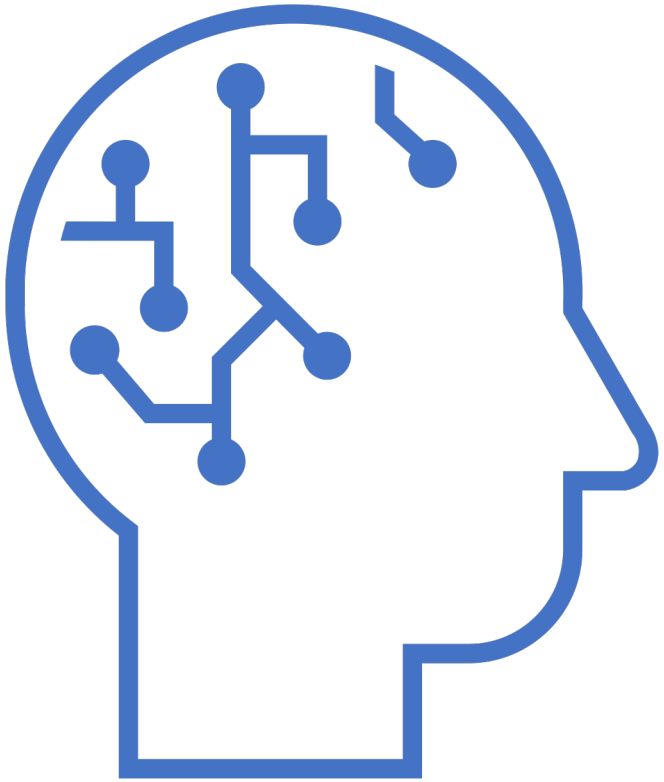
Trust in AI Recommendations in Supply Chain Planning

Eirini Spiliotopoulou (TiU)

Joint work with

Willem van Jaarsveld (TU/e) and Lijia Tan (TU/e)



Motivation

Many supply chain planning decisions increasingly rely on the guidance of AI-based algorithms

Such as forecasting, ordering and production decisions

Planners remain responsible for decision outcomes

Discretion to adjust algorithmic recommendations

Focus: complex decision problems

Uncertainties, delays, interrelated decisions

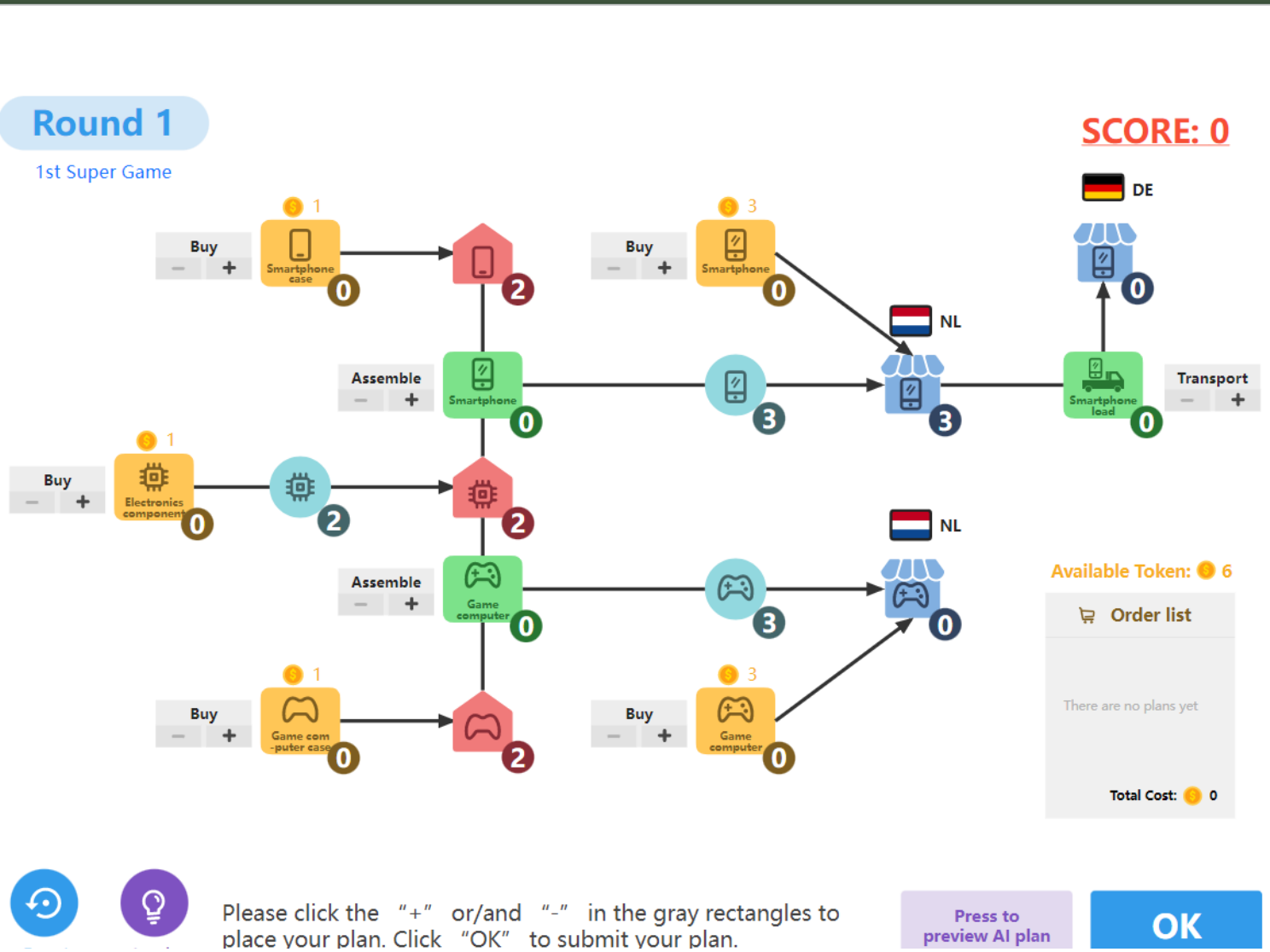
Sophisticated AI tool can significantly improve operational outcomes

