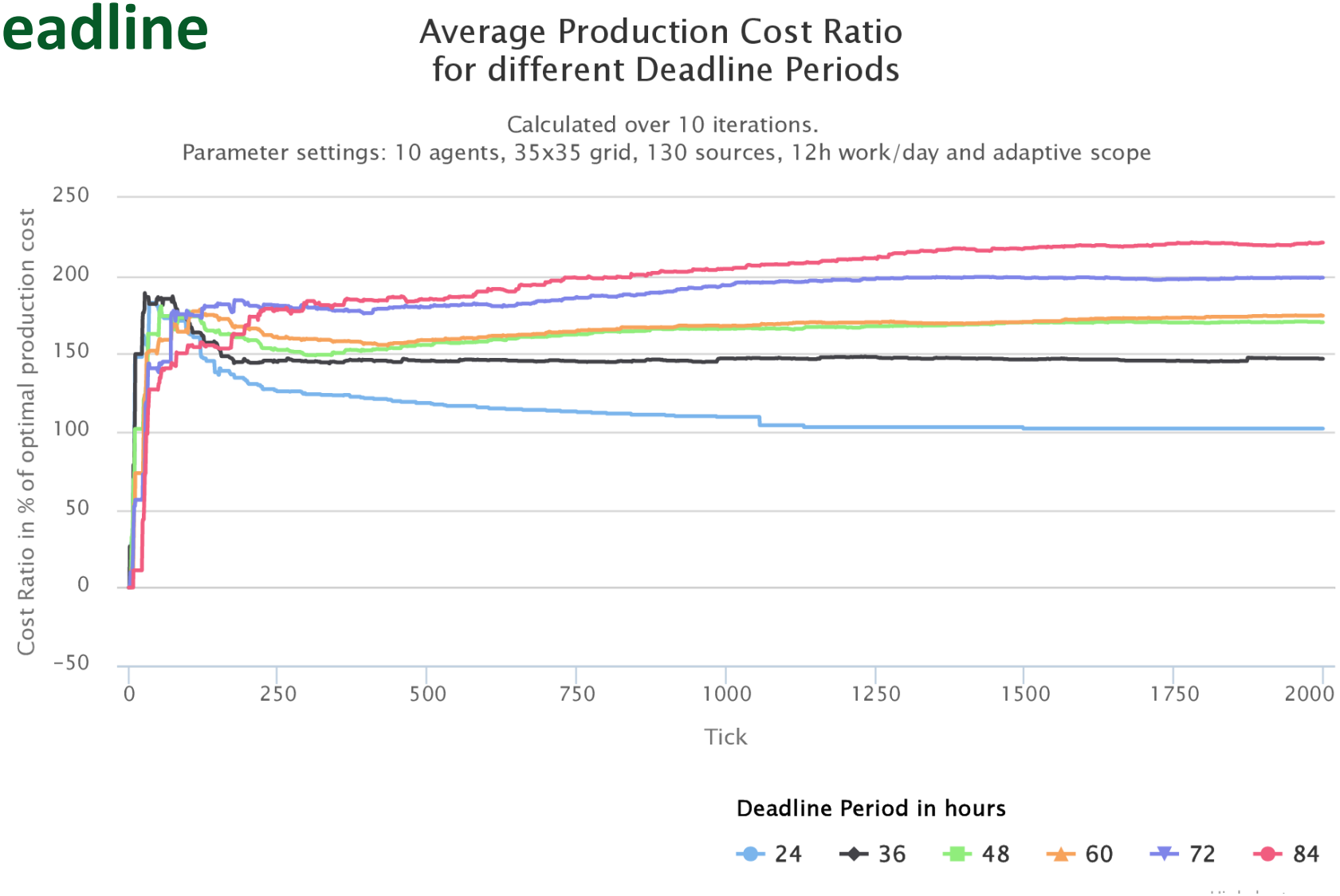
Calculated over 10 iterations.
Parameter settings: 10 agents, 35x35 grid, 130 sources, 12h work/day and adaptive scope



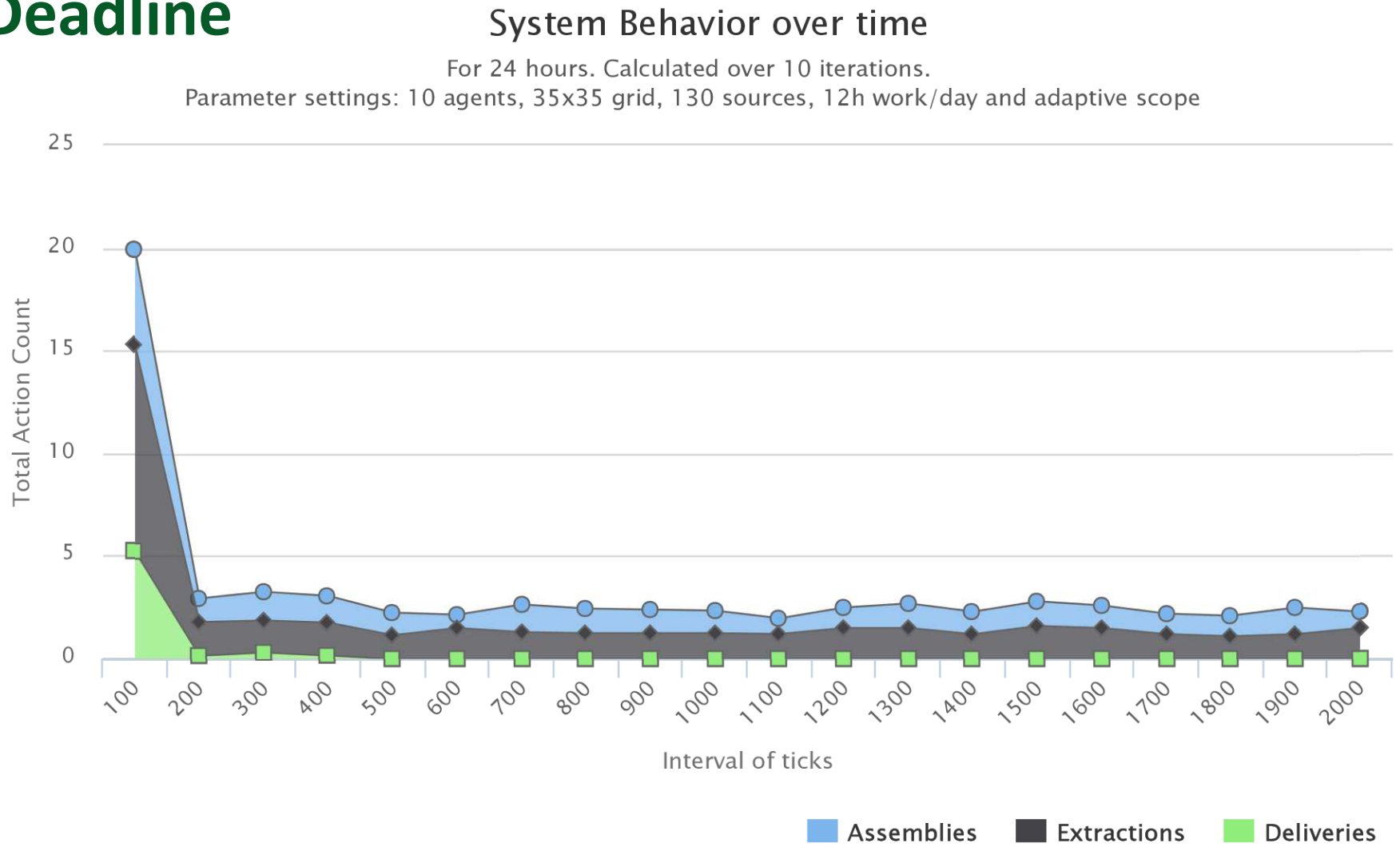
Deadline


Number of Wishes fulfilled per Agent
for different Deadline Periods
Calculated over 10 iterations.
Parameter settings: 10 agents, 35x35 grid, 130 sources, 12h work/day and adaptive scope
Total number wishes fulfilled
1.25
1
0.75
0.5
0.25
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Deadline Period in hours
24
36
48
60
72
84

