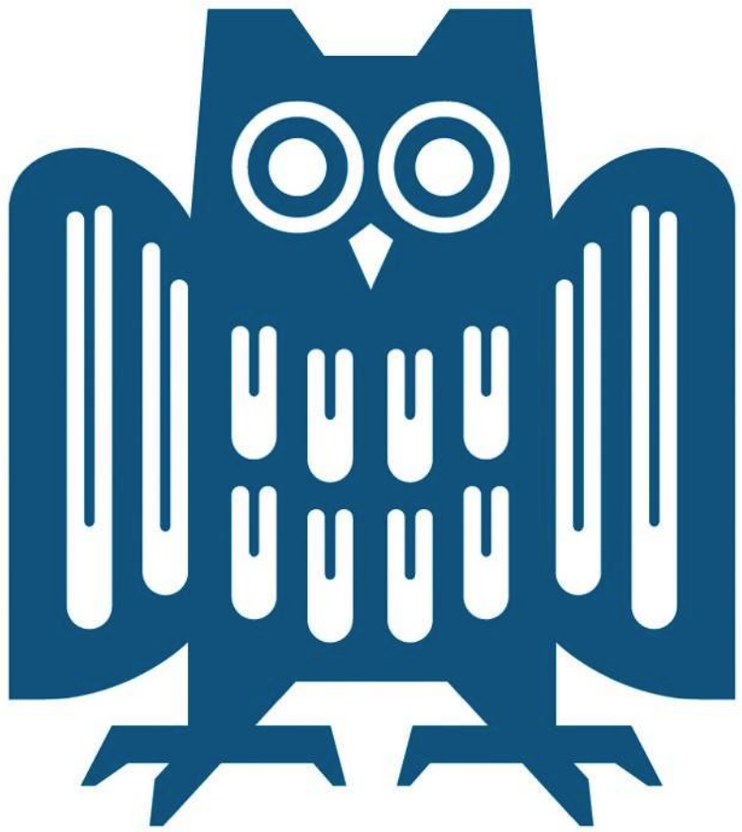


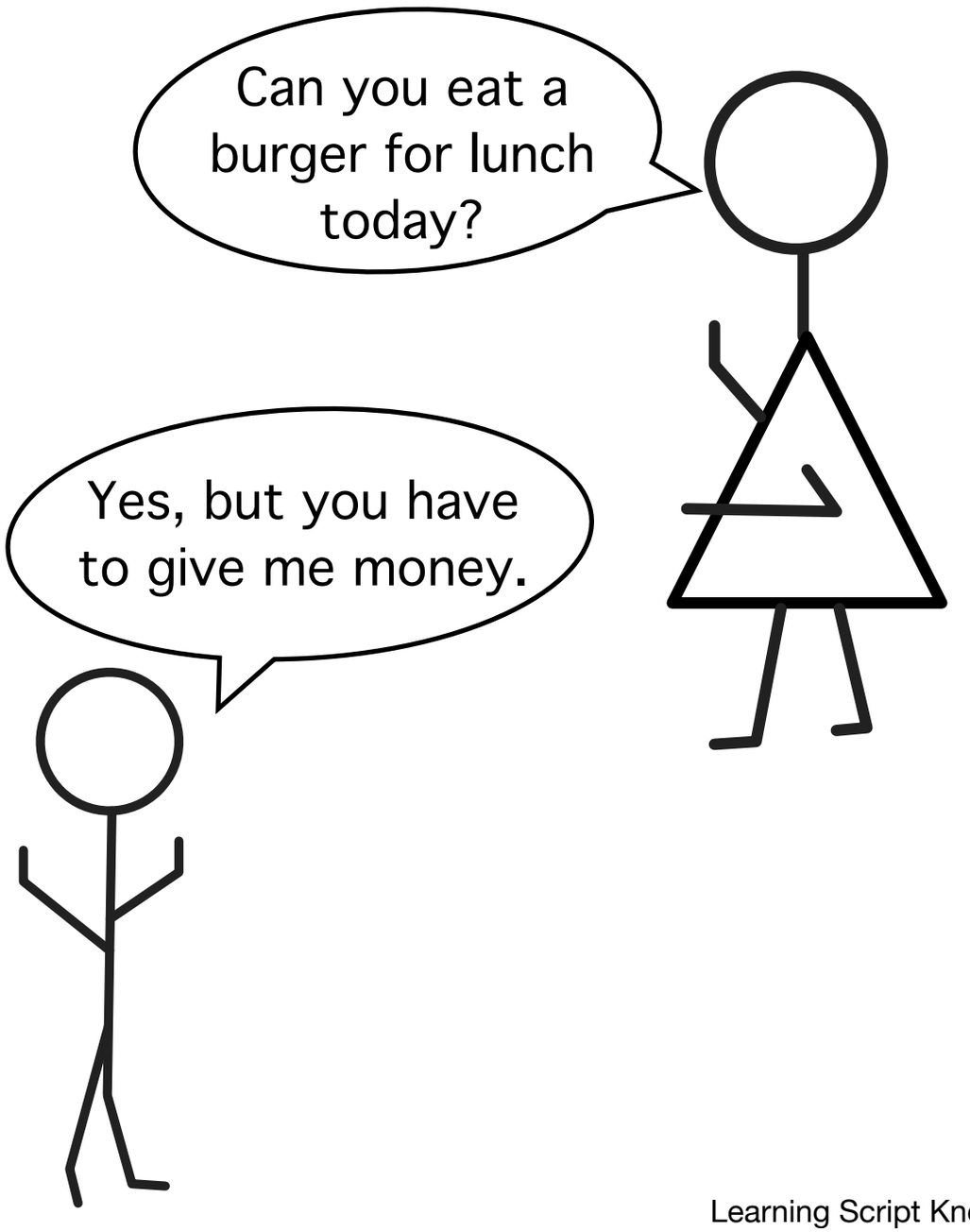
Learning Script Knowledge with Web Experiments

Michaela Regneri
(joint work with Alexander Koller and Manfred Pinkal)

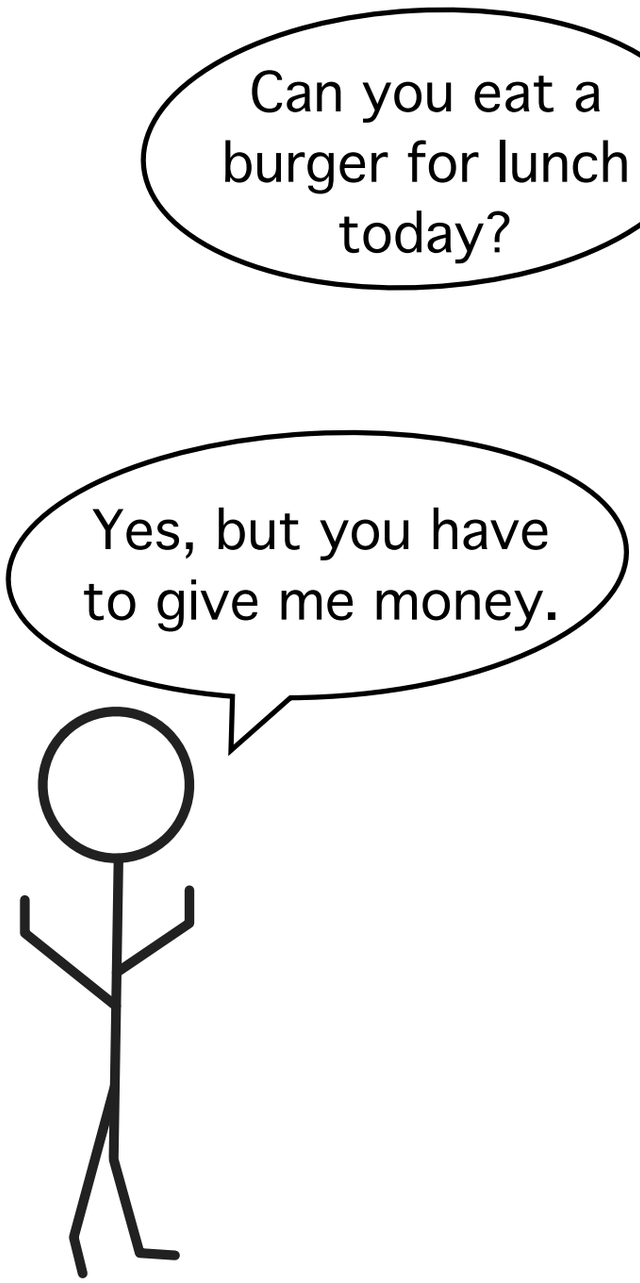
LORIA Nancy

January 18, 2011

Motivation


Can you eat a burger for lunch today?
Yes, but you have to give me money.

Motivation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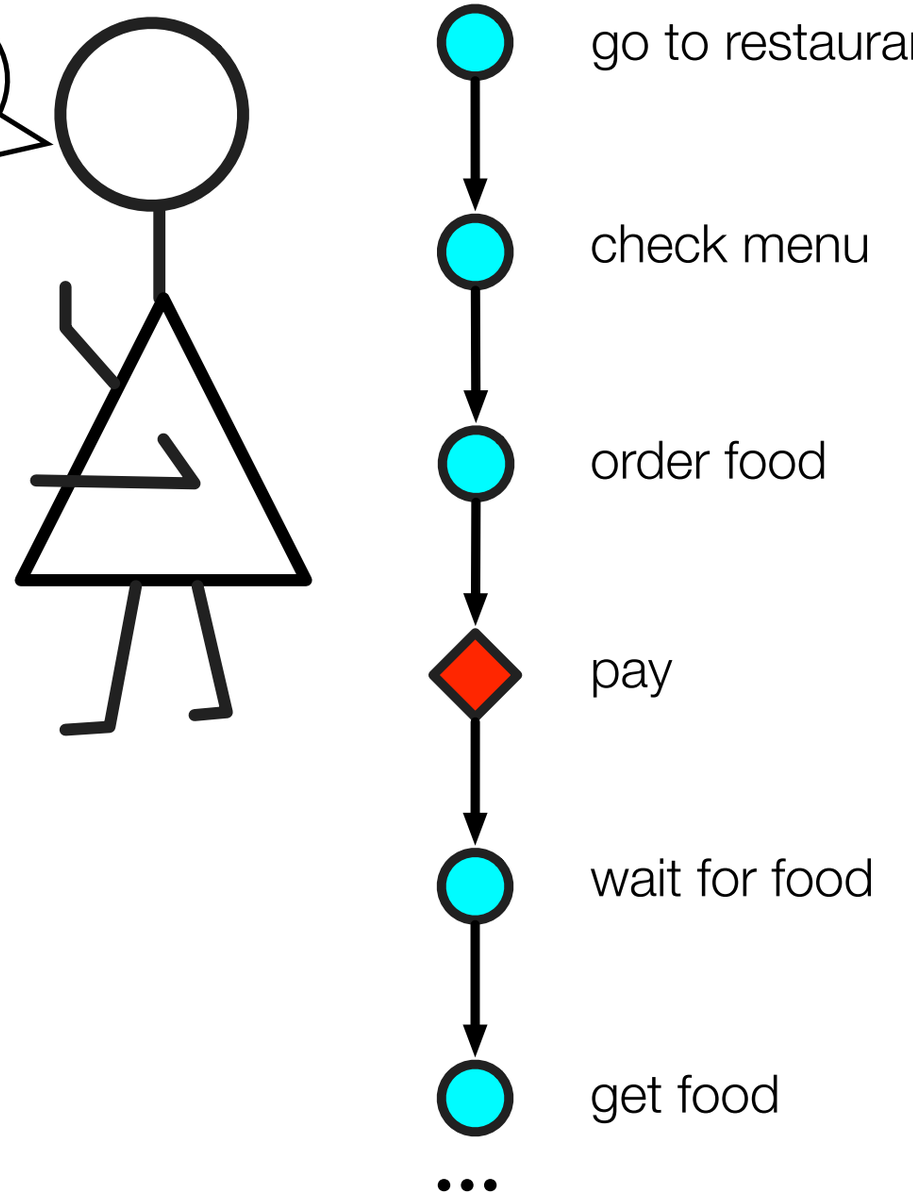
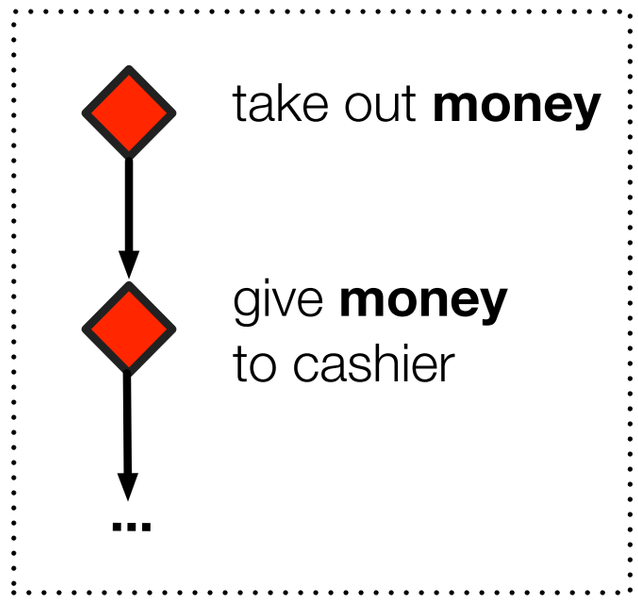

go to restaurant
check menu
order food
pay
wait for food
get food
...


take out **money**
give **money** to cashier
...

Outline

- Our view on Scripts
- Script mining
- Evaluation
- Next steps

Scripts

- a script is a temporally ordered sequence of events associated with a certain scenario

EATING IN A FAST FOOD RESTAURANT

scenario

1. go to restaurant
2. enter restaurant
3. look at menu
4. decide what to eat
...
15. leave

script

- the „classical“ view on scripts considers temporal event order, participants and causal links (Schank & Abelson, 1977)
- we are focussing on the temporal event structures here

Scripts & Implicit Knowledge

- some scripts can be learned from text
  (Chambers & Jurafsky 2008,2009)
- however, many scripts of every-day scenarios are usually not elaborated in detail
  (FAST FOOD RESTAURANT, SHOWERING...)
- people know those scripts very well (that‘s why there is no need to write them down)
- thus we asked people how they usually experience certain scenarios

Script Mining

1. Data collection

1. look at menu
2. decide what you want
3. order at counter
...
7. eat food

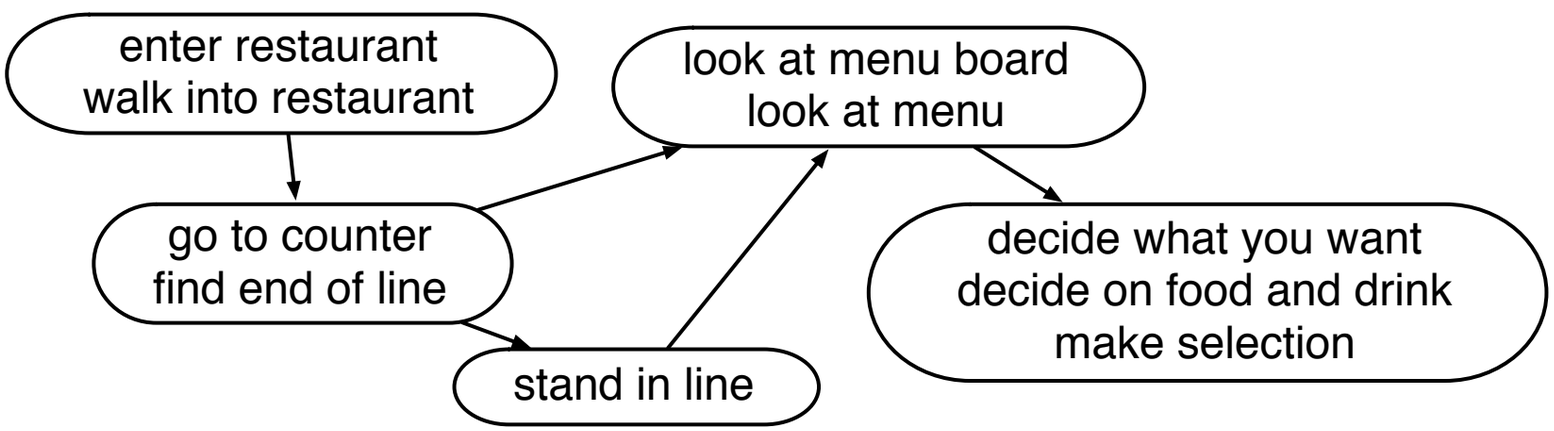
1. walk into restaurant
2. find end of the line
3. stand in line
...
16. get your drink

1. enter restaurant
2. go to counter
3. make selection
4. place order
...
10. leave

2. Sequence Alignment

enter restaurant	walk into restaurant	-
go to counter	find end of the line	-
-	stand in line	-
-	look at menu board	look at menu
decide what you want	decide on food and drink	make selection
place order	tell cashier your order	order at counter
...	...	...
leave	go home	-

3. Temporal Script Graphs



Script Mining

1. Data collection

1. look at menu
2. decide what you want
3. order at counter
...
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1. enter restaurant
2. go to counter
3. make selection
4. place order
...
10. leave

1. walk in
2. find end of the line
3. stand in line
...
16. get your drink

1. Data Collection

2. Sequence Alignment

enter restaurant	walk into restaurant	-
go to counter	find end of the line	-
-	stand in line	-
-	look at menu board	look at menu
decide what you want	decide on food and drink	make selection
	tell cashier your order	order at counter
	...	...
	go home	-

1. look at menu
2. decide what you want
3. order at counter
...
7. eat food

1. walk into restaurant
2. find end of the line
3. stand in line
...
16. get your drink

1. enter restaurant
2. go to counter
3. make selection
4. place order
...
10. leave

3. Tem

en
walk

find end of line

stand in line

decide what you want
decide on food and drink
make selection

Data Collection

- we picked 22 scenarios
- we asked people via Amazon Mechanical Turk for temporally ordered events that they would expect in the scenario (25 people / scenario)
- they had to write at least 5 (and at most 15) events
- we asked them to use „bullet point style“ (*go to counter - take out credit card* ...)