Research questions

How does AI help human planners' decisions in a supply chain?

1. Do people *use* the AI tool in planning i.e., *trust* the algorithmic recommendations?

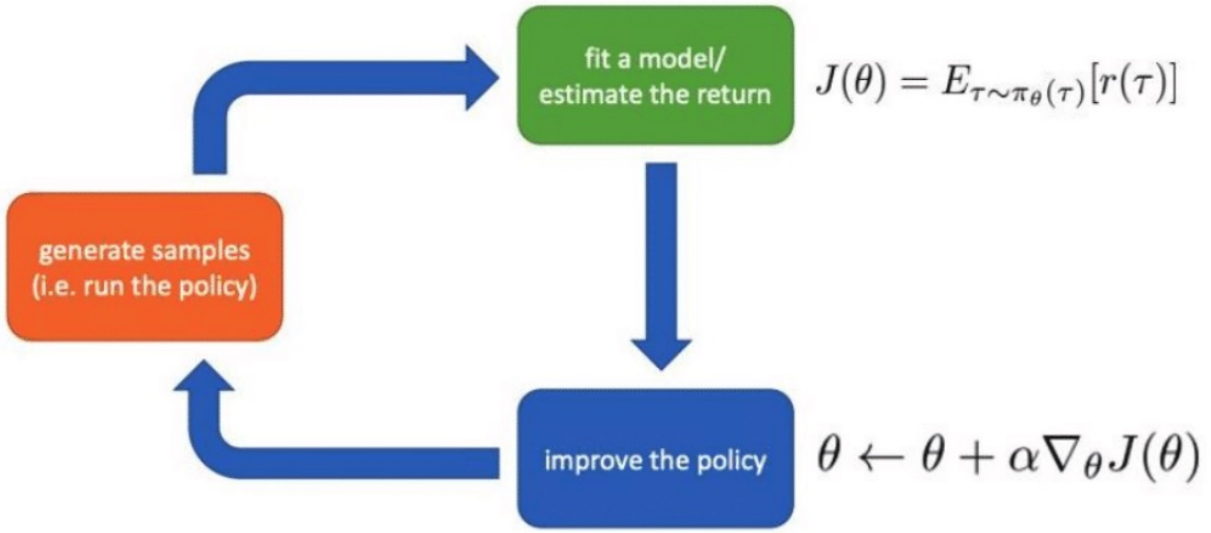
2. Does the AI tool help humans *learn* effective strategies in a complex setting?