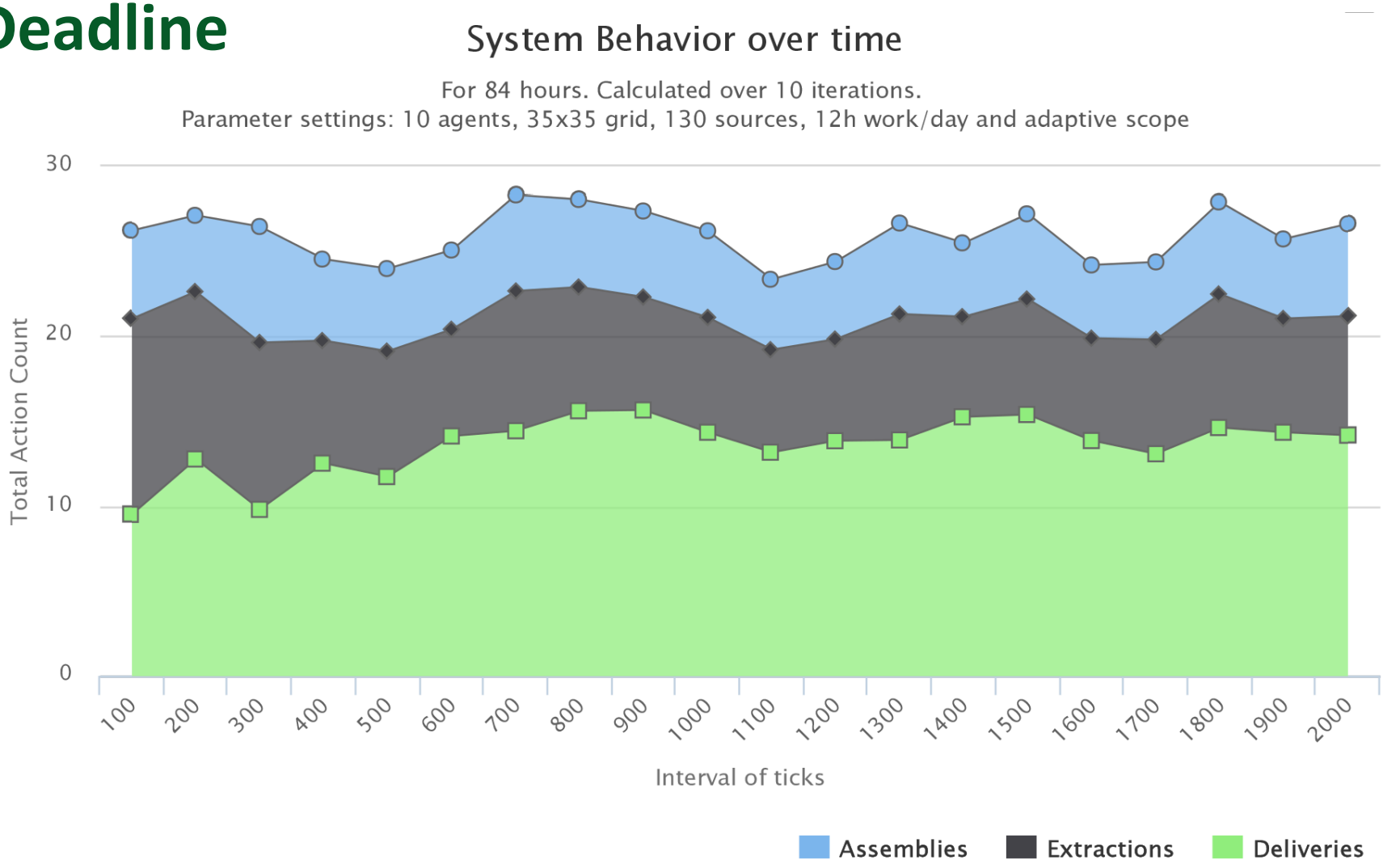
Deadline


Average Production Cost Ratio
for different Deadline Periods
Calculated over 10 iterations.
Parameter settings: 10 agents, 35x35 grid, 130 sources, 12h work/day and adaptive scope
Cost Ratio in % of optimal production cost
250
200
150
100
50
0
-50
0
250
500
750
1000
1250
1500
1750
2000
Tick
Deadline Period in hours
24
36
48
60
72
84