Data Collection

- some of the questions we asked:
  - What happens when you eat in a restaurant?
  - What happens when you eat in a fast food restaurant?
  - How do you make scrambled eggs?
  - What do you do when you take a train?
  - What do you do when you go shopping?
  - How do you pay (after buying something)?
  - How do you pay with a credit card?

Eating in a Fast Food Restaurant

1. walk into restaurant
2. find the end of the line
3. stand in line
4. look at menu board
5. decide on food and drink
6. tell cashier your order
7. listen to cashier repeat order
8. listen for total price
9. swipe credit card in scanner
10. put up credit card
11. take receipt
12. look at order number
13. take your cup
14. stand off to the side
15. wait for number to be called
16. get your drink

1. look at menu
2. decide what you want
3. order at counter
4. pay at counter
5. receive food at counter
6. take food to table
7. eat food

1. walk to the counter
2. place an order
3. pay the bill
4. wait for the ordered food
5. get the food
6. move to a table
7. eat food
8. exit the place

Event Sequence Descriptions (ESDs)

Eating in a Fast Food Restaurant

1. walk into restaurant
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5. get the food
6. move to a table
7. eat food
8. exit the place

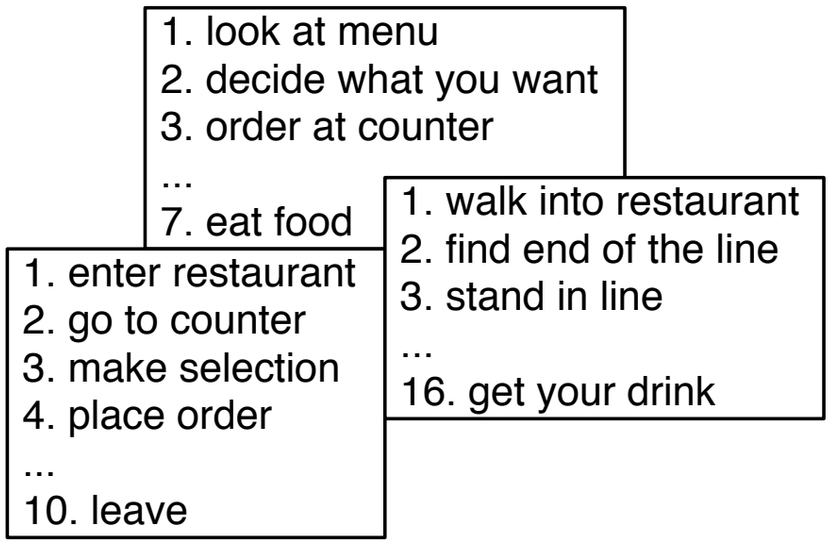
Event Sequence Descriptions (ESDs)

Data post-processing

- all kinds of participants were admitted, no restrictions on the input
- we got a lot of noise (spelling errors, bad grammar, people did not understand the task)
- we manually corrected spelling errors, and discarded instances that were not usable at all
- overall, 15% of the instances were discarded

Script Mining

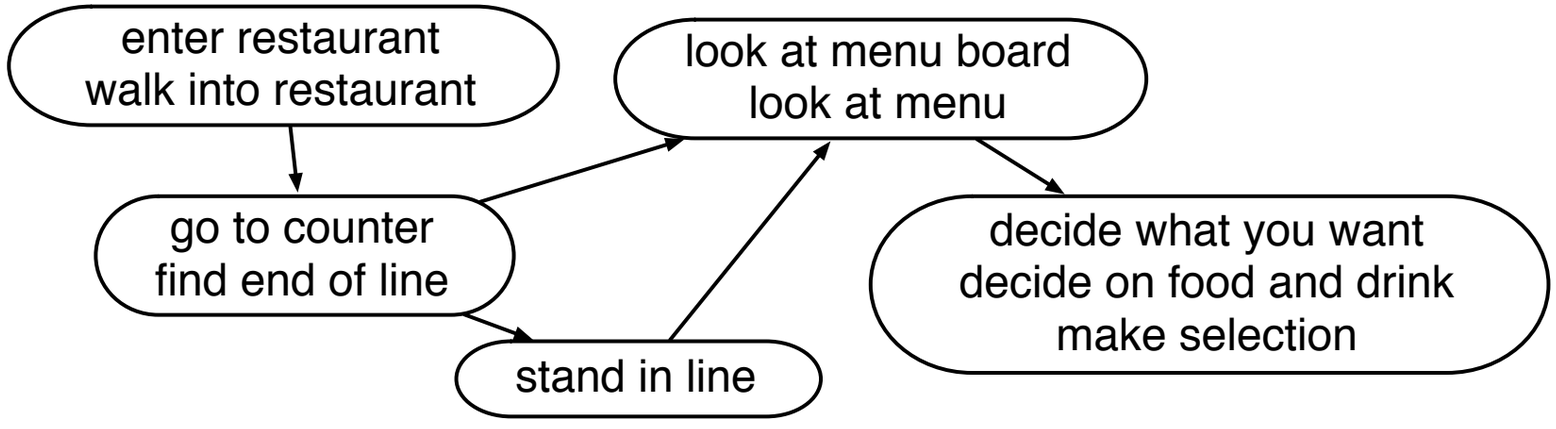
1. Data Collection



2. Sequence Alignment

enter restaurant	walk into restaurant	-
go to counter	find end of the line	-
-	stand in line	-
-	look at menu board	look at menu
decide what you want	decide on food and drink	make selection
place order	tell cashier your order	order at counter
...	...	...
leave	go home	-

3. Temporal Script Graphs



Script Mining

1. Data Collection

1. look at menu
2. decide what you want
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...
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...
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enter restaurant	walk into restaurant	-
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...	...	...
leave	go home	-

2. Sequence Alignment

enter restaurant	walk into restaurant	-
go to counter	find end of the line	-
-	stand in line	-
-	look at menu board	look at menu
decide what you want	decide on food and drink	make selection
place order	tell cashier your order	order at counter
...	...	...
leave	go home	-

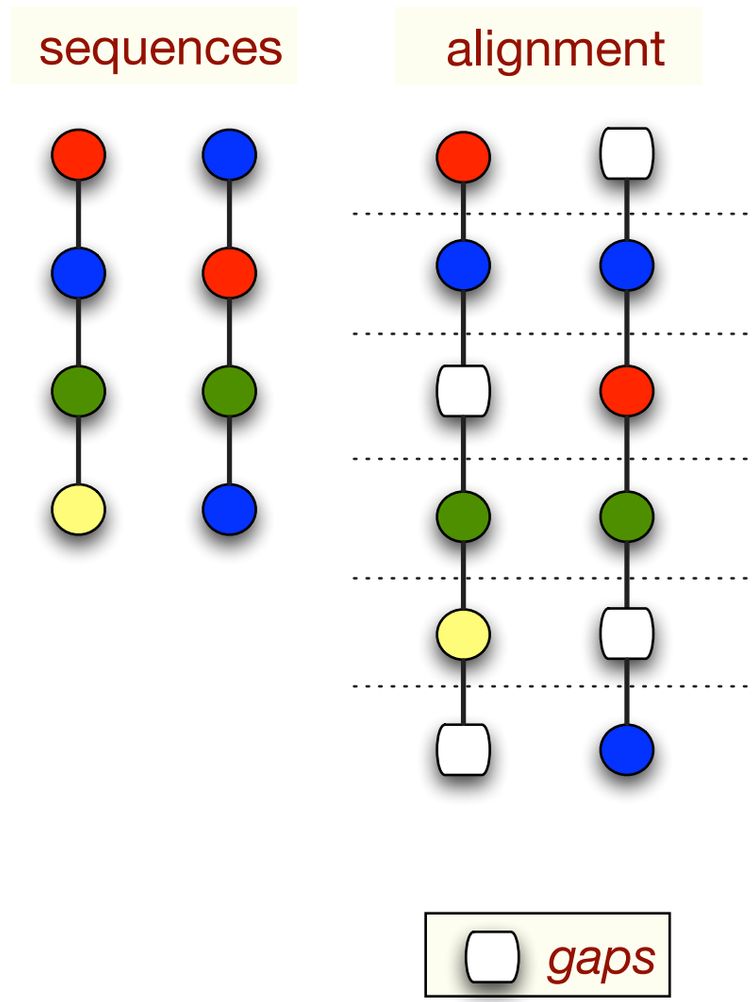
go to counter
find end of line

stand in line

decide what you want
decide on food and drink
make selection

Sequence Alignment

- Sequence Alignment arranges two sequences so as to align as many similar (equal) elements as possible
- compute the alignment with the lowest cost, given costs for
  - gap introduction
  - matching two items
- Multiple Sequence Alignment (MSA) generalizes this task for more than two sequences



Multiple Sequence Alignment

- align string sequences according our cost function

sequence 1	sequence 2	sequence 3
enter restaurant	∅	∅
go to counter	walk to counter	∅
∅	∅	look at menu
make selection	∅	decide what you want
place an order	place order	order at counter
pay the bill	pay for food	pay at counter
wait for the food	∅	∅
get the food	pick up order	receive food at counter
move to a table	go to table	take food to table
eat food	consume food	eat

Multiple Sequence Alignment

- align string sequences according our cost function
- introducing gaps has a constant cost

sequence 1	sequence 2	sequence 3
enter restaurant	∅	∅
go to counter	walk to counter	∅
∅	∅	look at menu
make selection	∅	decide what you want
place an order	place order	order at counter
pay the bill	pay for food	pay at counter
wait for the food	∅	∅
get the food	pick up order	receive food at counter
move to a table	go to table	take food to table
eat food	consume food	eat

Multiple Sequence Alignment

- align string sequences according our cost function
- introducing gaps has a constant cost
- every matching of strings has a cost depending on their semantic similarity

sequence 1	sequence 2	sequence 3
enter restaurant	∅	∅
go to counter	walk to counter	∅
∅	∅	look at menu
make selection	∅	decide what you want
place an order	place order	order at counter
pay the bill	pay for food	pay at counter
wait for the food	∅	∅
get the food	pick up order	receive food at counter
move to a table	go to table	take food to table
eat food	consume food	eat

Multiple Sequence Alignment

- align string sequences according our cost function
- introducing gaps has a constant cost
- every matching of strings has a cost depending on their semantic similarity
- we assume all event descriptions in a row to be paraphrases

sequence 1	sequence 2	sequence 3
enter restaurant	∅	∅
go to counter	walk to counter	∅
∅	∅	look at menu
make selection	∅	decide what you want
place an order	place order	order at counter
pay the bill	pay for food	pay at counter
wait for the food	∅	∅
get the food	pick up order	receive food at counter
move to a table	go to table	take food to table
eat food	consume food	eat

Semantic Similarity

get food

predicate **object**

get‘ *food‘*

receive meal

predicate **object**

receive‘ *meal‘*

- compare verbs and nouns with WordNet
- compute a similarity score (high score = low cost)
  - synonyms > hypernyms > other relations
  - similar verb > similar nouns

Script Mining

1. Data Collection

1. look at menu
2. decide what you want
3. order at counter
...
7. eat food

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2. find end of the line
3. stand in line
...
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1. enter restaurant
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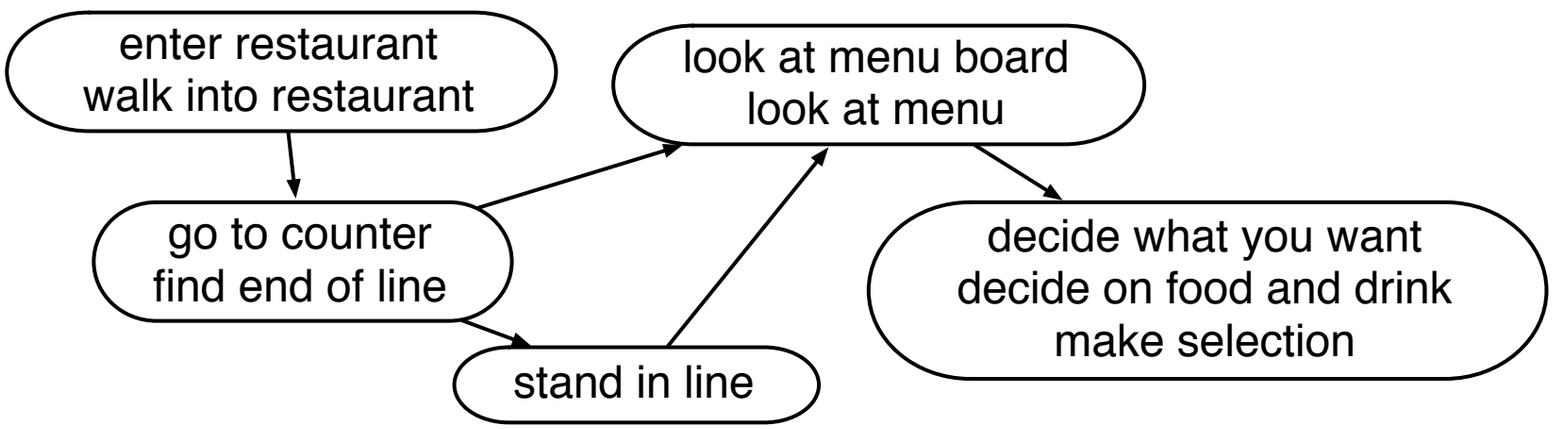
3. make selection
4. place order
...
10. leave

2. Sequence Alignment

enter restaurant	walk into restaurant	-
go to counter	find end of the line	-
-	stand in line	-
-	look at menu board	look at menu
decide what you want	decide on food and drink	make selection
place order	tell cashier your order	order at counter
...	...	...
leave	go home	-