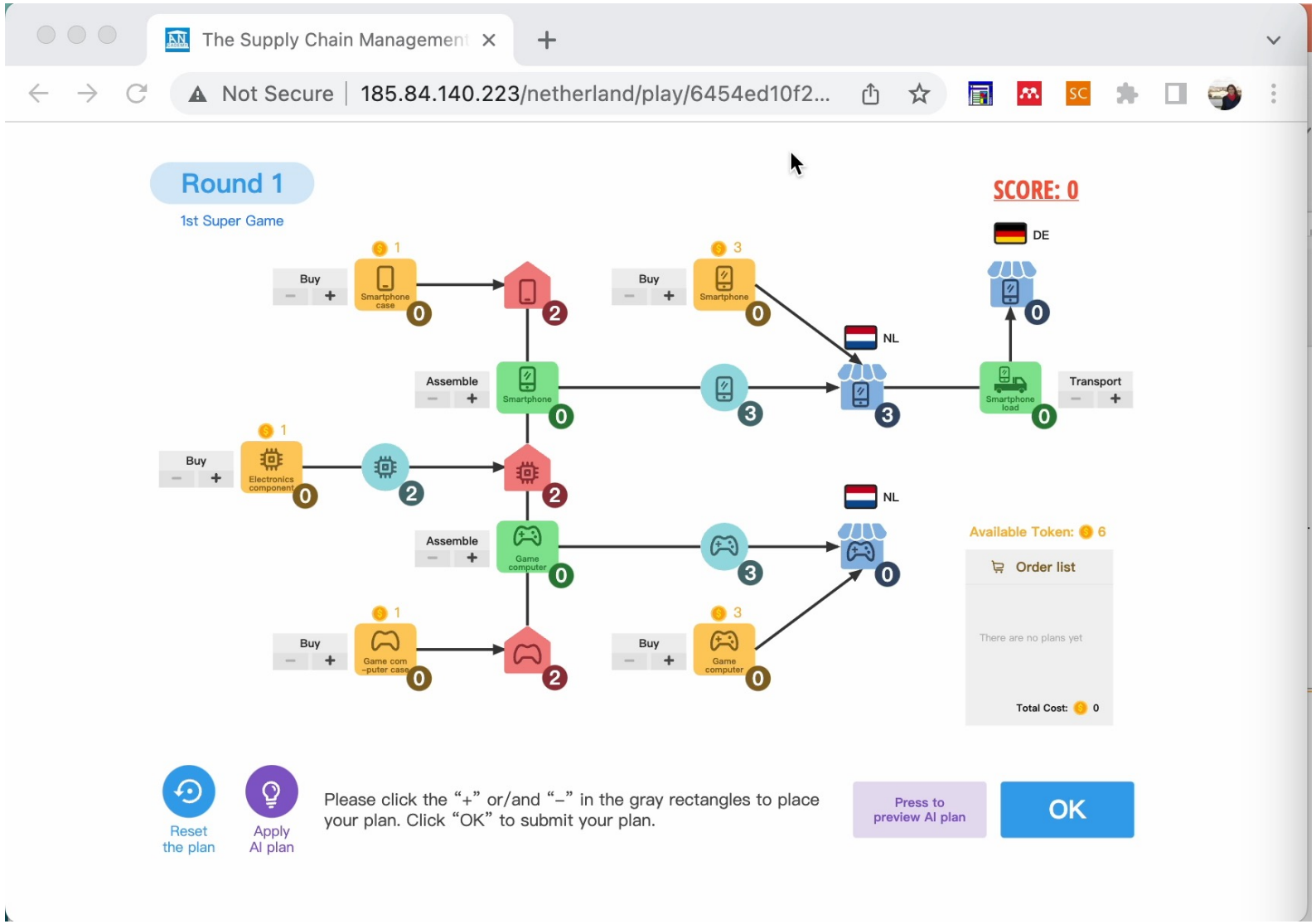
Game Setting

The algorithm

- Neural network algorithm
  - Trained a model via trial and error methods/reinforcement learning
  - Employed DynaPlex/DCL
- Performs quite well in the context!
  - Clearly outperformed PPO
  - Outperformed about 50 human subjects in semi-controlled trial, where the algorithm was fed the same demand sequence as the humans.
  - Outperforms several well-known heuristics.



Example


The Supply Chain Management
Not Secure | 185.84.140.223/netherland/play/6454ed10f2...
Round 1
1st Super Game
SCORE: 0
DE
NL
NL
Buy
Smartphone case
Smartphone
Assemble
Transport
Smartphone load
Electronics component
Game computer
Game com -puter case
Available Token: 6
Order list
There are no plans yet
Total Cost: 0
Reset the plan
Apply AI plan
Please click the "+" or/and "−" in the gray rectangles to place your plan. Click "OK" to submit your plan.
Press to preview AI plan
OK

Experimental Design

Controlled between-subjects incentivized laboratory experiments

Treatment	Game 1	Game 2	Game 3	No Subjects
Baseline	No AI	No AI	No AI	34
Learning	No AI	AI	No AI	39
Experienced	No AI	No AI	AI	38
AI-able	No AI	AI	AI	39
Total				*150*

Subject pool: university students (CentERLab)

Each game has 10 rounds, each subject plays 3 games in total

Each session lasted around 1,5 hours

Payment based on performance:

~ 21,4 Euros

Do decision makers use AI plans (as-is)?

- Looking at the plan implemented in a round (when AI tool is available)…
- Only 13 out of 116 subjects (13%) *always* followed AI plans as-is

Used AI plan As-Is	Deviated from AI plan
49,7%	50,3%

Decision makers largely **use** the AI tool (even if it is “black-box”)
…. *but* they also very frequently **modify** it

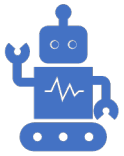
How often do decision makers deviate from AI recommendations?