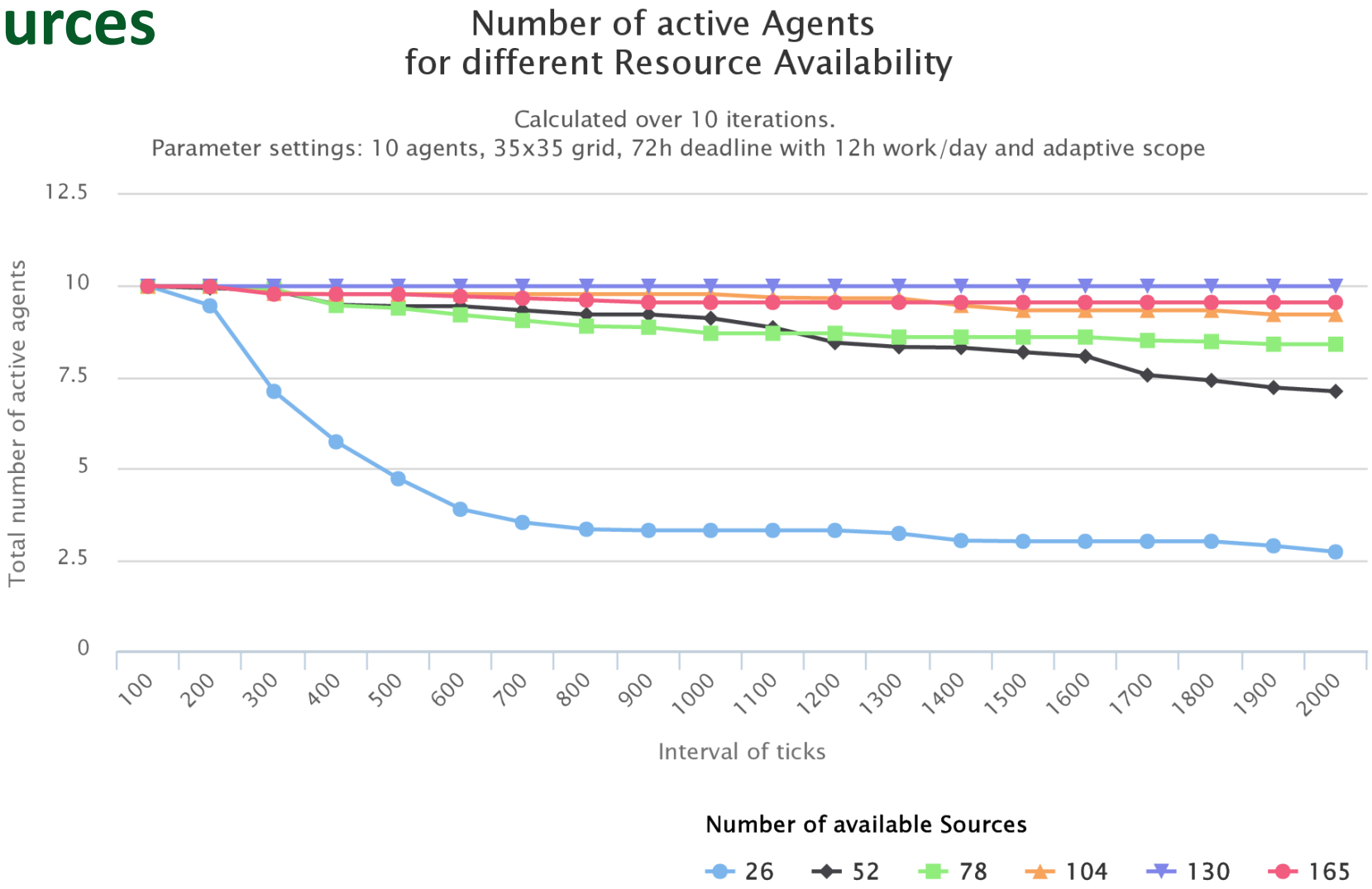
Deadline


System Behavior over time
For 24 hours. Calculated over 10 iterations.
Parameter settings: 10 agents, 35x35 grid, 130 sources, 12h work/day and adaptive scope
Total Action Count
25
20
15
10
5
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Assemblies
Extractions
Deliveries

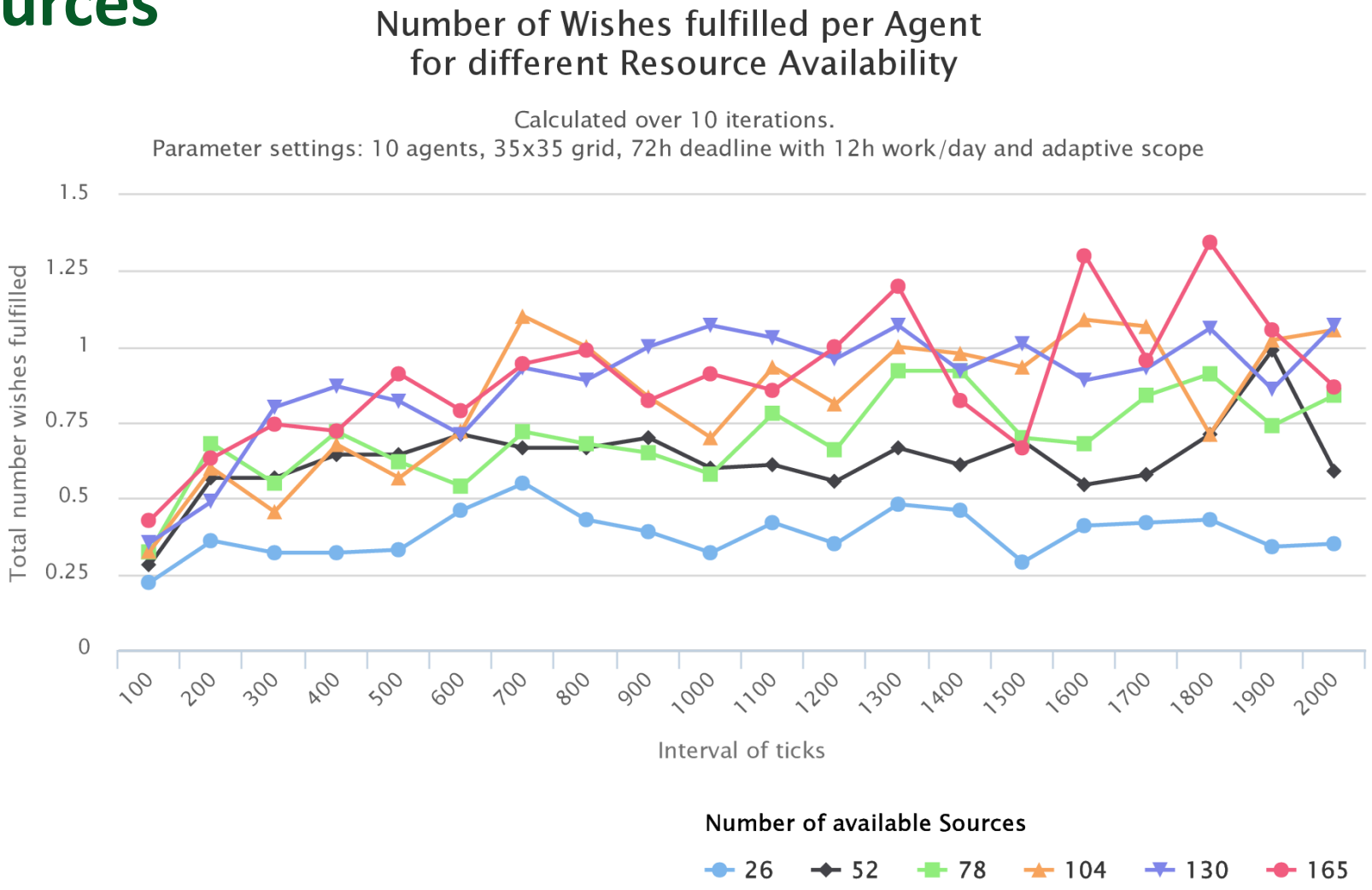
Deadline


System Behavior over time
For 84 hours. Calculated over 10 iterations.
Parameter settings: 10 agents, 35x35 grid, 130 sources, 12h work/day and adaptive scope
Total Action Count
30
20
10
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Assemblies
Extractions
Deliveries