3. Temporal Script Graphs



Script Mining

1. Data Collection

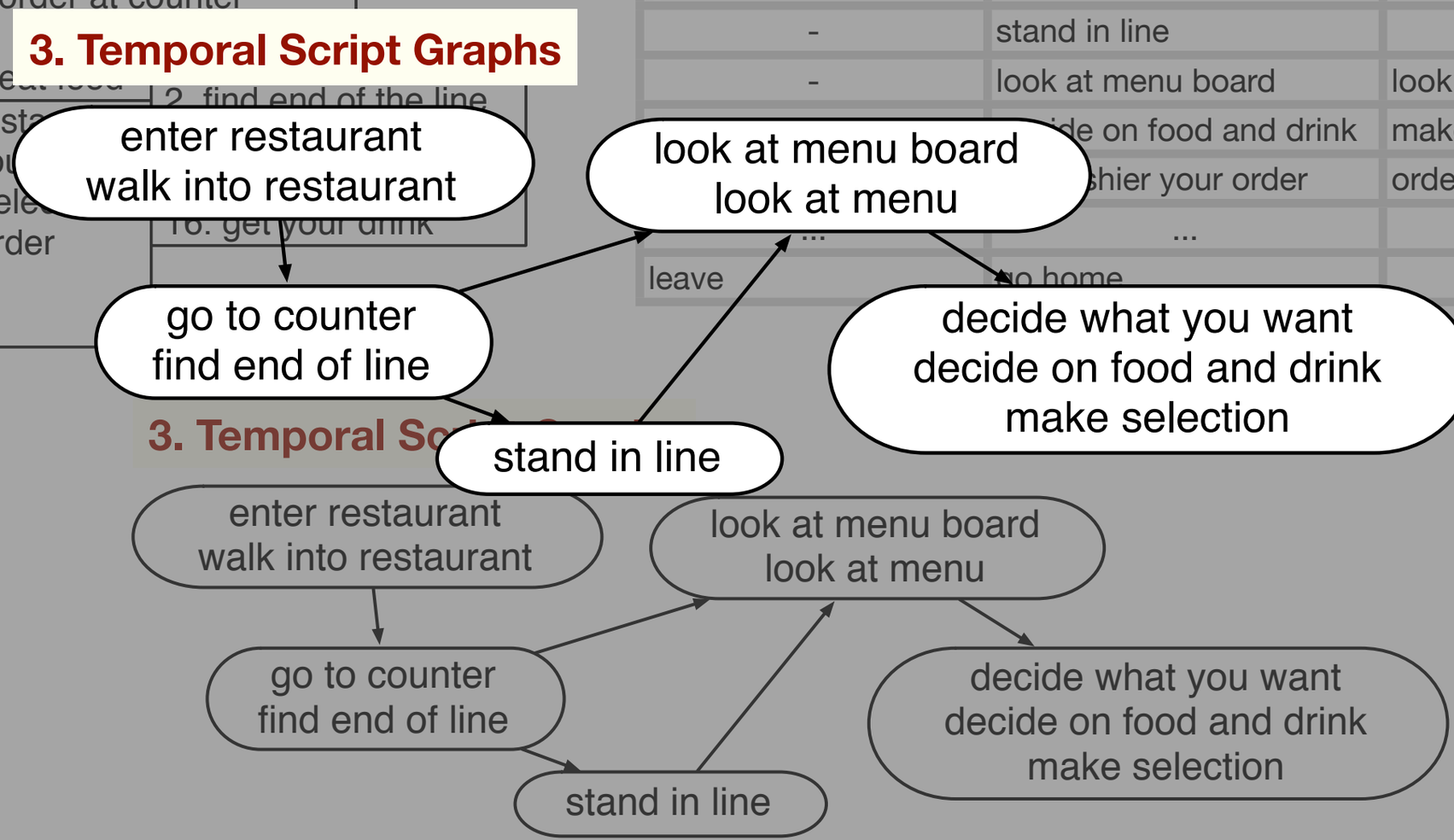
1. look at menu
2. decide what you want
3. order at counter
...
7. eat food

1. enter restaurant
2. go to counter
3. make selection
4. place order
...
10. leave

2. Sequence Alignment

enter restaurant	walk into restaurant	-
go to counter	find end of the line	-
-	stand in line	-
-	look at menu board	look at menu
...	...	...
leave	go home	-

3. Temporal Script Graphs

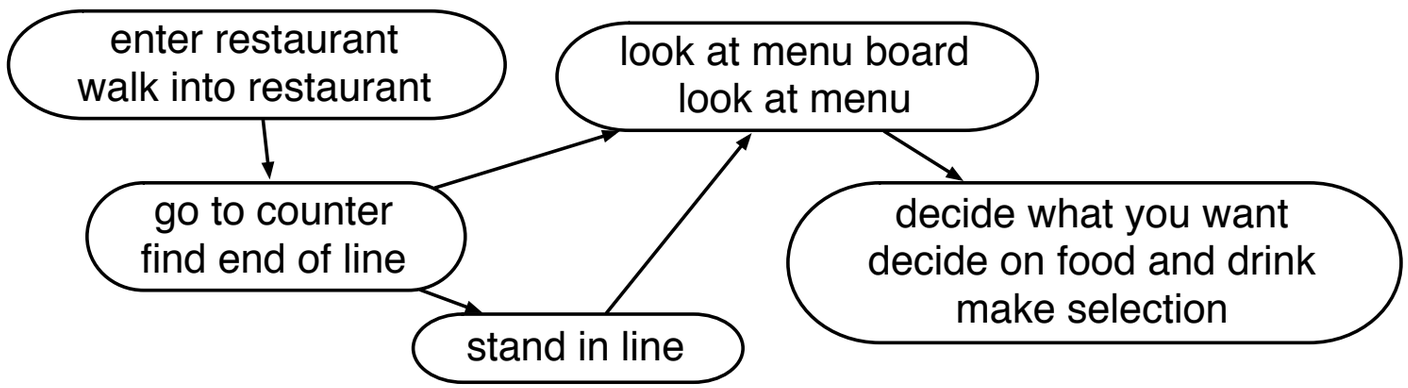


Temporal Script Graphs

- A Temporal Script Graph (TSG) is a directed graph representing events and temporal precedence constraints

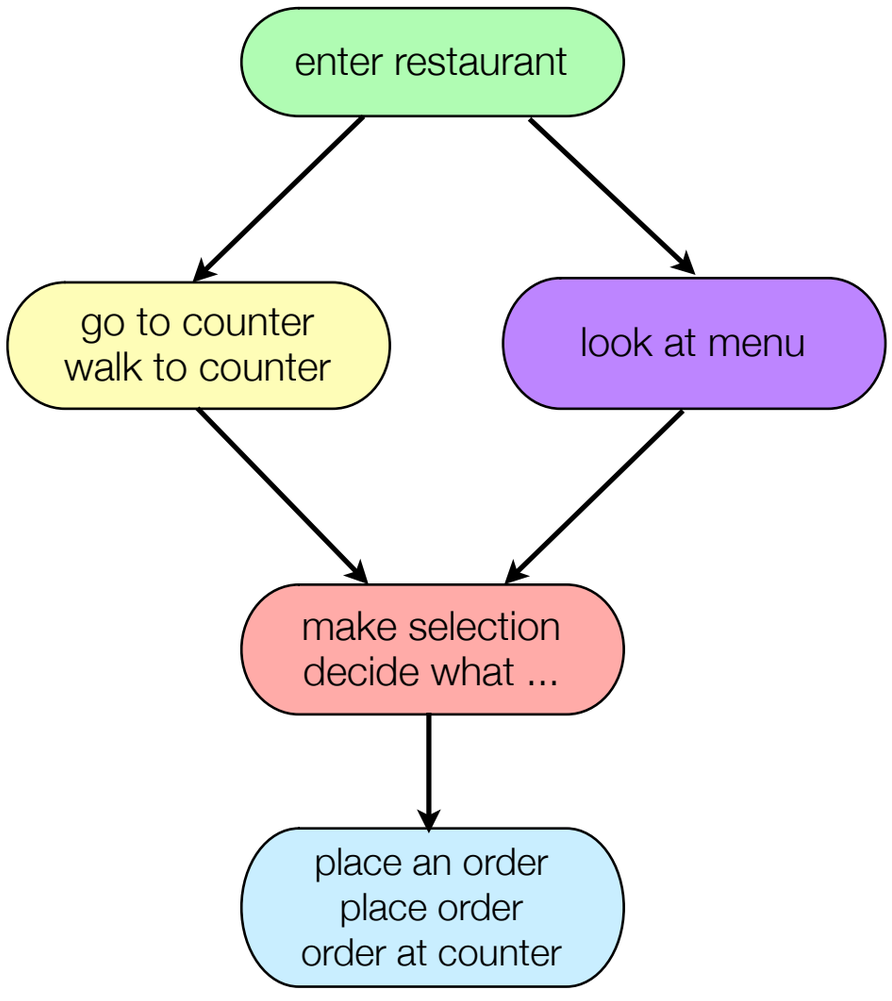
- a node (~ *event*) is a set of event descriptions (event *paraphrases*)

- an edge means that the source event typically happens before the target event



MSA ➡ Temporal Script Graphs

s1	s2	s3
enter restaurant	∅	enter restaurant
go to counter	walk to counter	∅
∅	∅	look at menu
make selection	∅	decide what you want
place an order	place order	order at counter

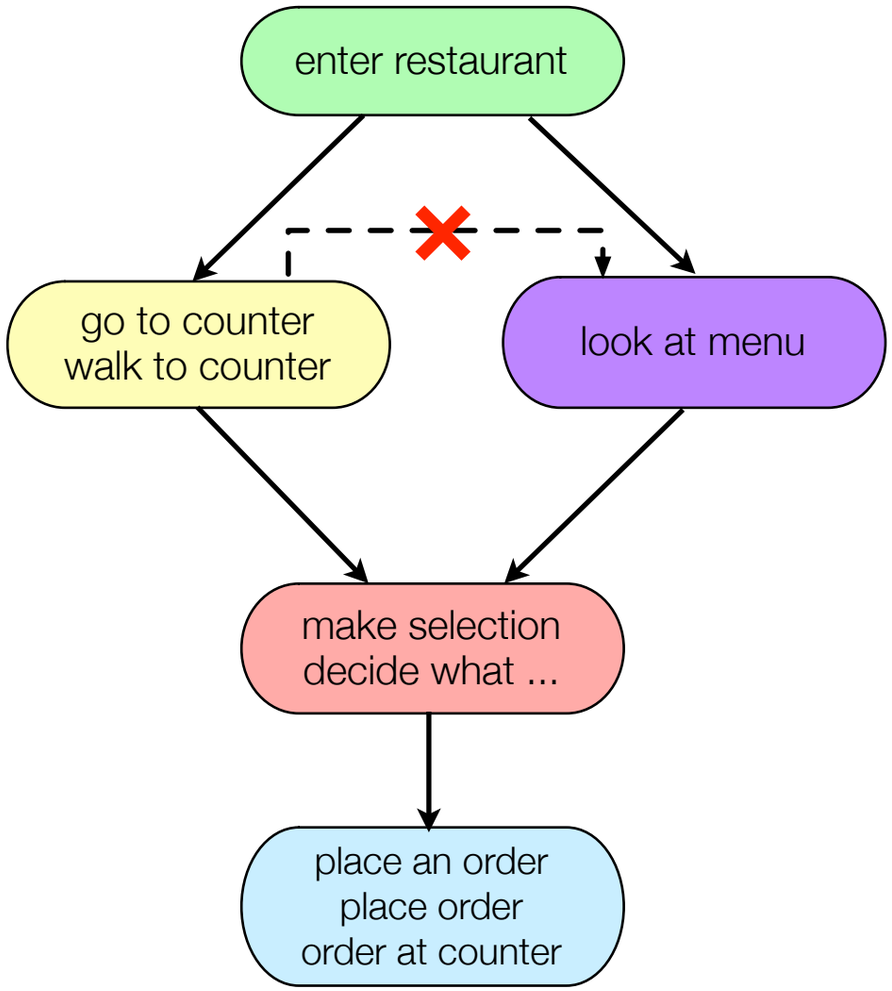


- rows become nodes

- edges reflect temporal constraints of the MSA table

MSA ➡ Temporal Script Graphs

s1	s2	s3
enter restaurant	∅	enter restaurant
go to counter	walk to counter	∅
∅	∅	look at menu
make selection	∅	decide what you want
place an order	place order	order at counter



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MSA ➡ Temporal Script Graphs

s1	s2	s3
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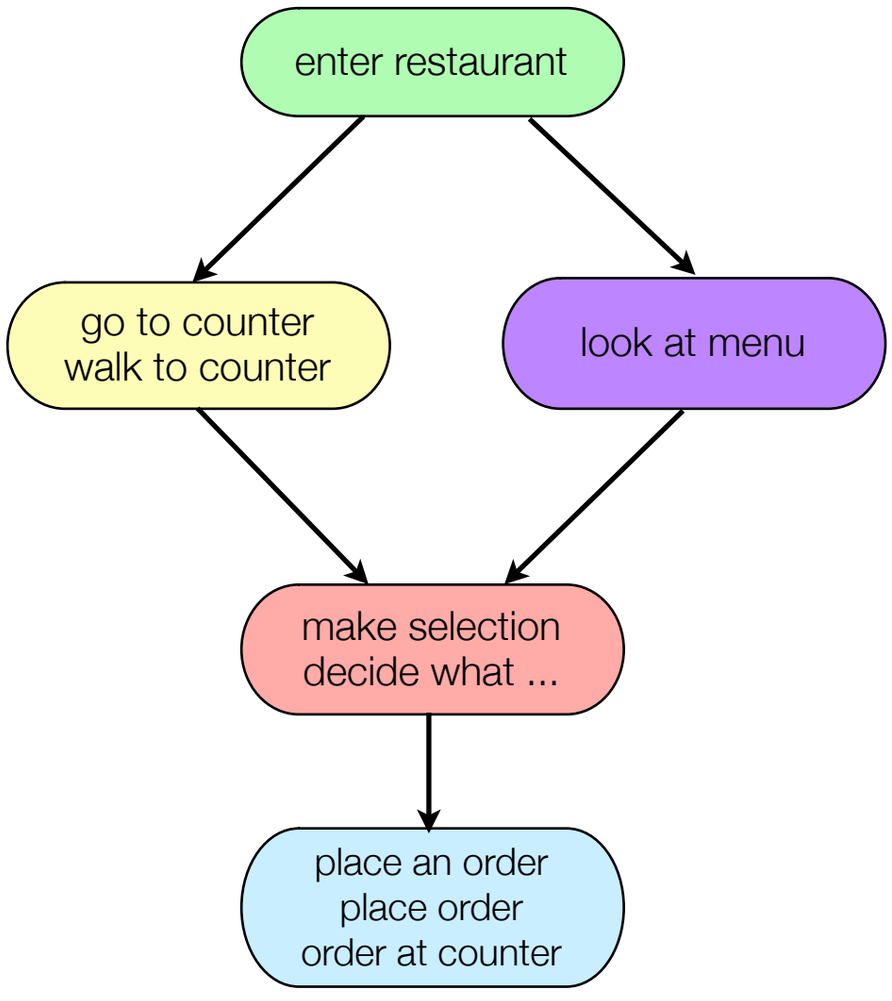
go to counter	walk to counter	∅
∅	∅	look at menu
make selection	∅	decide what you want
place an order	place order	order at counter