- We look at each type of decision seperately:

	Deviations from AI recommendations			
Decision	Avg	Frequency	Game 2	Game 3
Buy smartphone case	0,26	18,5%	20,8%	16,2%
Buy electronics	0,55	25,3%	28,5%	22,1%
Buy computerccase	0,18	14,2%	17,2%	11,2%
Buy smartphone	0,18	15,4%	15,5%	15,3%
Buy computer	0,11	9,2%	9,4%	9,1%
Assemble smartphone	0,11	8,8%	11,3%	6,4%
Assemble computer	0,10	8,8%	10,6%	6,9%
Total		*14,3%*	*16,2%*	*12,4%*

**For each decision we look at the (absolute) difference between the planner's choice and the AI recommendation*

Individual-level characteristics



General attitude toward AI/algorithmic tools

Questionnaire based on Technology Acceptance Model (TAM) (Davis (1989)

(1) perceived usefulness, (2) perceived ease of use, (3) attitude towards use, (4) intention to use of AI/algorithmic tools in general

Risk attitude

Incentivized Holt & Laury (2002) task

Cognitive reflection

CRT Test (Frederick, 2005)

Demographics

Gender, age, experience etc

What drives trust in AI recommendations?

Or alternatively, deviations from AI suggestions?

deviation_AI	Coefficient	Std. err.	z	P>|z|
TAM_score	-.0610551	.0231279	-2.64	0.008
crt_score	-.1553413	.1129392	-1.38	0.169
risk	.0107724	.0734294	0.15	0.883
round	-.1611804	.0191819	-8.40	0.000
game	-.381455	.1395396	-2.73	0.006
clarity	.1411076	.1329659	1.06	0.289
age	.0093255	.0876318	0.11	0.915
female	.0286343	.2911294	0.10	0.922
education	-.0970347	.1383252	-0.70	0.483
study_field	.0362355	.0392593	0.92	0.356
course_scm	.3305503	.300303	1.10	0.271
experience	.0151543	.0828267	0.18	0.855
_cons	4.962557	1.902613	2.61	0.009
sigma_u	1.2048289			
sigma_e	2.1562915			

GLS panel data regression with errors clustered at the participant level

General Attitude towards AI/algorithmic tools

Task experience

Do planners make better decisions when they trust AI more?

- Participant's score in a round *decreases* in the size of deviations from AI recommendations

  (similar results for total game score)

roundscore	Coefficient	Std. err.	z	P>|z|
cum_total_dev_AI	-.0051326	.0017401	-2.95	0.003
round	.0909159	.0076102	11.95	0.000
demand	.6824941	.0123098	55.44	0.000
_cons	.1039195	.0536414	1.94	0.053
sigma_u	0			
sigma_e	.69905099			

Panel data random effects regression, grouping variable participant

Lower trust in AI has a negative effect

Does AI tool availability improve performance?

- Comparison of Total Game Score between Baseline and AI-able

	Total Score								
	Game 1			Game 2			Game 3		
	Avg	Median	St.dev	Avg	Median	St.dev	Avg	Median	St.dev
Baseline	22,6	23,0	3,8	24,8	25,0	2,7	25,5	26,5	3,1
AI-Able	23,1	23,0	3,1	26,2	27,0	2,8	25,6	26,0	3,4

- Total score is *not* different in Game 1 (p=0.4495) and Game 3 (p=0.9956)
- Total score *is* different *in* Game *2 (*p=0.0310)

  (Wilcoxon rank-sum tests at the subject level)

- *AI seems to help improve planning decisions but only for less experienced planners*

Do planners learn from AI algorithms?

Preliminary analysis

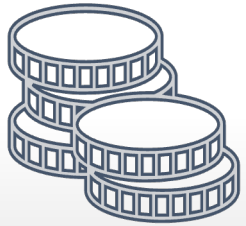
- We look at subject differences in performance between Game 1 and Game 3
- And compare between the *Baseline* (No AI) and *Learning* (No AI - AI - No AI) treatments

- “Learning” = Total Score Game 3 – Total Score Game 1

	"Learning"		
	Avg	Median	St.dev.
Baseline	2,9	3,0	3,6
Learning	2,5	2,0	4,3

Caution! demand uncertainty realizations are not taken into account!

Next steps



Look at *hypothetical* profits instead of realized profits, to account for randomness in demand realizations

- What if the decision maker had followed the AI suggestions?

Focus on *learning* and specific strategies

- Do planners learn from the AI tool strategies that perform well in this context but are non-intuitive?

Thank you!

Eirini Spiliotopoulou

Associate Professor of Supply Chain Management, Tilburg University

e.spiliotopoulou@tilburguniversity.edu