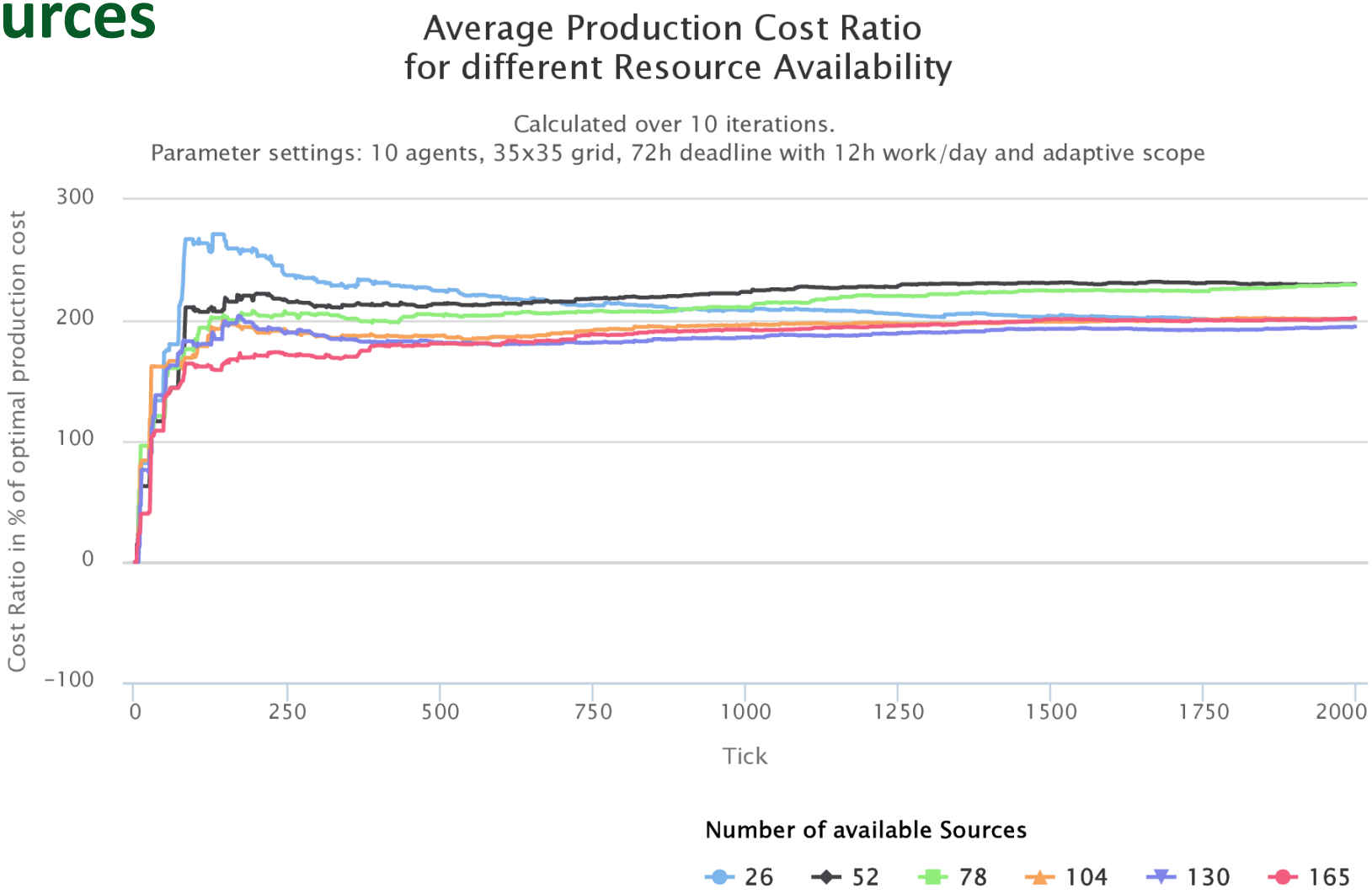
Sources


Number of active Agents
for different Resource Availability
Calculated over 10 iterations.
Parameter settings: 10 agents, 35x35 grid, 72h deadline with 12h work/day and adaptive scope
Total number of active agents
12.5
10
7.5
5
2.5
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Number of available Sources
26
52
78
104
130
165

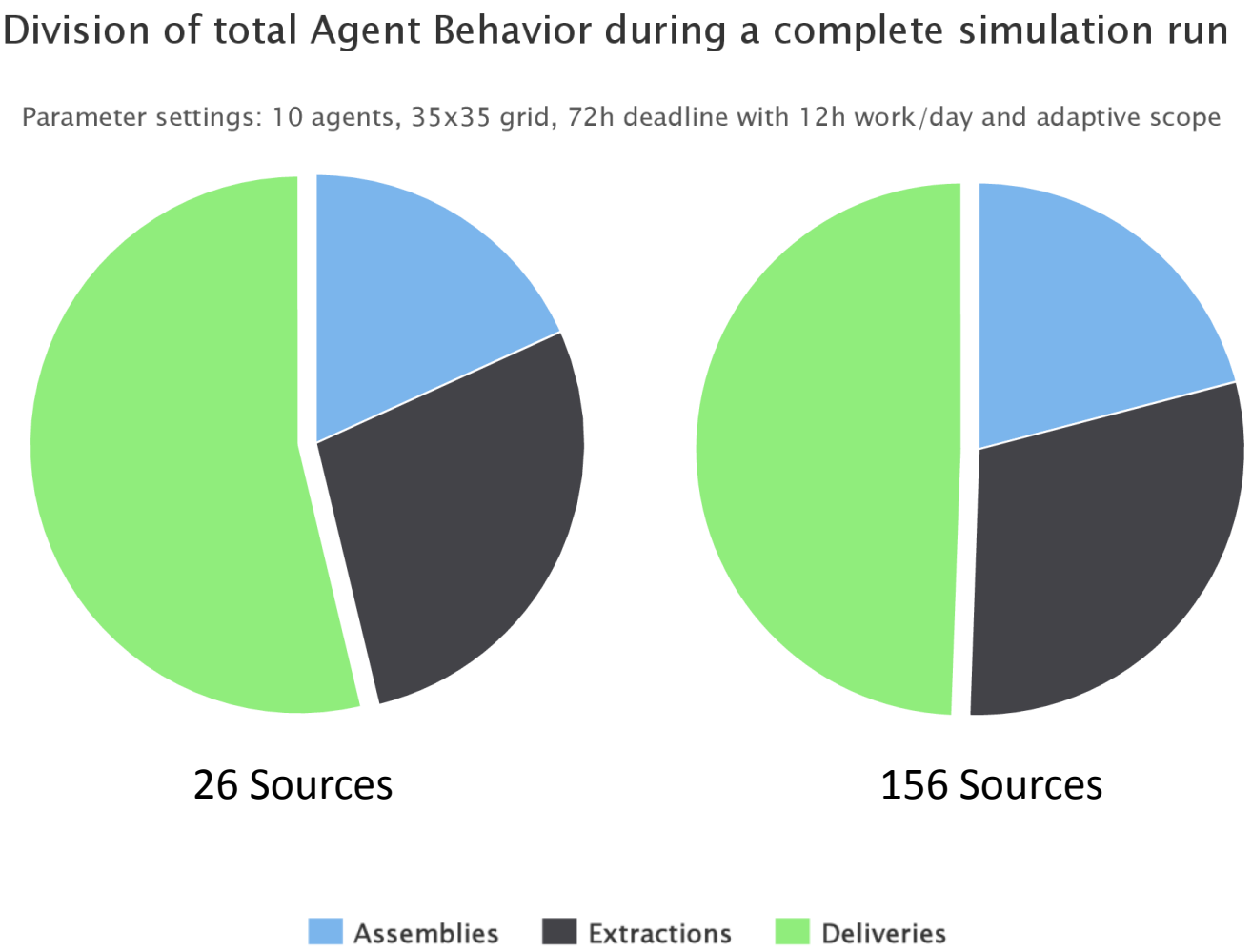
Sources


Number of Wishes fulfilled per Agent
for different Resource Availability
Calculated over 10 iterations.
Parameter settings: 10 agents, 35x35 grid, 72h deadline with 12h work/day and adaptive scope
Total number wishes fulfilled
1.5
1.25
1
0.75
0.5
0.25
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Number of available Sources
26
52
78
104
130
165