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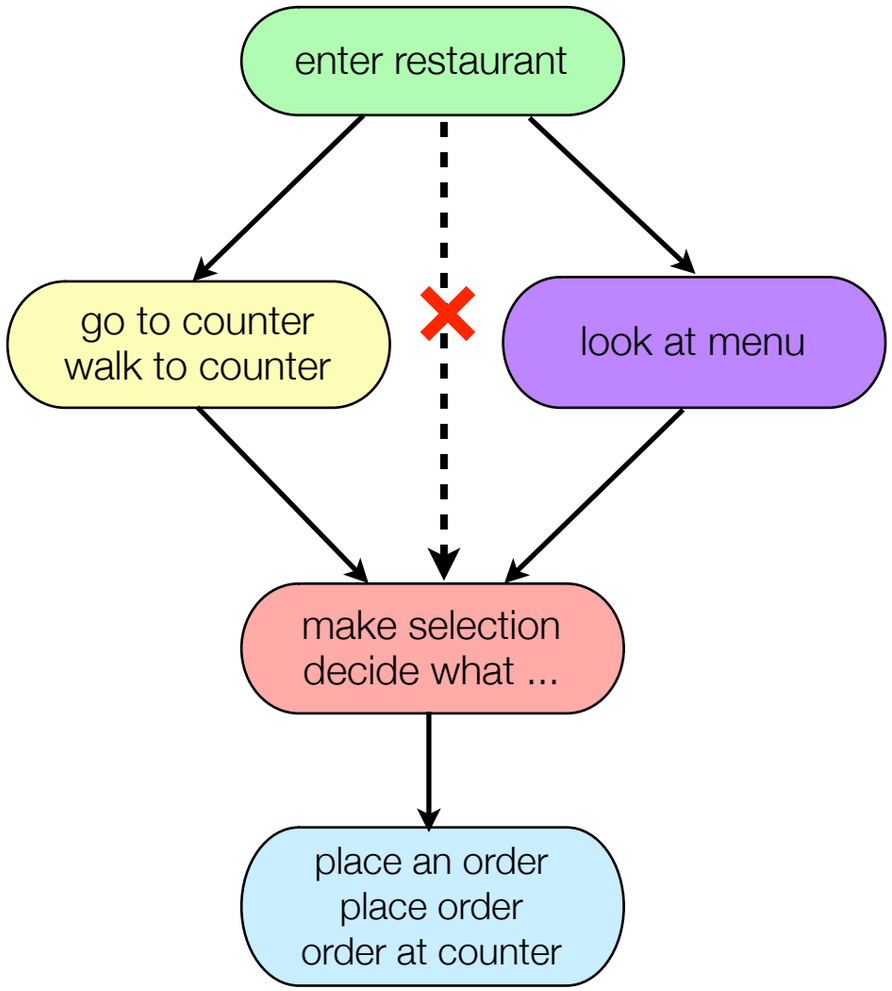


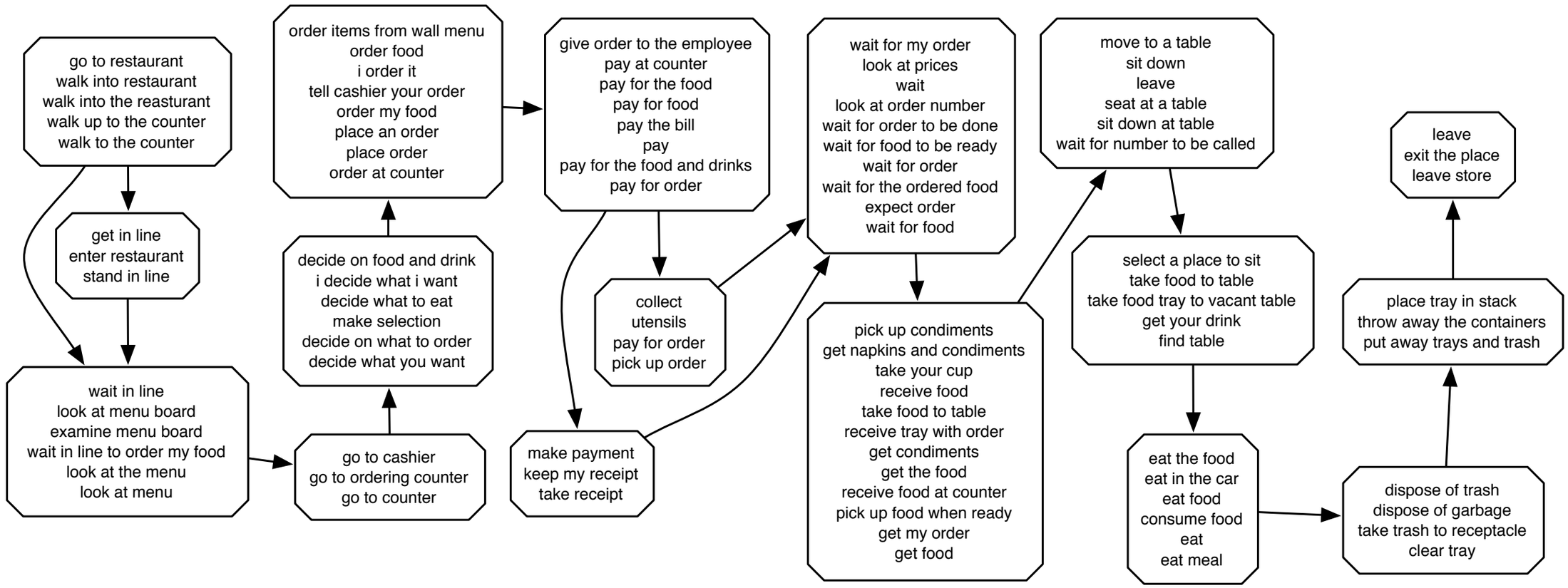
- rows become nodes

- edges reflect temporal constraints of the MSA table

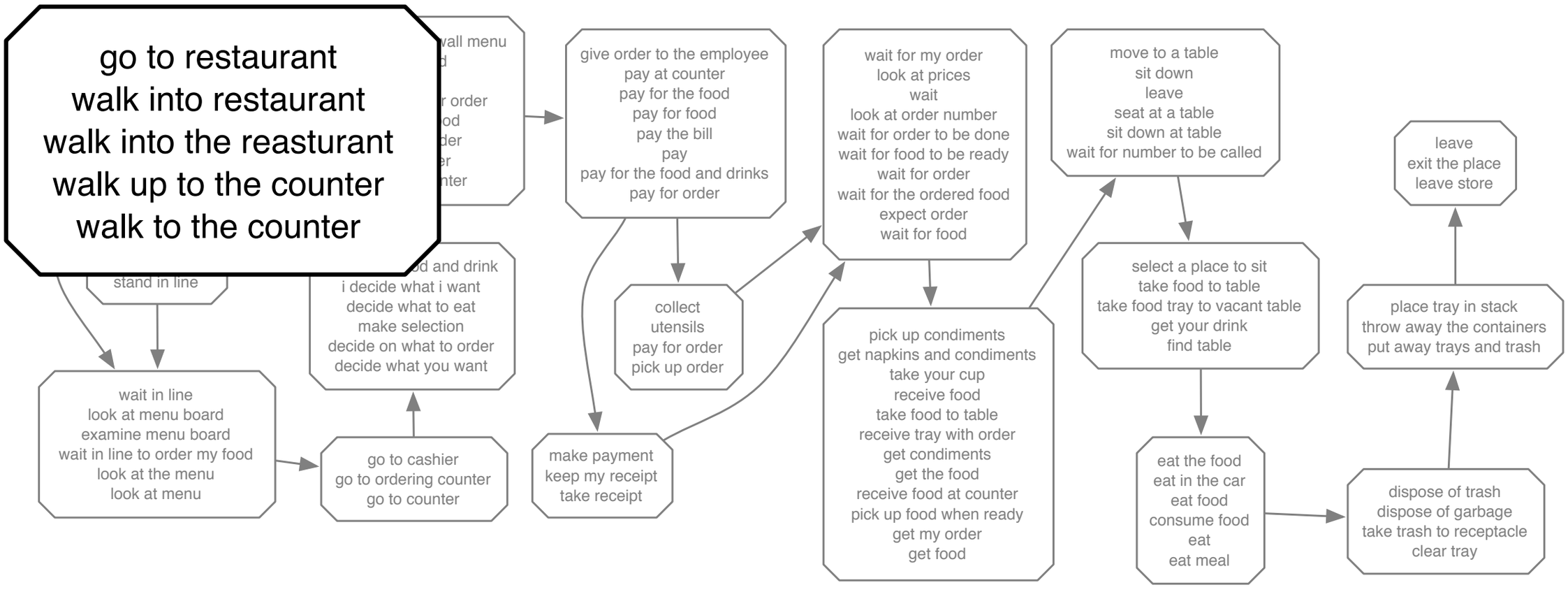
TSG post-processing

- MSA with our setup tends to produce too many nodes
- we merge nodes if they meet certain structural and semantic constraints
  - semantically, the event descriptions of the nodes have to be similar enough
  - structurally, we may not introduce temporal constraints that do not fit our input data

TSG - example


go to restaurant
walk into restaurant
walk into the reasturant
walk up to the counter
walk to the counter
get in line
enter restaurant
stand in line
wait in line
look at menu board
examine menu board
wait in line to order my food
look at the menu
look at menu
order items from wall menu
order food
i order it
tell cashier your order
order my food
place an order
place order
order at counter
decide on food and drink
i decide what i want
decide what to eat
make selection
decide on what to order
decide what you want
go to cashier
go to ordering counter
go to counter
give order to the employee
pay at counter
pay for the food
pay for food
pay the bill
pay
pay for the food and drinks
pay for order
collect
utensils
pay for order
pick up order
make payment
keep my receipt
take receipt
wait for my order
look at prices
wait
look at order number
wait for order to be done
wait for food to be ready
wait for order
wait for the ordered food
expect order
wait for food
pick up condiments
get napkins and condiments
take your cup
receive food
take food to table
receive tray with order
get condiments
get the food
receive food at counter
pick up food when ready
get my order
get food
move to a table
sit down
leave
seat at a table
sit down at table
wait for number to be called
select a place to sit
take food to table
take food tray to vacant table
get your drink
find table
eat the food
eat in the car
eat food
consume food
eat
eat meal
leave
exit the place
leave store
place tray in stack
throw away the containers
put away trays and trash
dispose of trash
dispose of garbage
take trash to receptacle
clear tray

TSG - example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make selection
decide on what to order
decide what you want
go to cashier
go to ordering counter
go to counter
give order to the employee
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pay for food
pay the bill
pay
pay for the food and drinks
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pick up order
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keep my receipt
take receipt
wait for my order
look at prices
wait
look at order number
wait for order to be done
wait for food to be ready
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wait for the ordered food
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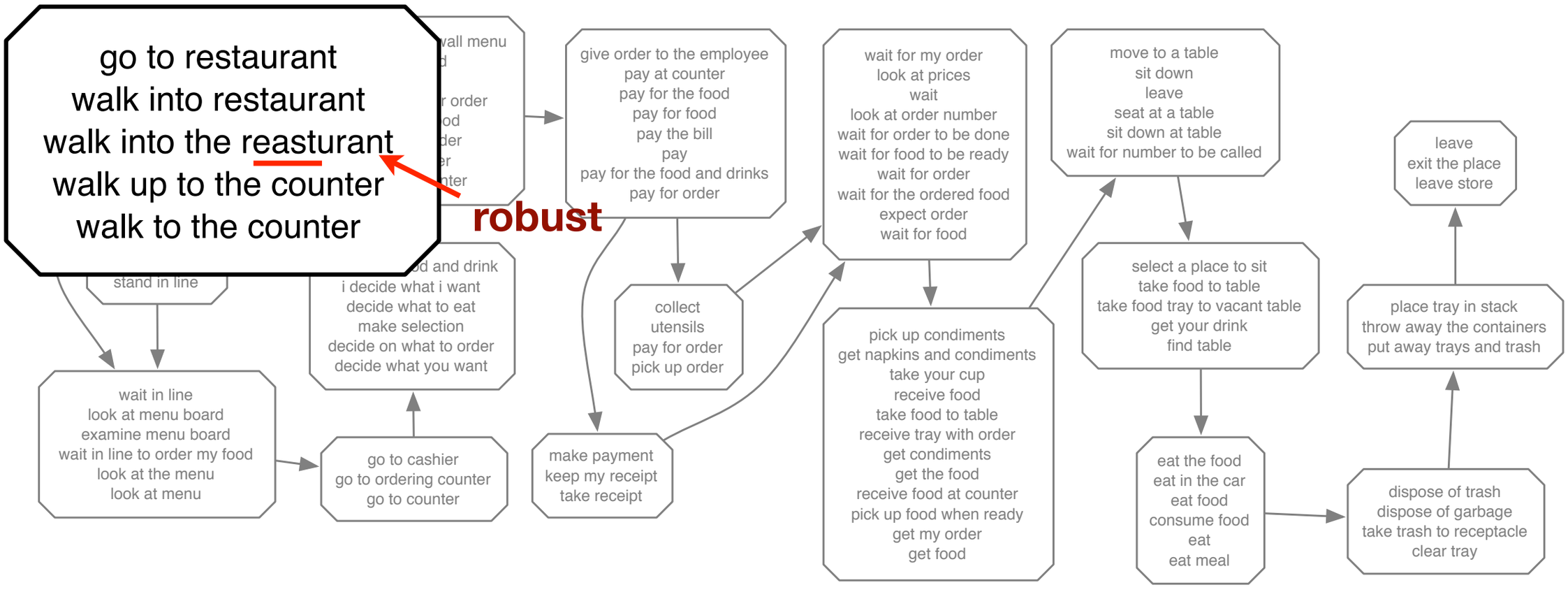
pick up condiments
get napkins and condiments
take your cup
receive food
take food to table
receive tray with order
get condiments
get the food
receive food at counter
pick up food when ready
get my order
get food
move to a table
sit down
leave
seat at a table
sit down at table
wait for number to be called
select a place to sit
take food to table
take food tray to vacant table
get your drink
find table
eat the food
eat in the car
eat food
consume food
eat
eat meal
dispose of trash
dispose of garbage
take trash to receptacle
clear tray
place tray in stack
throw away the containers
put away trays and trash
leave
exit the place
leave store

TSG - example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robust
stand in line
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look at menu board
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go to ordering counter
go to counter
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make selection
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decide what you want
give order to the employee
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pay for food
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pay for the food and drinks
pay for order
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utensils
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take receipt
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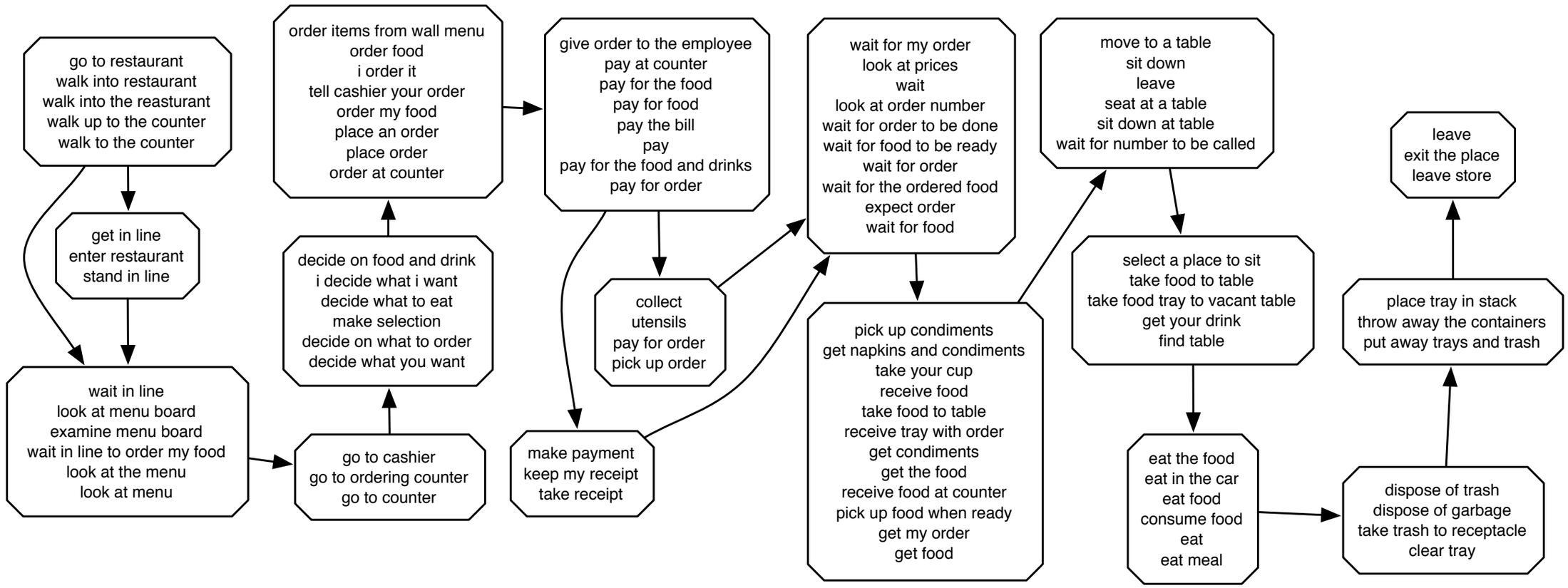
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take trash to receptacle
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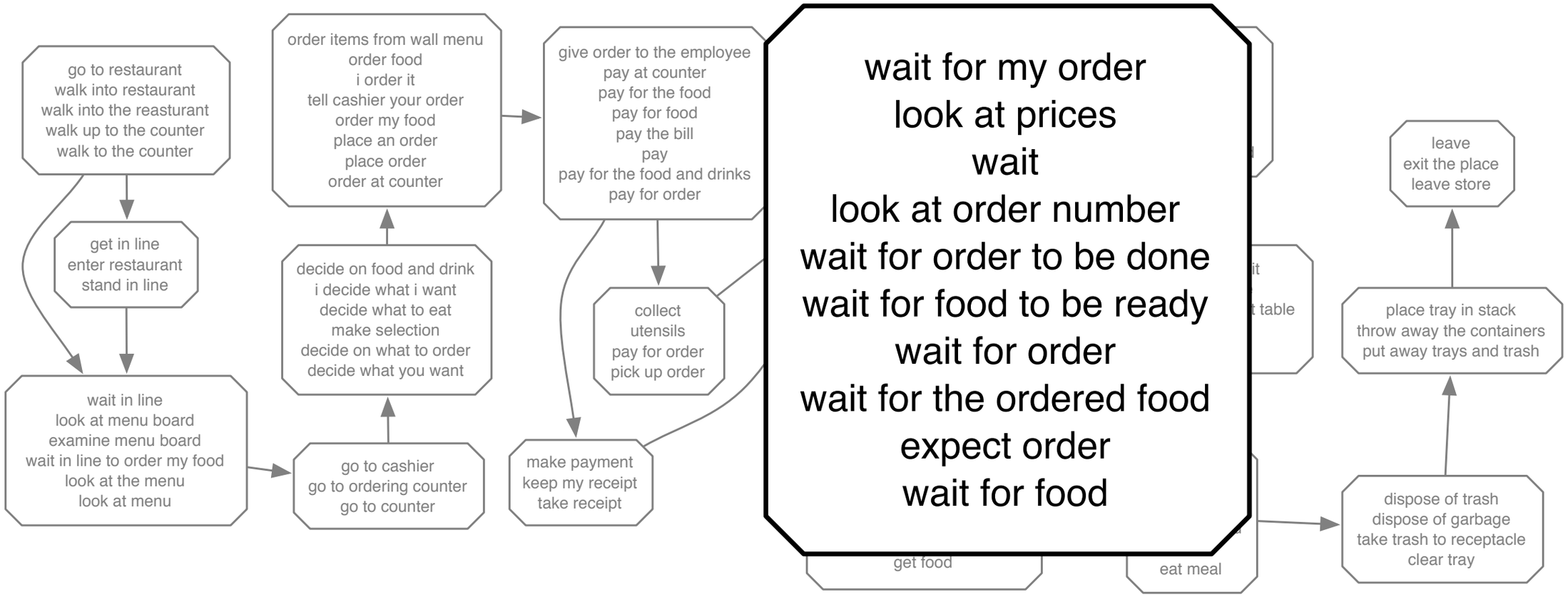
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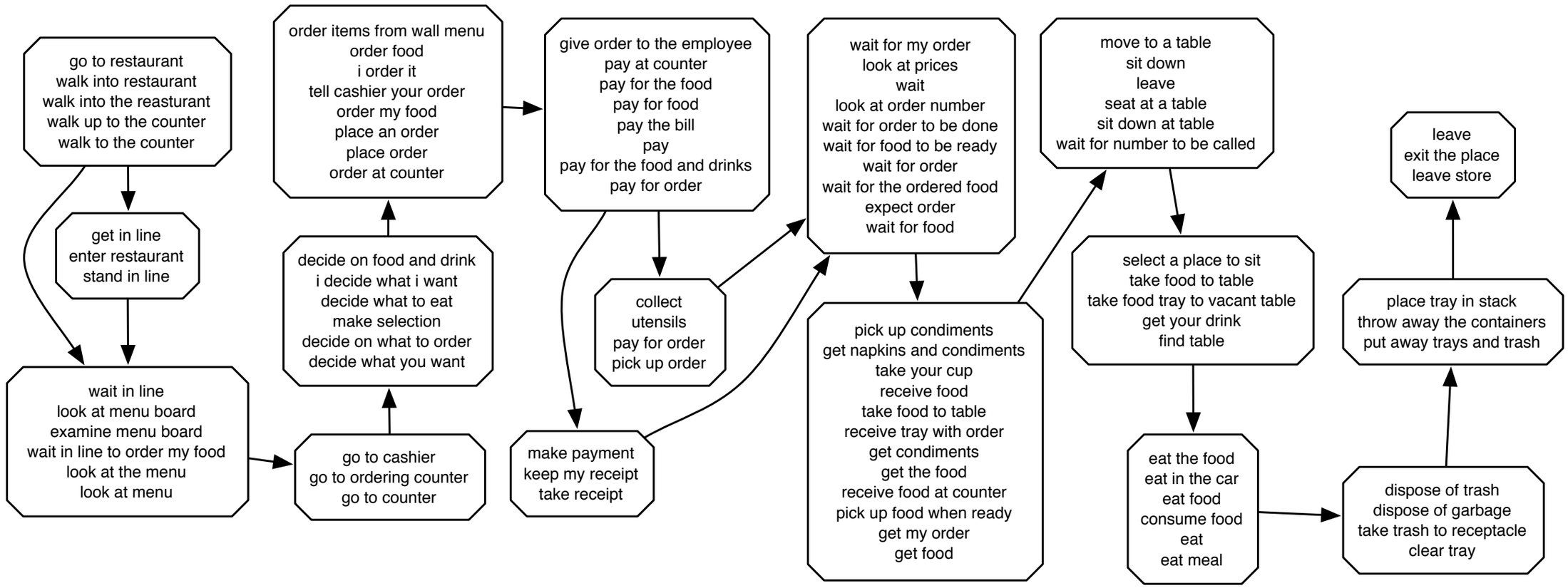
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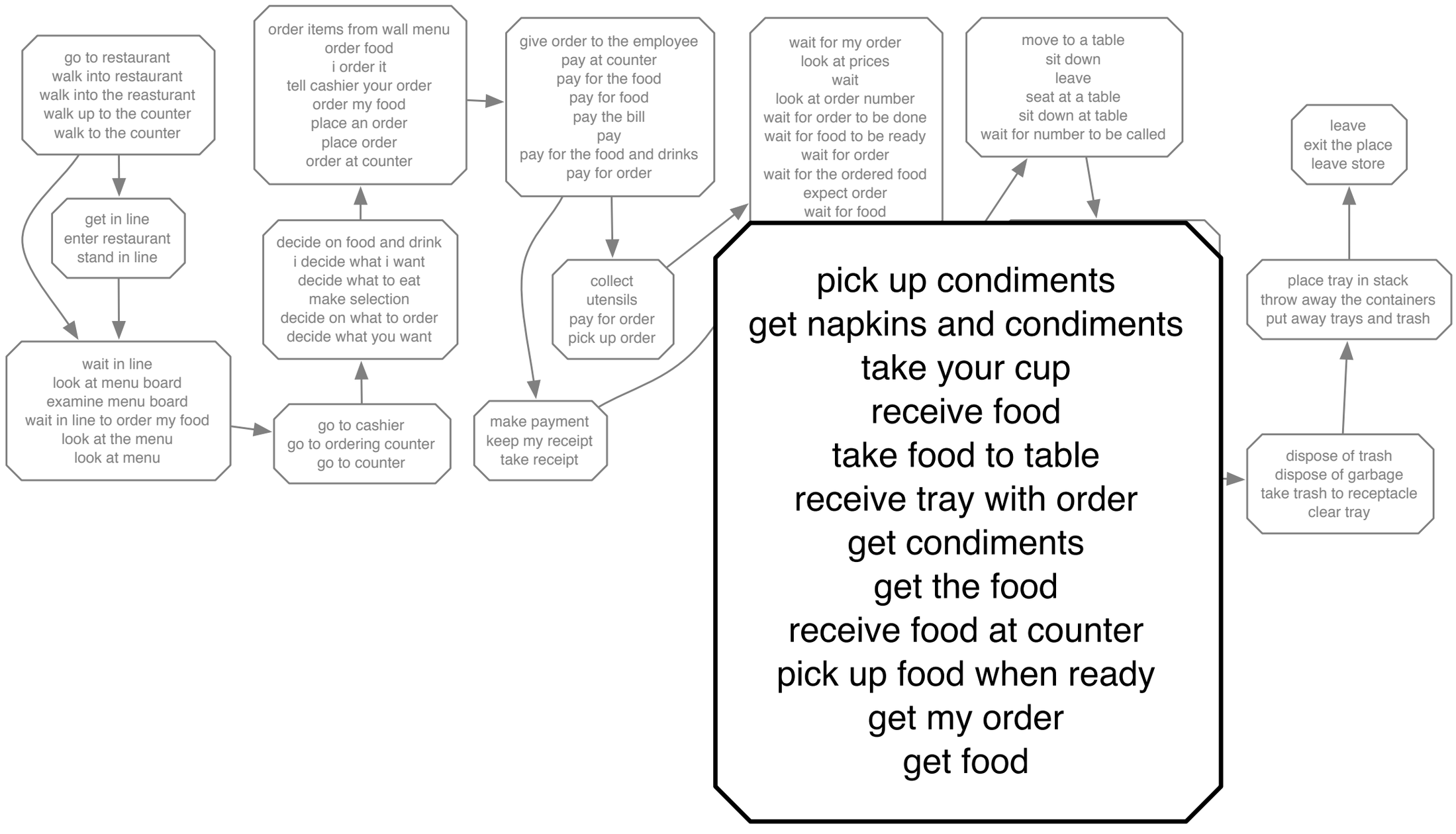
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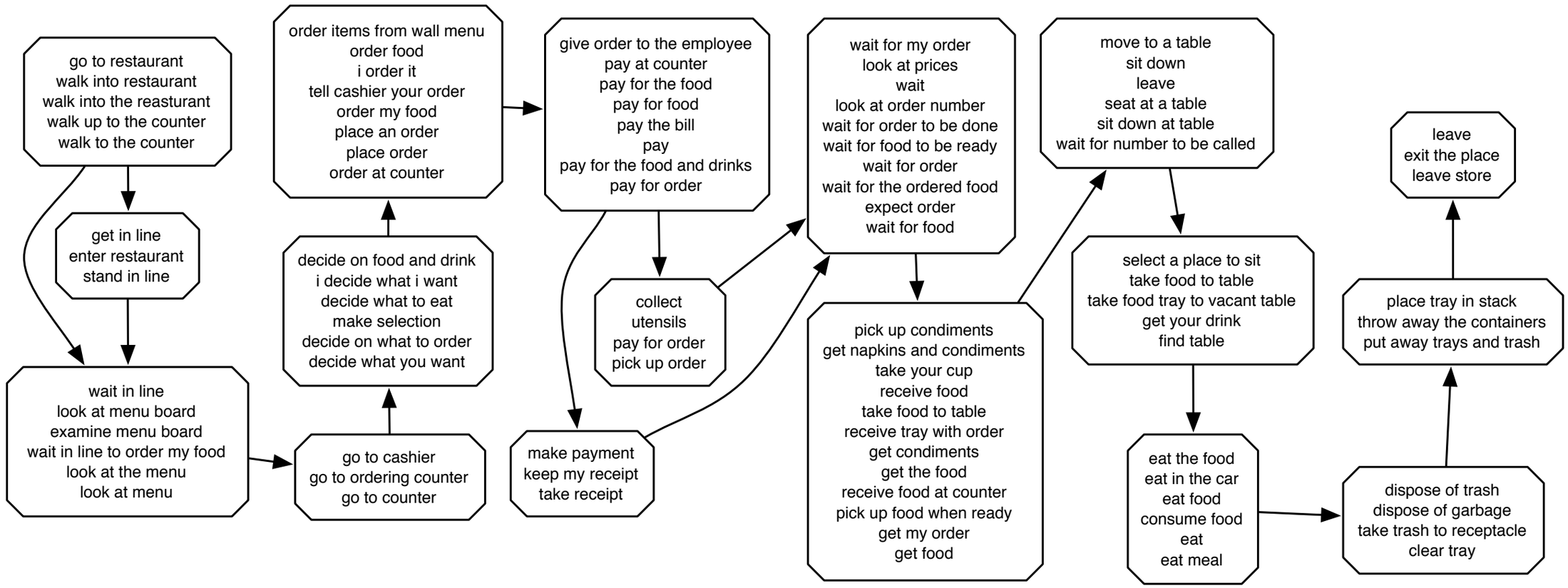
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Evaluation

- we evaluate the two core features of our algorithm:
  - recognizing event paraphrases
  - generalizing over the temporal constraints in the input (and introducing new, valid constraints)

Gold Standard

- 10 scenarios that were not used for development
- 5 from our Mechanical Turk data
- 5 from the OMICS corpus
  - OMICS data is very similar to ours
  - more instances per scenario, but restricted to indoor scenarios

Gold Standard

- two evaluation sets per scenario
- the paraphrase set:
  - 30 event description pairs our system classified as paraphrases,
  - 30 random pairs
- the happens-before set:
  - 30 event description pairs whose events had a follow-up relation in our graph
  - 30 random pairs
  - all 60 pairs in reverse order

Gold Standard

- we used Mechanical Turk and asked 5 annotators per pair (majority decision)
- question for the paraphrase task:

Imagine two people, both telling a story about SCENARIO. Could the first one say [event$_2$] to describe the same part of the story that the second one describes with [event$_1$] ?

EATING IN A FAST FOOD RESTAURANT
1: make selection
2: decide what you want

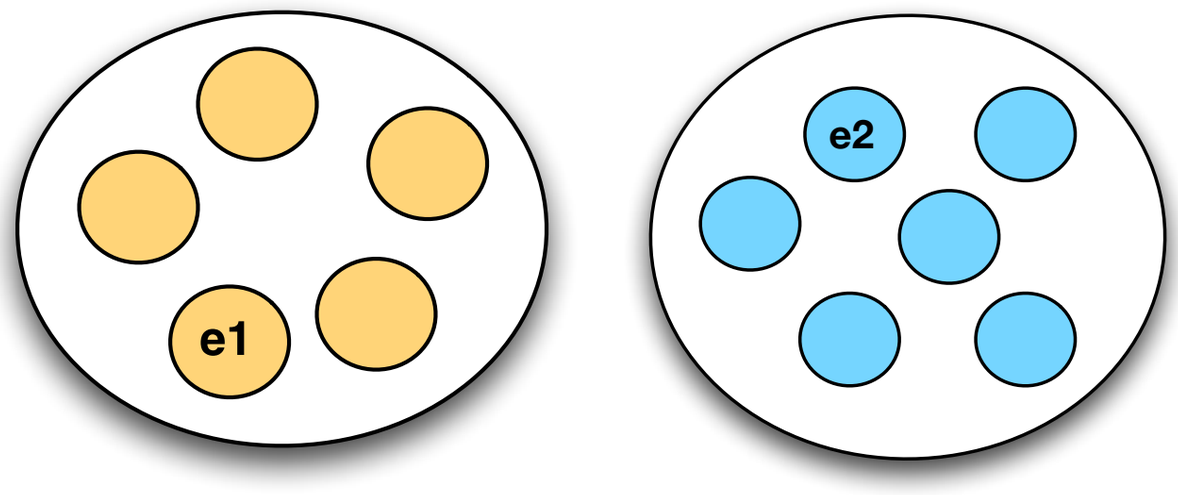
- question for the happens-before task:

Imagine somebody telling a story about SCENARIO in which the events [event$_1$] and [event$_2$] occur. Would [event$_1$] normally happen before [event$_2$]?