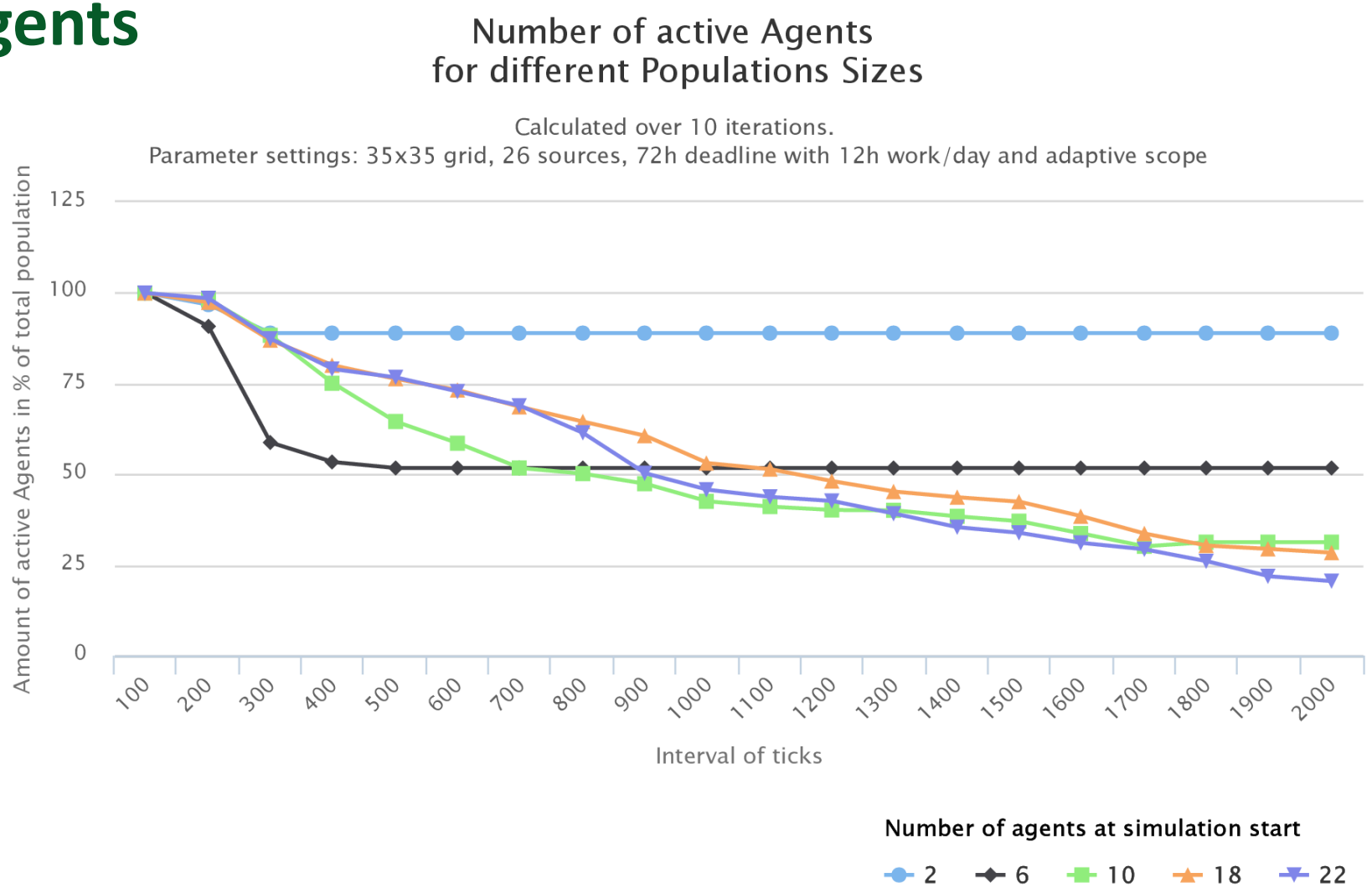
Sources


Average Production Cost Ratio
for different Resource Availability
Calculated over 10 iterations.
Parameter settings: 10 agents, 35x35 grid, 72h deadline with 12h work/day and adaptive scope
Cost Ratio in % of optimal production cost
300
200
100
0
-100
0
250
500
750
1000
1250
1500
1750
2000
Tick
Number of available Sources
26
52
78
104
130
165

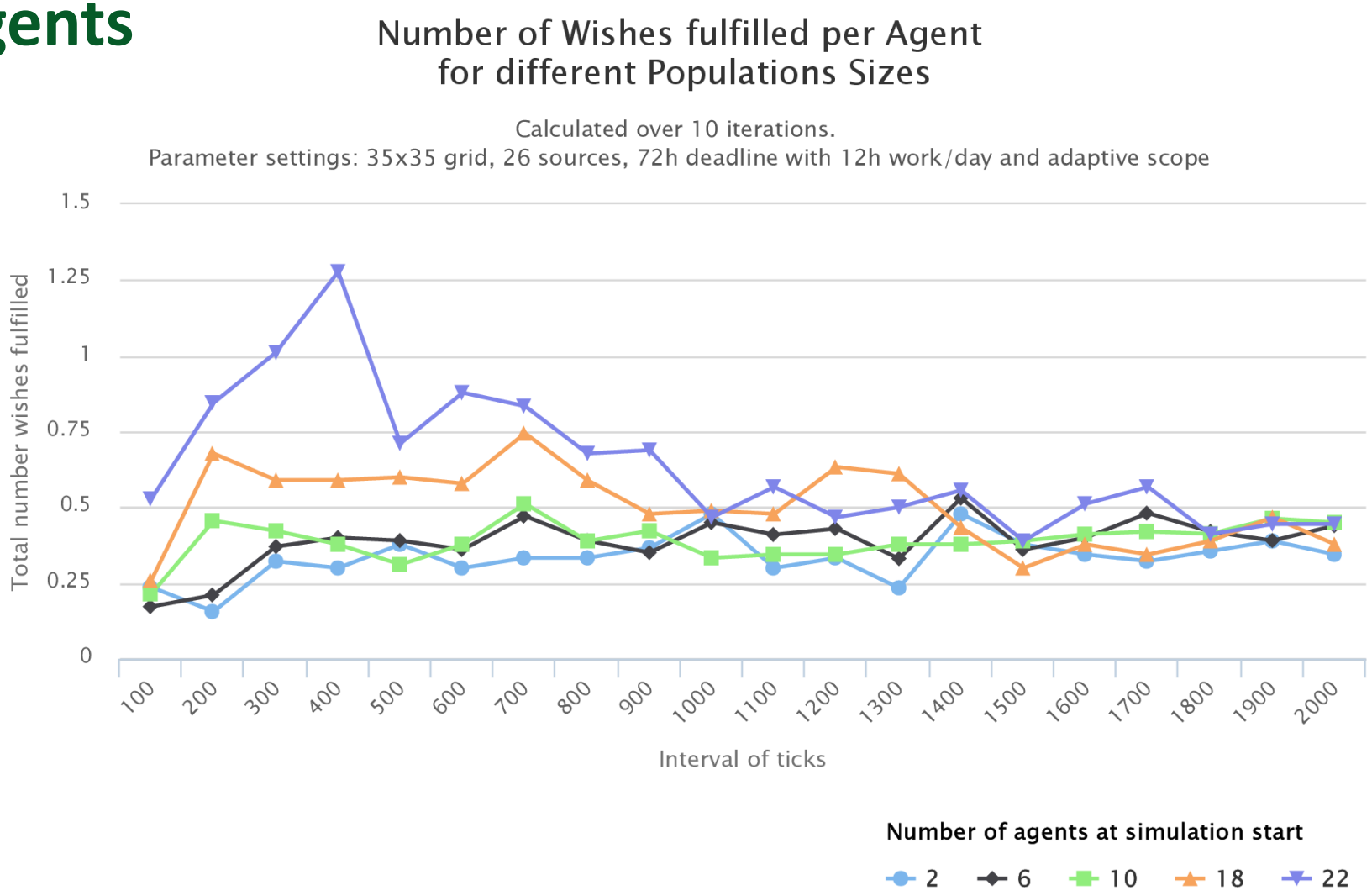
Sources


Division of total Agent Behavior during a complete simulation run
Parameter settings: 10 agents, 35x35 grid, 72h deadline with 12h work/day and adaptive scope
26 Sources
156 Sources
Assemblies
Extractions
Deliveries