EATING IN A FAST FOOD RESTAURANT
1: enter restaurant
2: eat food

Clustering Baseline

- tests the contribution of MSA
- for each scenario, we take all input event descriptions and cluster them using our similarity measure
- event descriptions in the same cluster → paraphrases
- temporal order is derived from clusters and input



s1	s2	s3
…	…	…

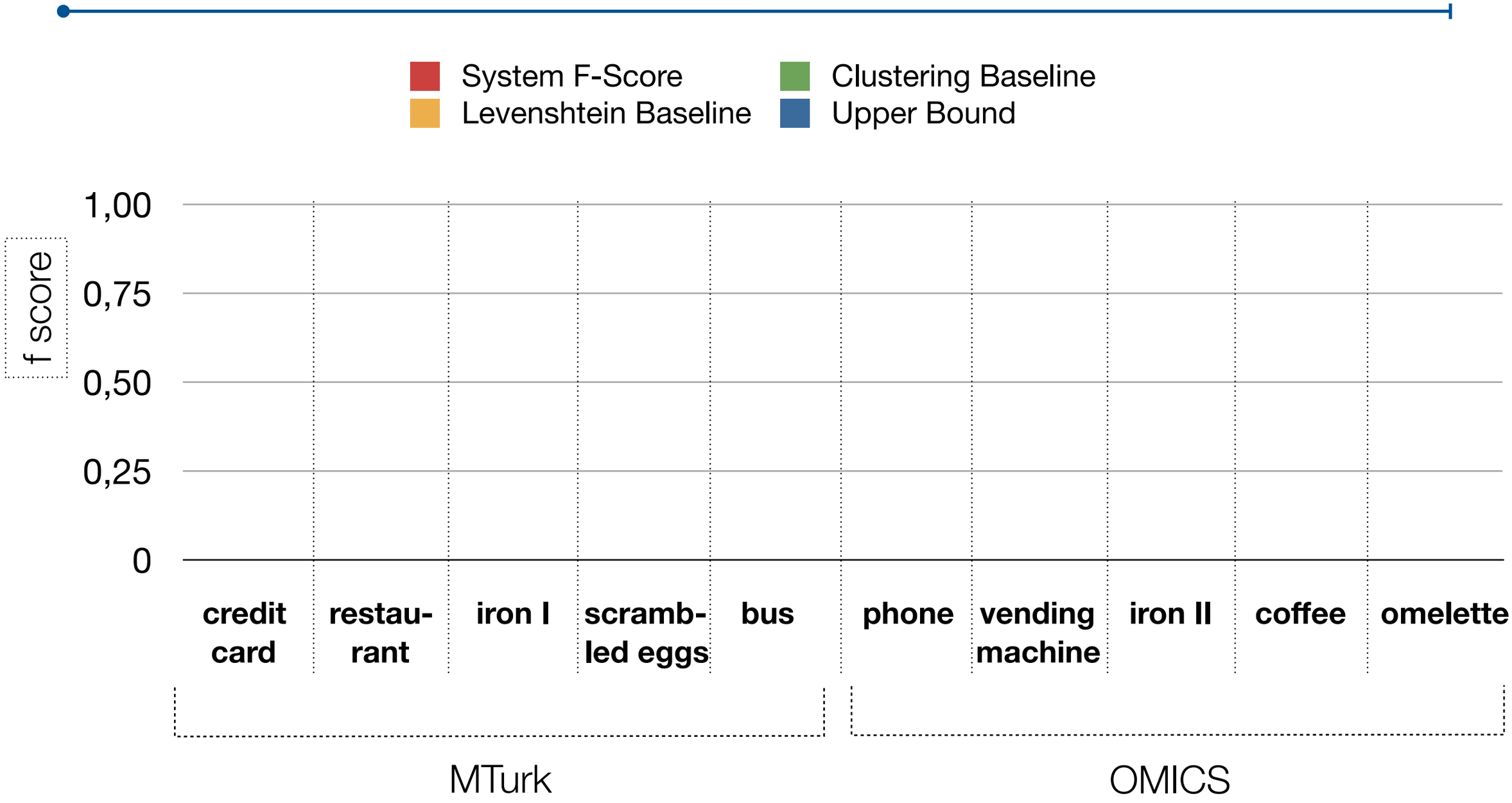
Levenshtein Baseline

- tests the contribution of our similarity measure
- we use our system, but exchange our similarity measure for Levensthein distance
- we use (character-wise) Levenshtein distance, normalized over the string length

Upper bound

- an upper bound approximating human performance (compared to the Gold Standard)
- for each pair in a task, we pick a random annotator‘s decision
- we compare this virtual random annotator to the gold standard

Results: Paraphrase Recognition



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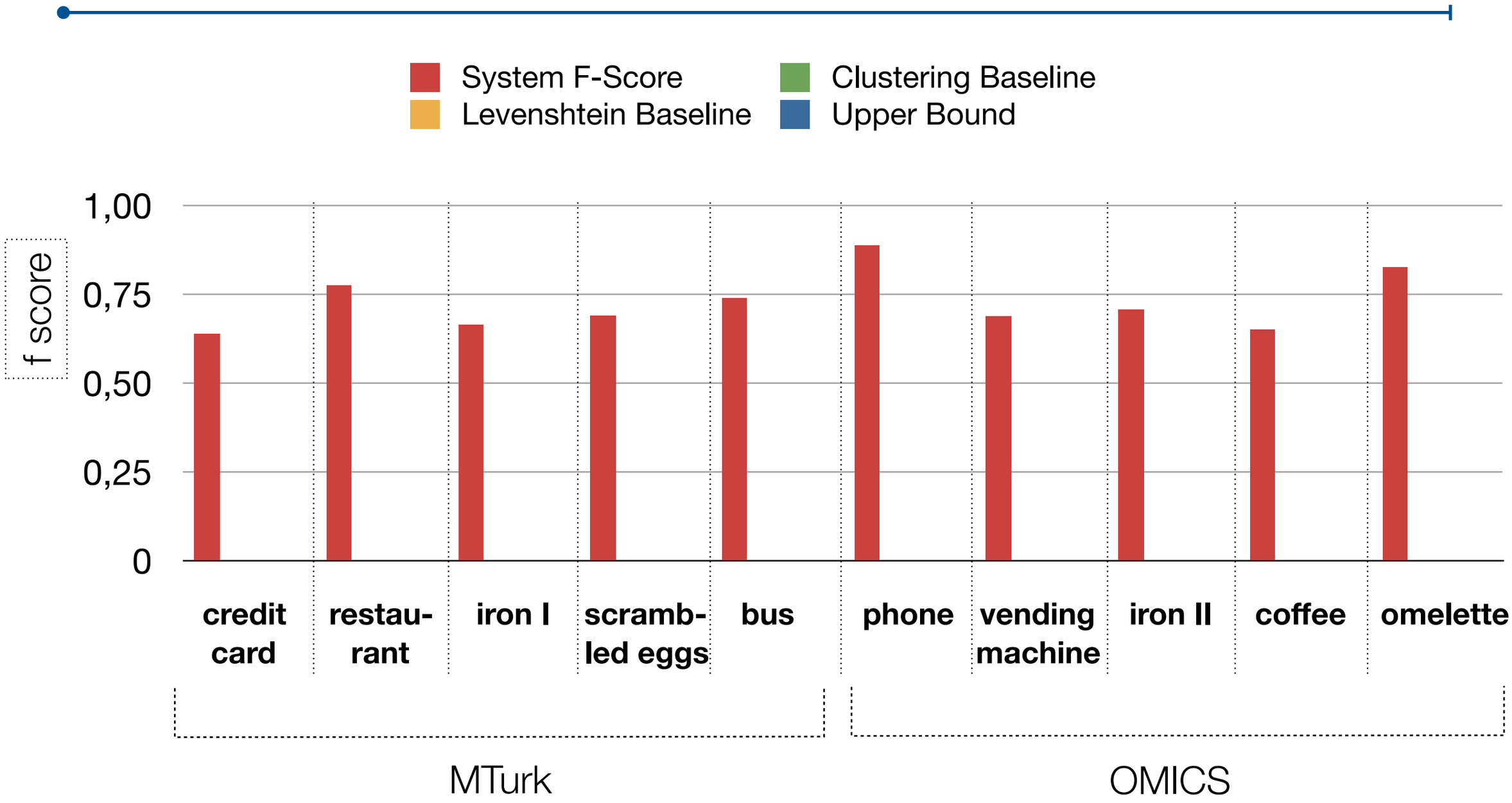

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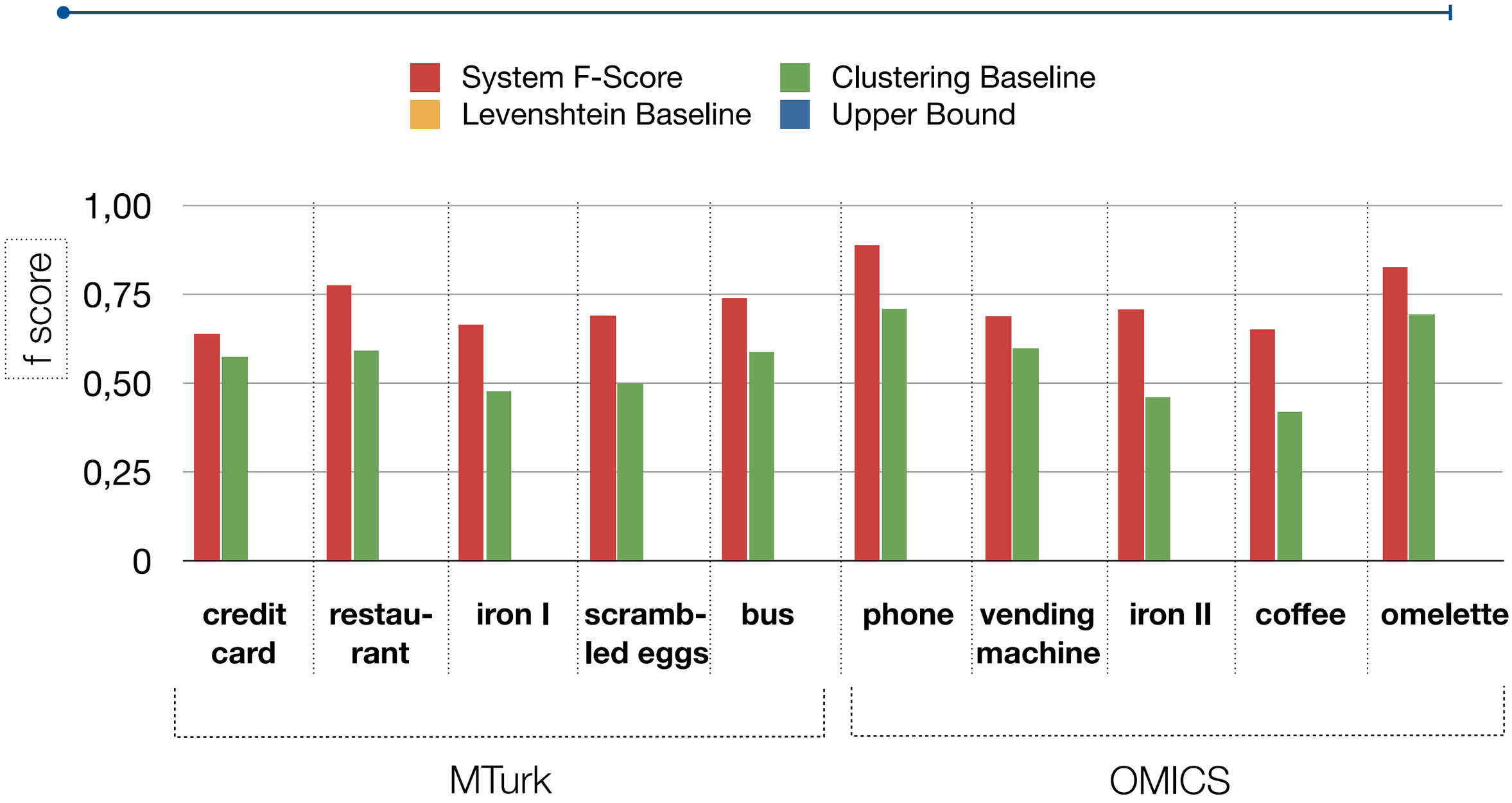

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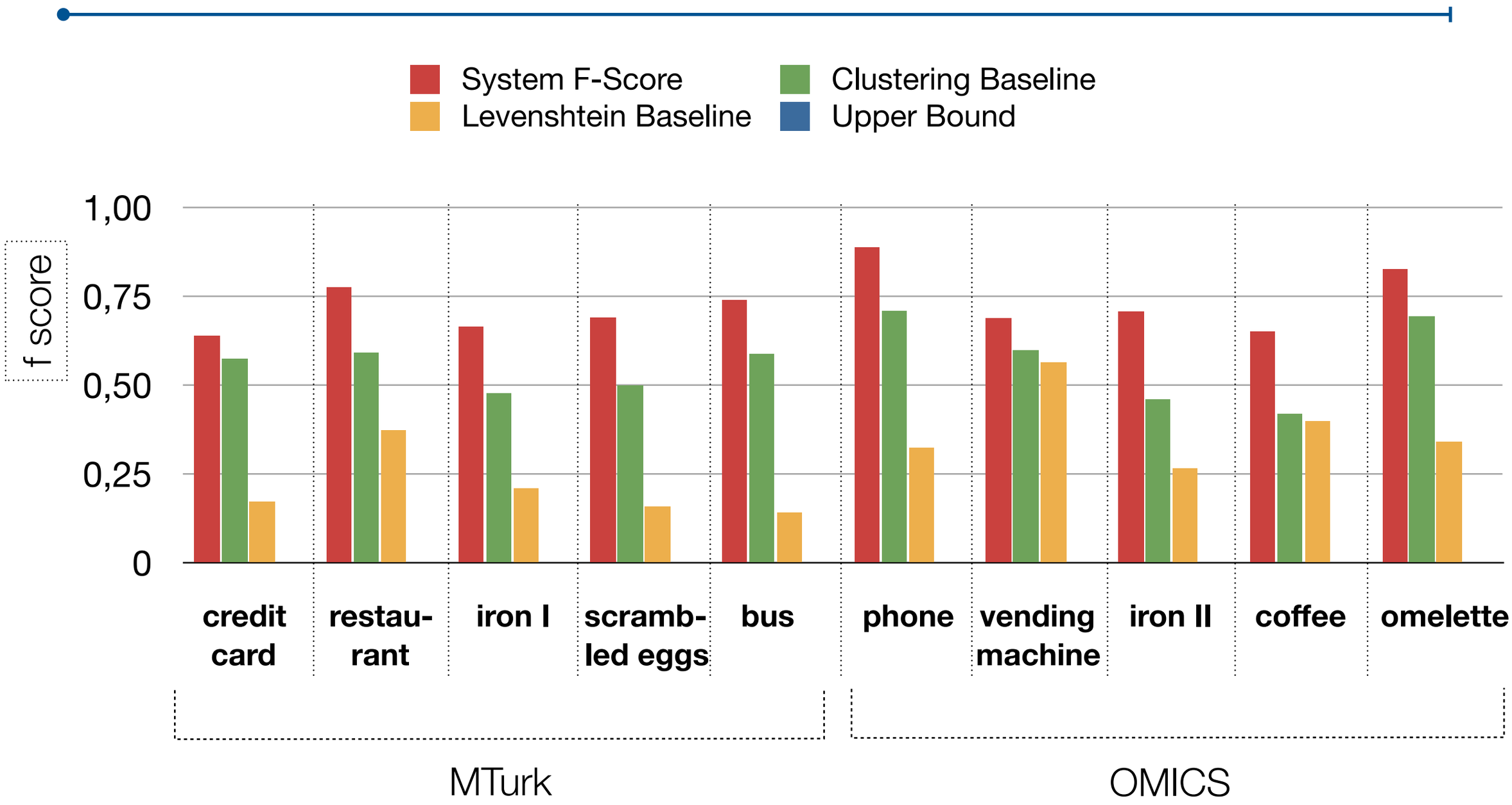