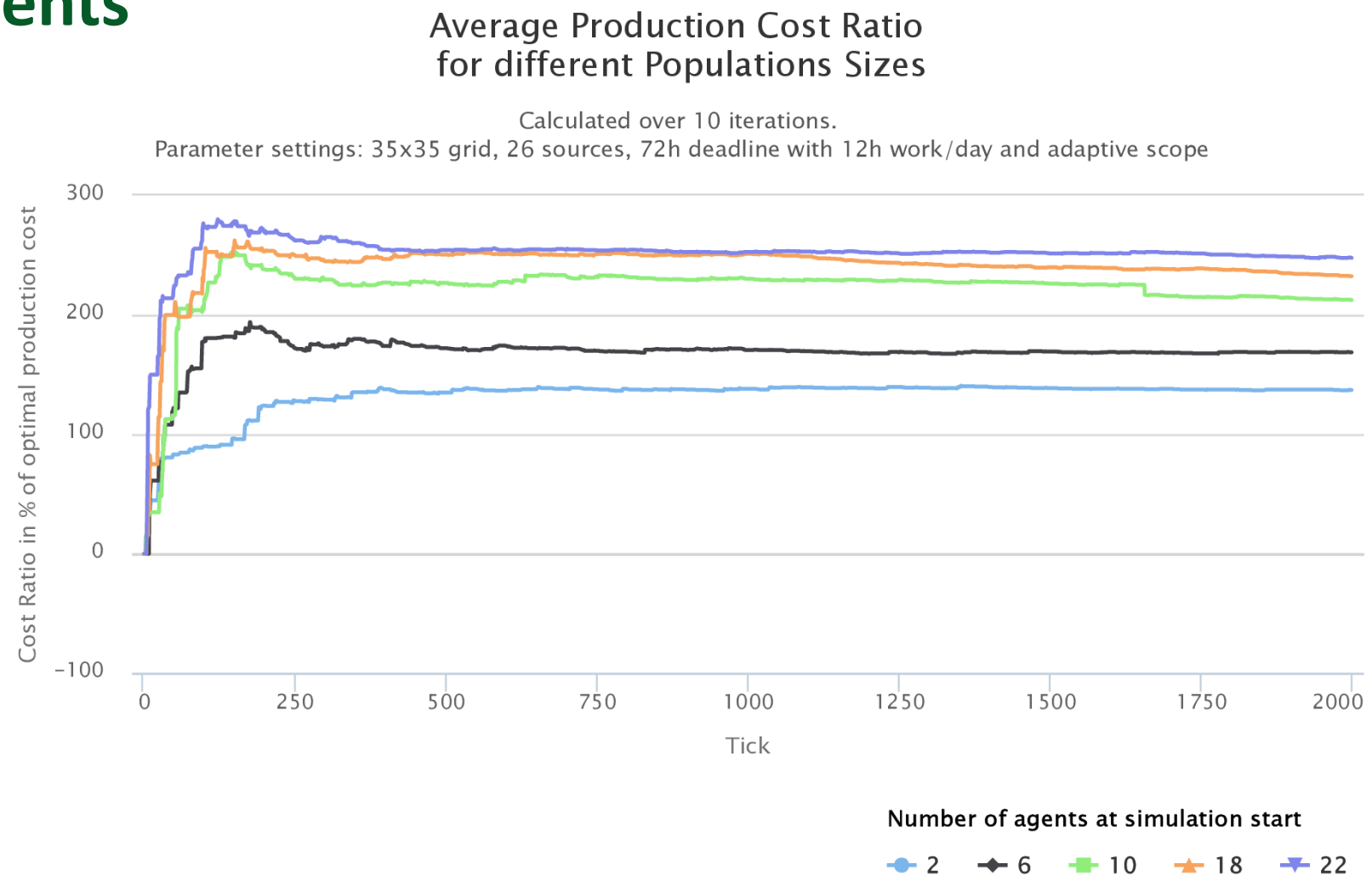
Agents


Number of active Agents
for different Populations Sizes
Calculated over 10 iterations.
Parameter settings: 35x35 grid, 26 sources, 72h deadline with 12h work/day and adaptive scope
Amount of active Agents in % of total population
125
100
75
50
25
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Number of agents at simulation start
2
6
10
18
22

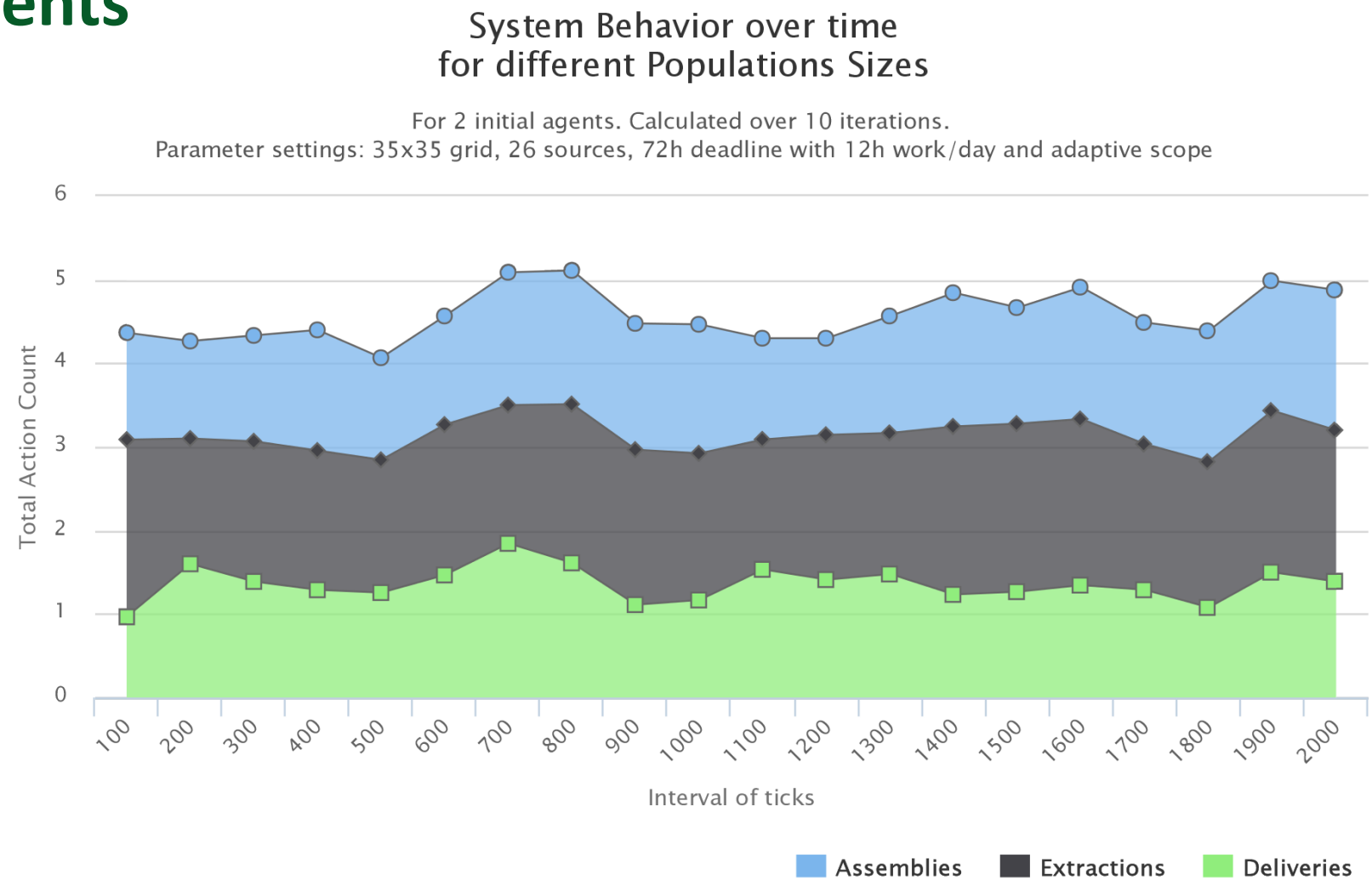
Agents


Number of Wishes fulfilled per Agent
for different Populations Sizes
Calculated over 10 iterations.
Parameter settings: 35x35 grid, 26 sources, 72h deadline with 12h work/day and adaptive scope
Total number wishes fulfilled
1.5
1.25
1
0.75
0.5
0.25
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Number of agents at simulation start
2
6
10
18
22

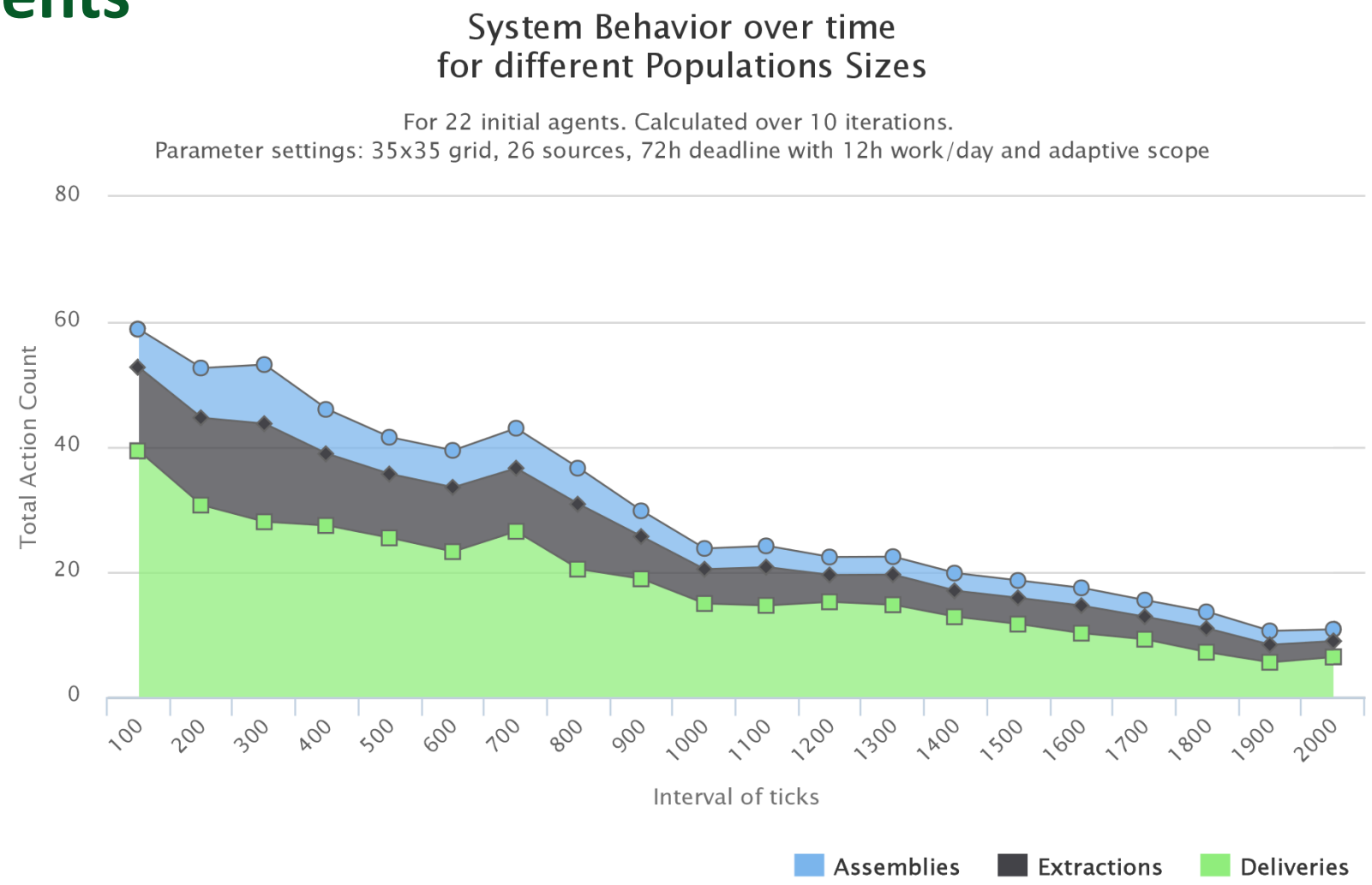
Agents


Average Production Cost Ratio
for different Populations Sizes
Calculated over 10 iterations.
Parameter settings: 35x35 grid, 26 sources, 72h deadline with 12h work/day and adaptive scope
Cost Ratio in % of optimal production cost
300
200
100
0
-100
0
250
500
750
1000
1250
1500
1750
2000
Tick
Number of agents at simulation start
2
6
10
18
22

Agents


System Behavior over time
for different Populations Sizes
For 2 initial agents. Calculated over 10 iterations.
Parameter settings: 35x35 grid, 26 sources, 72h deadline with 12h work/day and adaptive scope
Total Action Count
0
1
2
3
4
5
6
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Assemblies
Extractions
Deliveries

Agents


System Behavior over time
for different Populations Sizes
For 22 initial agents. Calculated over 10 iterations.
Parameter settings: 35x35 grid, 26 sources, 72h deadline with 12h work/day and adaptive scope
Total Action Count
80
60
40
20
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
Interval of ticks
Assemblies
Extractions
Deliveries

Conclusions

- **Resource availability** and **demand distribution** determine system sustainability
  Also: Even in scarce environments can networks of certain size develop **self-sustainability**

Conclusions

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  Also: Even in scarce environments can networks of certain size develop **self-sustainability**

- A certain **basis level of resource availability** is necessary to preserve a larger group of agents
  And: Higher resource availability decreases the average production cost ratio

Conclusions

- **Resource availability** and **demand distribution** determine system sustainability
  Also: Even in scarce environments can networks of certain size develop **self-sustainability**

- A certain **basis level of resource availability** is necessary to preserve a larger group of agents
  And: Higher resource availability decreases the average production cost ratio

- Different **weighing of rating functions** impacts the average production cost ratio

Future Work

- Thoroughly test the influence of the **different rating functions**
- Assess model performance on **large scale simulation runs**

Future Work

- Thoroughly test the influence of the **different rating functions**
- Assess model performance on **large scale simulation runs**

- Implement real-world **production cost determination** processes
- Replace the static intelligence heuristics by true **cybernetic/ML evaluation functionality**
- Implement **higher and lower levels** of the viable system model

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Supervisor: Dr. Roberto Valenti

UNIVERSITY OF AMSTERDAM

Image Sources

1) http://www.vanityfair.fr/uploads/images/201506/dc/vf_stafford_beer_2180.png
2) Based on Medina (2006, p. 21)
3) https://www.singularityweblog.com/wp-content/uploads/2013/05/Jacque-Fresco-Venus-Project.jpg
4) https://www.thevenusproject.com/en/about/the-venus-project
5) Taken from Gershenson (2005)
6) http://repast.sourceforge.net/images/Repast_logo_100h.png
7) Graph generated with https://graphsketch.com/