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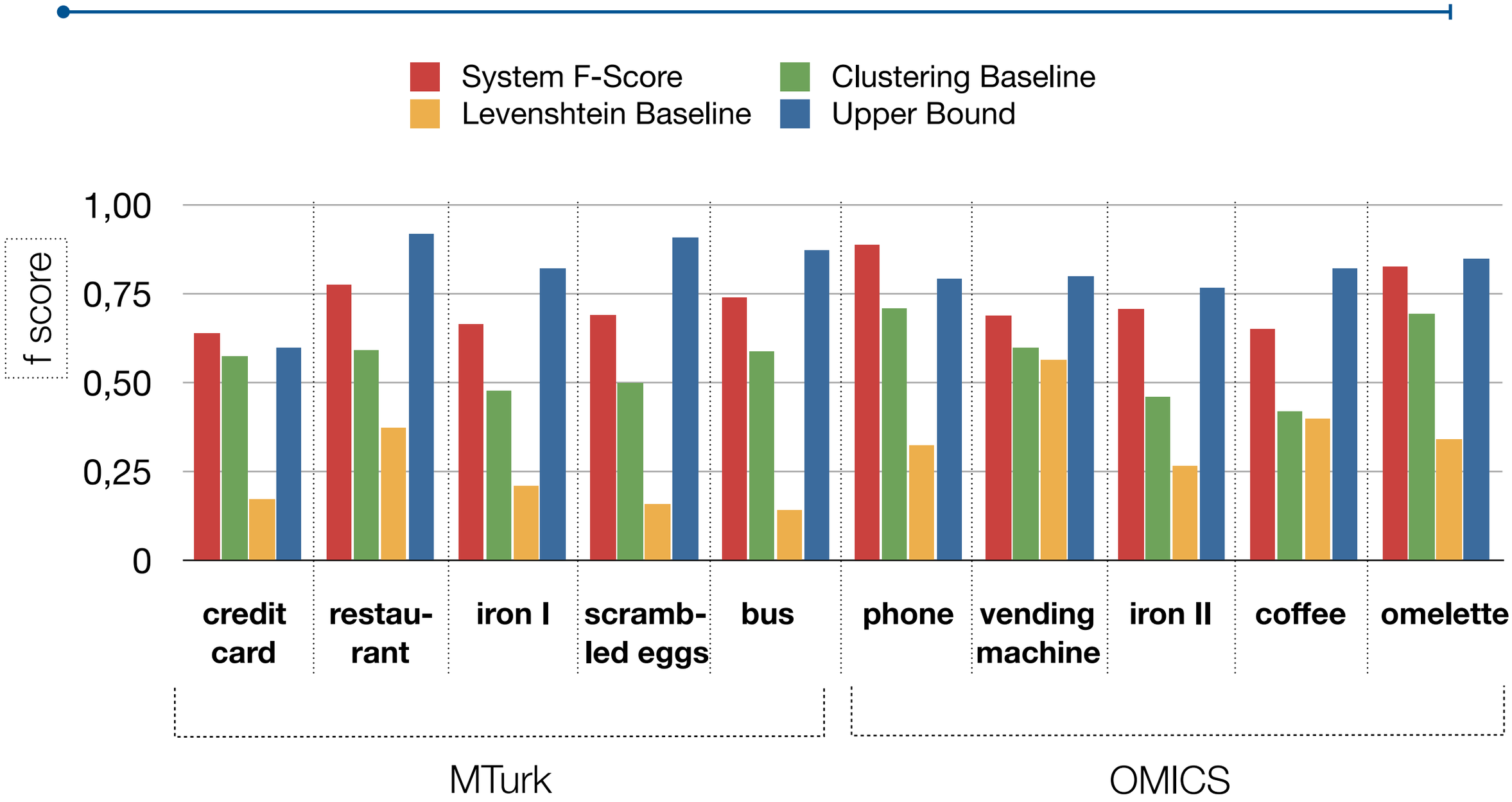
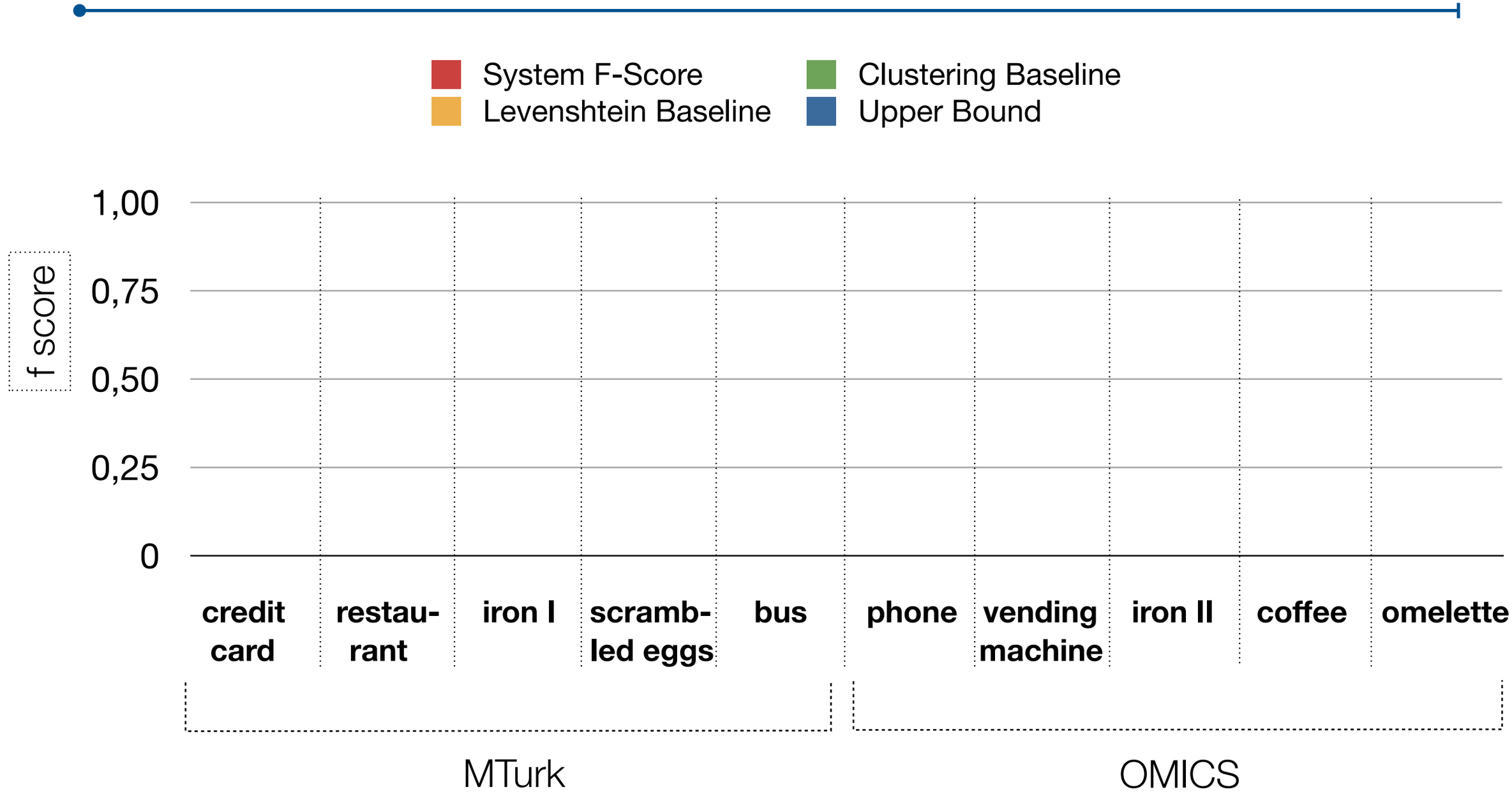


Results: Temporal Ordering



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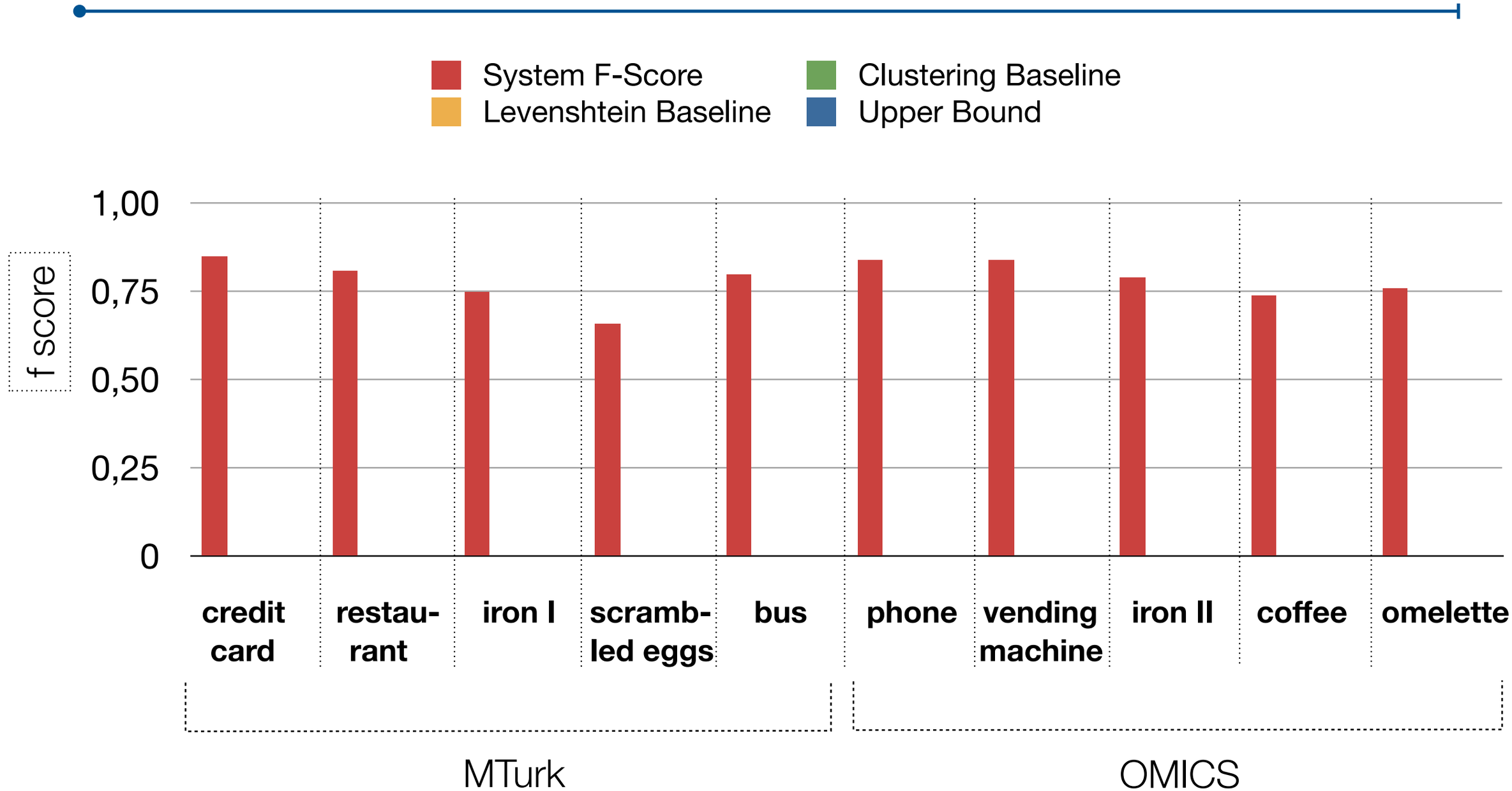

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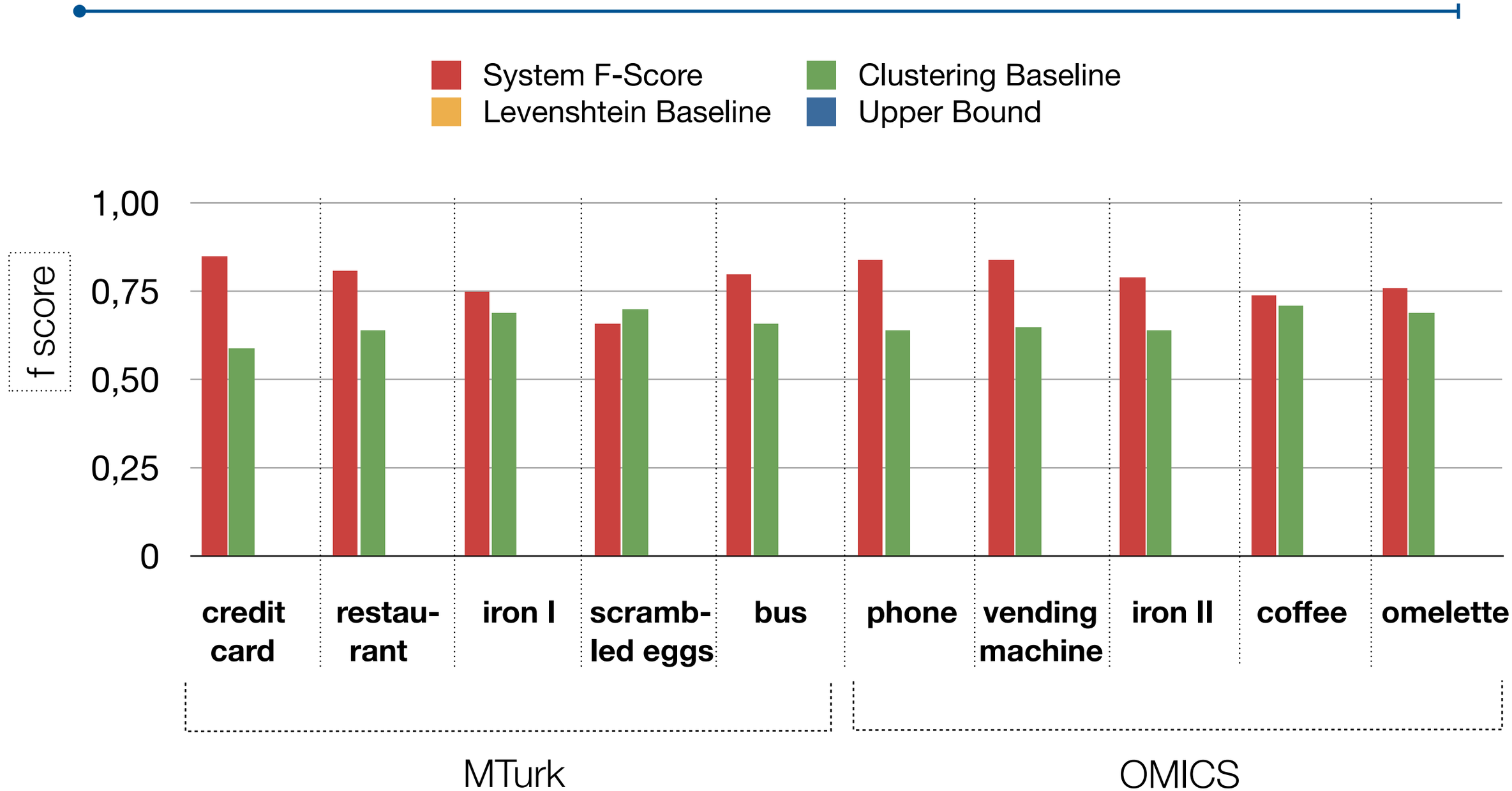

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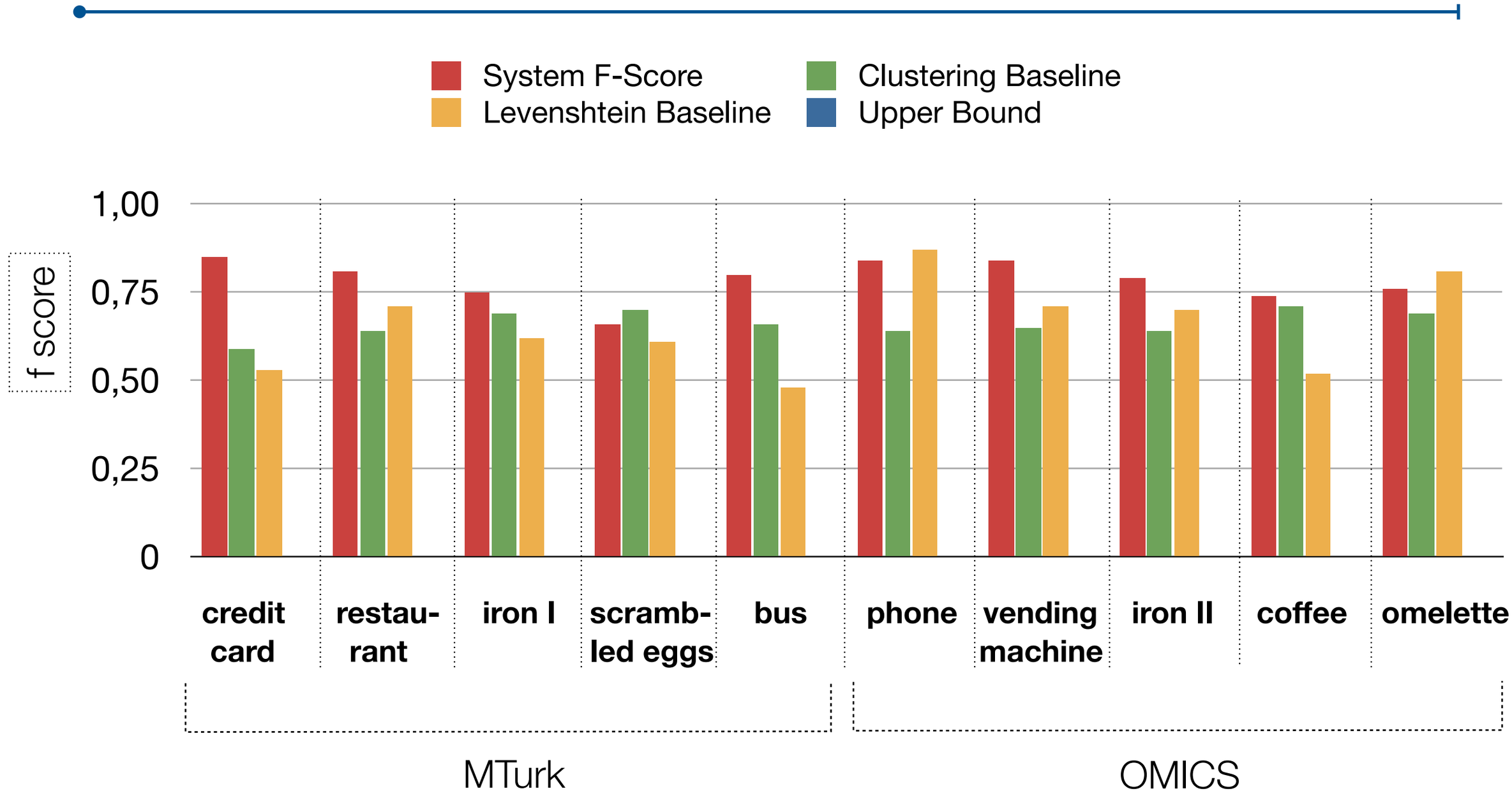

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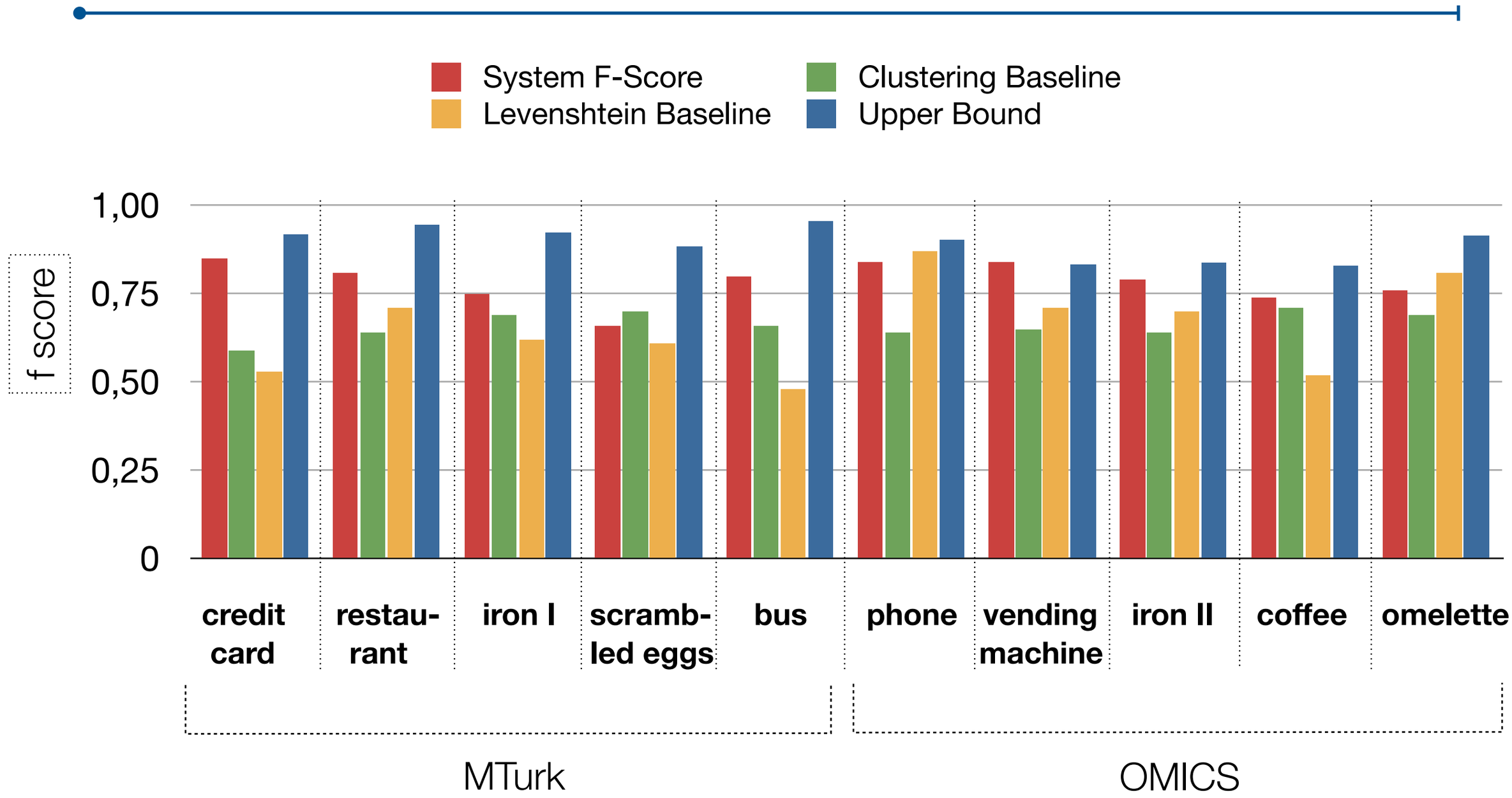
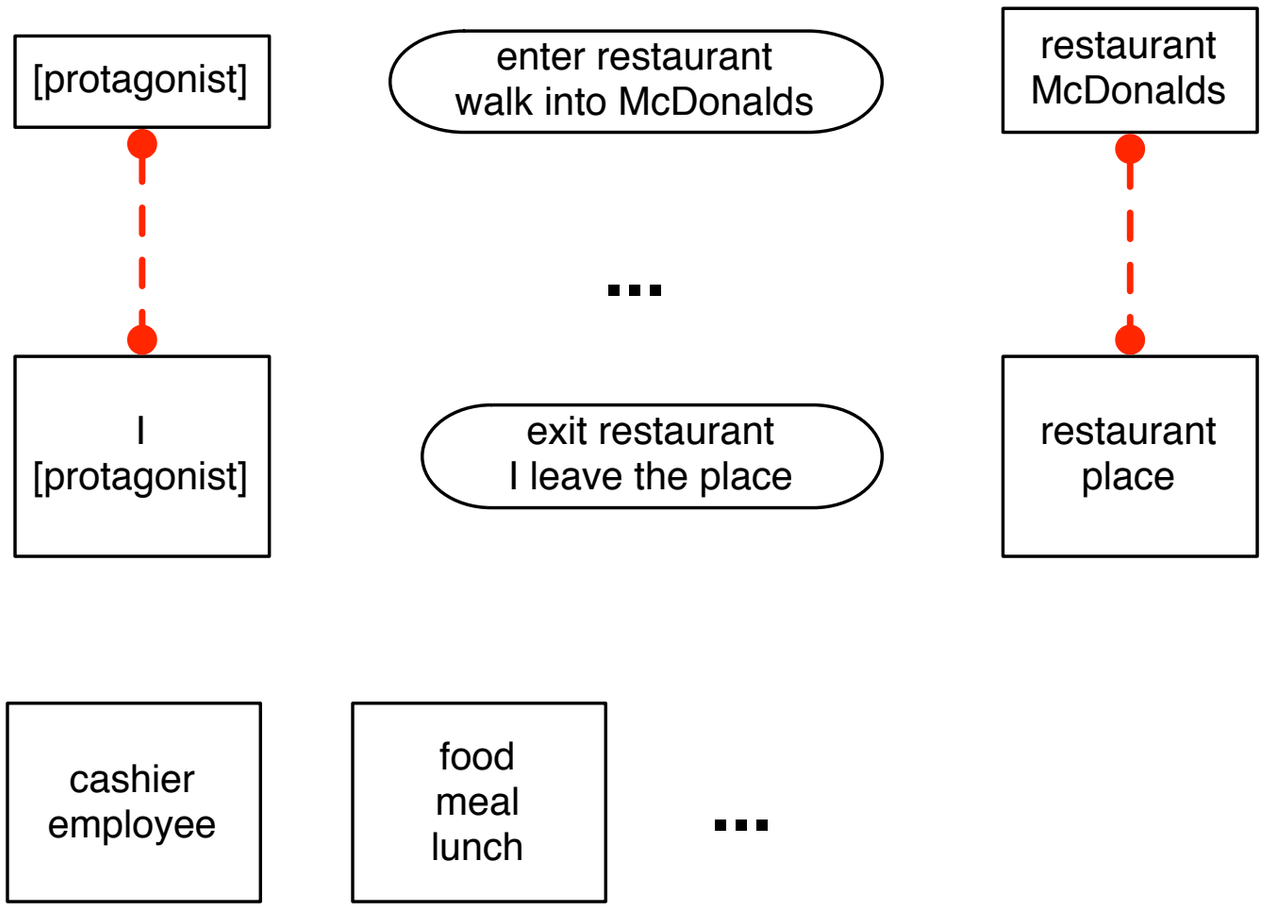


Future Work

- extract Script participants



Future Work

- find a new way for data collection (a game)
- automate preprocessing
- find a way to select new candidate scenarios automatically
- dealing with loops, alternatives and events that don‘t have a fixed order, see example...

undress	disrobe	take off clothes	take clothes off	remove clothing	get naked

		turn on water	turn on hot water		start water

step in shower	enter shower	go into shower	get in shower	get in shower

turn on water	turn on water

soap		rub with soap	apply soap		use soap

shampoo hair		shampoo hair	shampoo hair	shampoo

rinse		rinse body	rinse	rinse hair	rinse

rub with soap			rub with soap

shampoo hair		shampoo hair		shampoo hair again

rinse	rinse	rinse hair		rinse everything

• • •

undress	disrobe	take off clothes	take clothes off	remove clothing	get naked

easy

			turn on water	turn on hot water		start water
step in shower	enter shower	go into shower	get in shower	get in shower		
turn on water	turn on water					
soap		rub with soap	apply soap		use soap	
shampoo hair		shampoo hair	shampoo hair	shampoo hair	shampoo	
rinse		rinse body	rinse	rinse hair	rinse	
	rub with soap			rub with soap		
shampoo hair		shampoo hair		shampoo hair again		
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rinse	rinse	rinse hair		rinse everything

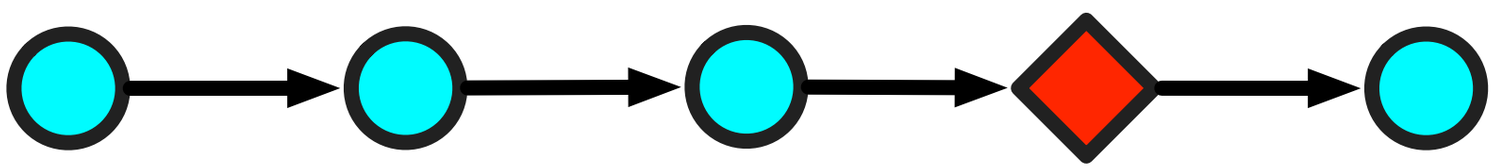
mhm.

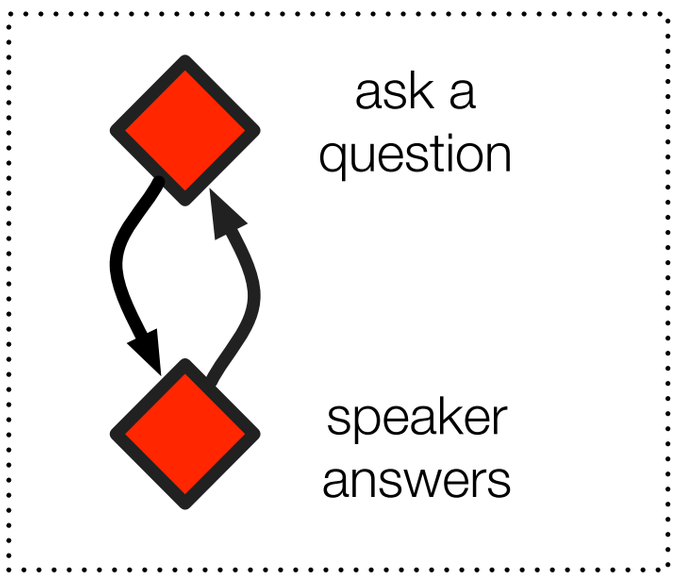
...

Summary

- Scripts, and their temporal layer
- Data collection of script instances
- Multiple Sequence Alignment to find event paraphrases
- Graph mining to get a convenient representation
- system outperforms two well-informed baselines
- nice basis for future work

Thank you!


introduce speaker
speaker begins talk
speaker concludes talk
questions, discussion w. audience
everybody leaves


ask a question
speaker answers

References

- Nathanael Chambers and Dan Jurafsky. 2009. Unsupervised learning of narrative schemas and their participants. In Proceedings of ACL-IJCNLP 2009.

- Michaela Regneri, Alexander Koller and Manfred Pinkal: Learning Script Knowledge with Web Experiments. In Proceedings of ACL 2010.

- Roger C. Schank and Robert P. Abelson. 1977. Scripts, Plans, Goals and Understanding. Lawrence Erl- baum, Hillsdale, NJ.

- The OMICS corpus: `http://openmind.hri– us.com/`