2

Modelling Assumptions

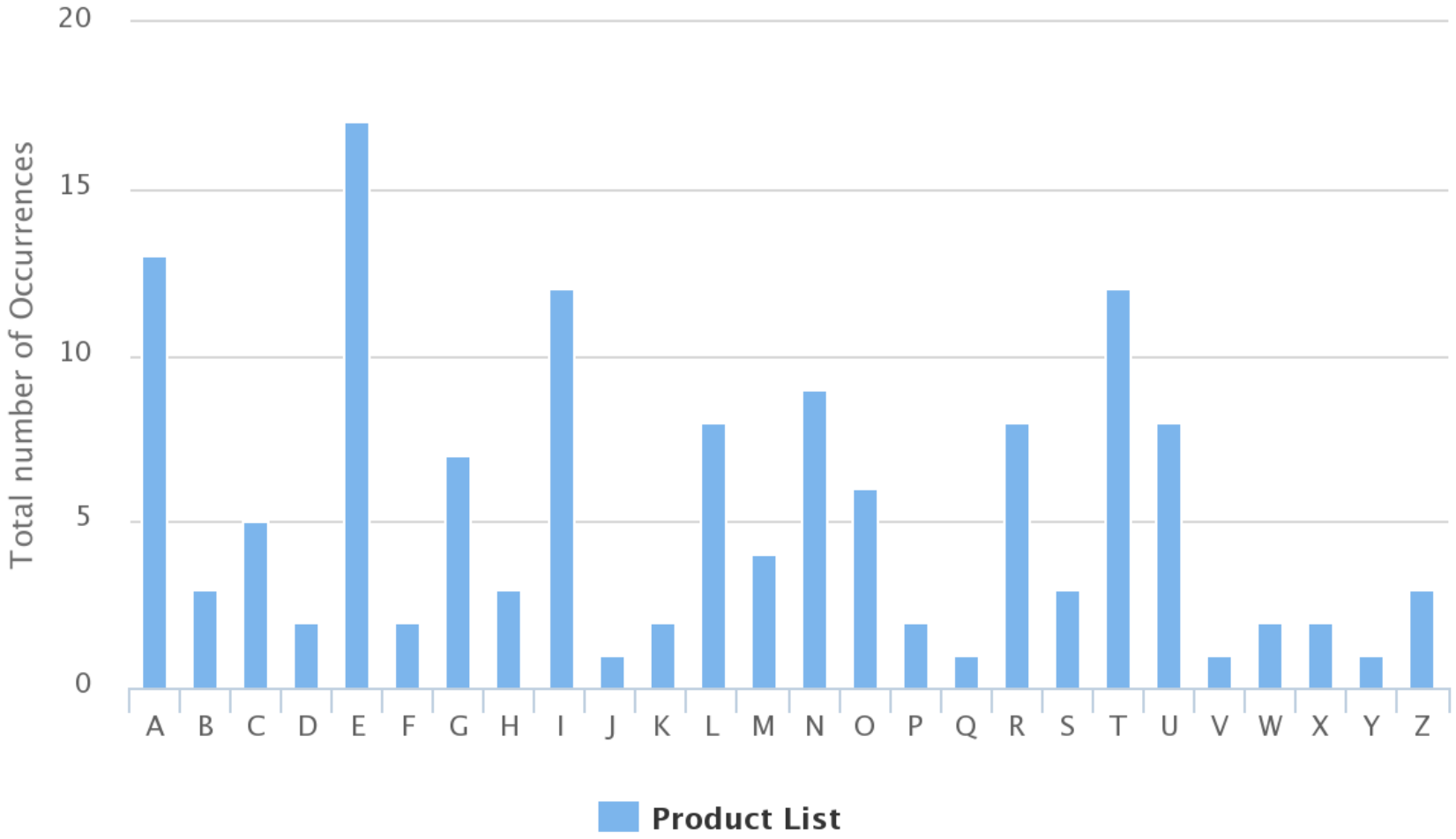
- Products are represented through words that can be assembled from letter Resources
- Agents can only contact other Agents and extract Resources within a limited range
- All actions within this range have a cost of 1
- Action utility rating is based on
  - Request Urgency
  - Resource Availability
  - Delivery Distance

2

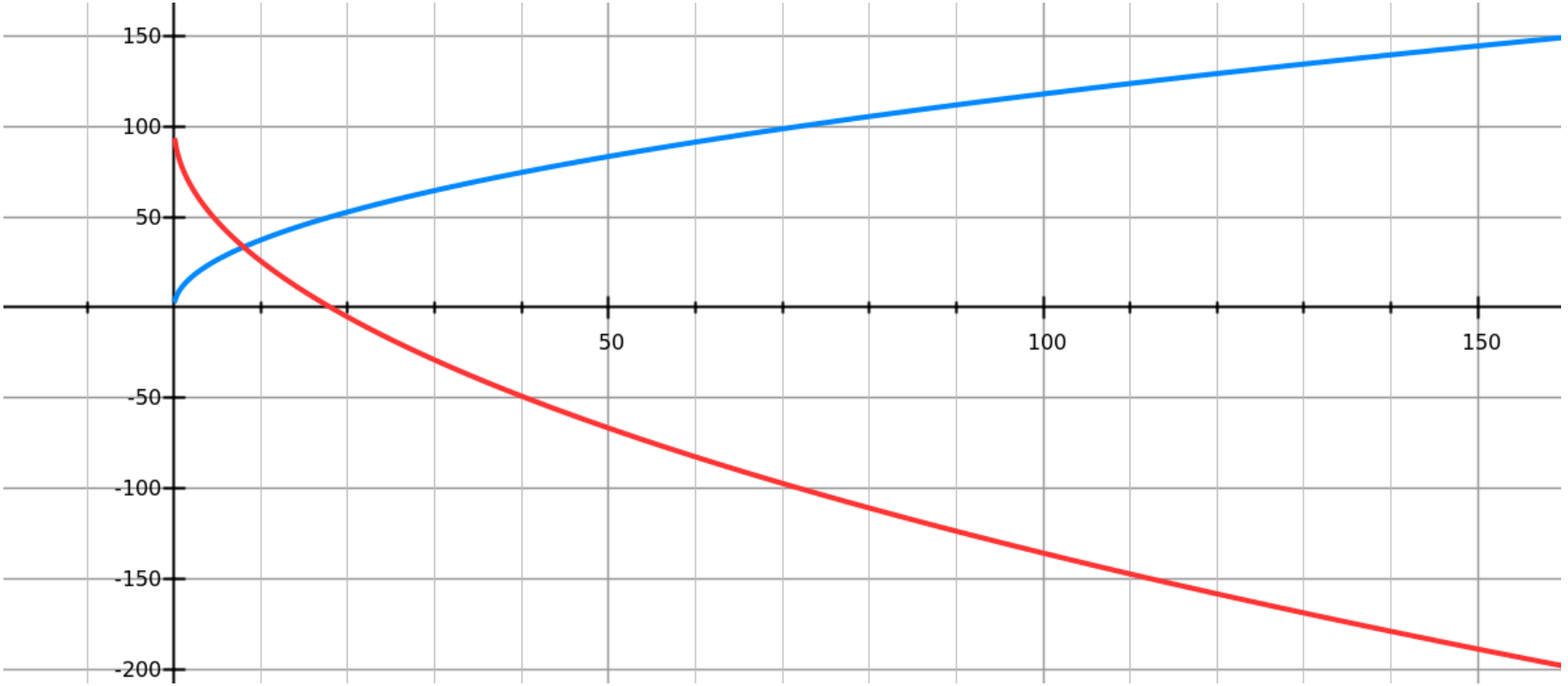
Modelling Assumptions

- All Sources are regenerative
- Agents select the highest rating possible action
- Agents can contact requesters to validate active requests
- Optimal production cost = 2n-1 where n is the product size
- Re-use of parts still increases the production cost ratio

Letter Distribution (Resource Availability)



Heuristic Intelligence (Static approach)



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