A Language Visualization System

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KOÇ UNIVERSITY

Artificial Intelligence Laboratory

Outline

- Introduction & Prior work
- Components
- Implementation
- Conclusion & Future Work

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What is language visualization?

Why are we interested in language visualization?

- A language visualization system
- A question answering module

Prior Work

- SHRDLU
- PUT System
- CarSim
- WordsEye
- DESCRIBER
- CONFUCIUS

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Components

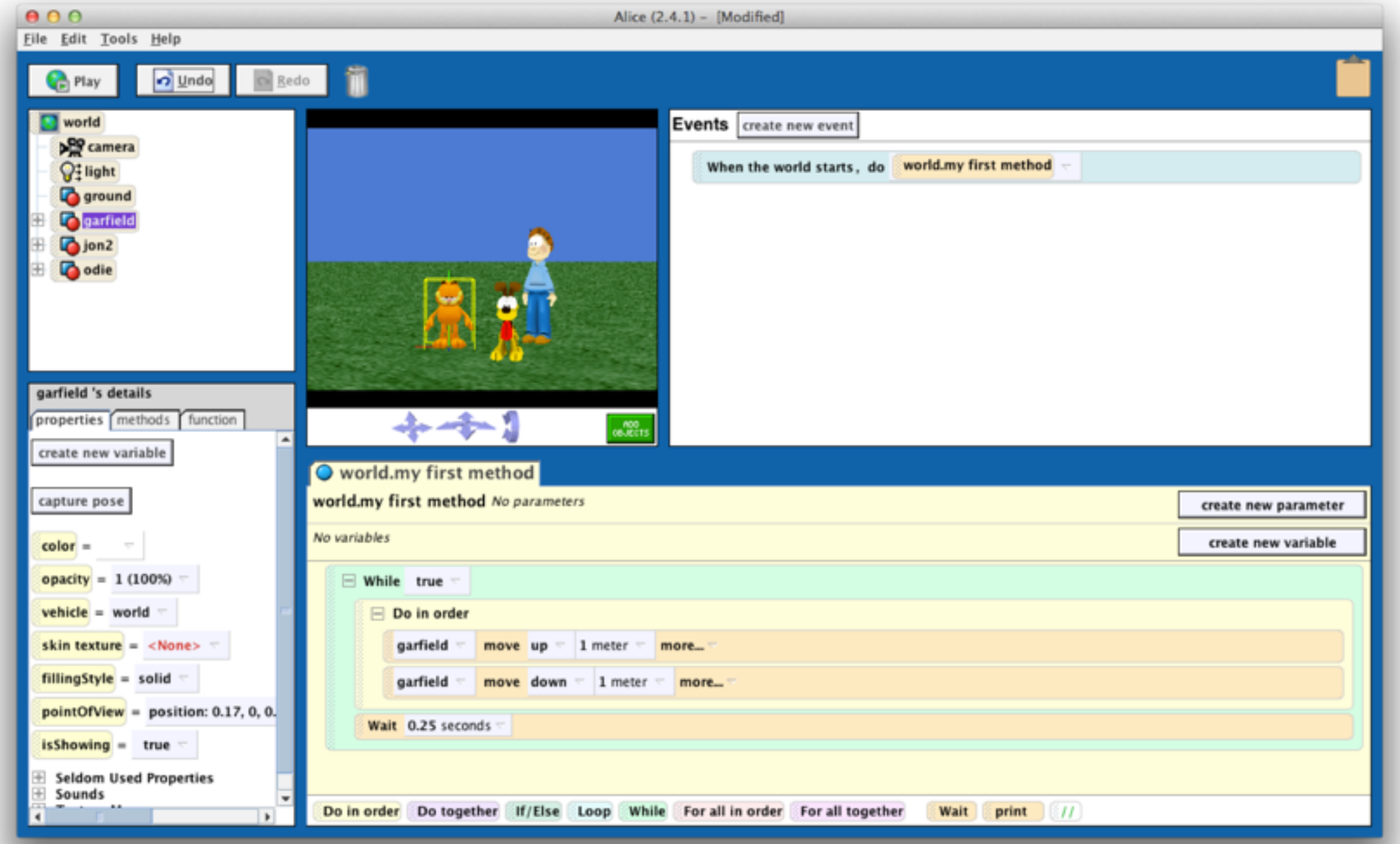
- Alice
- WordNet
- CoreNLP

Alice

- 3D programming environment
- Used mostly for educational purposes
- Open source

alice.org

Alice


Alice (2.4.1) - [Modified]
File Edit Tools Help
Play
Undo
Redo
world
camera
light
ground
garfield
jon2
odie
Events
create new event
When the world starts, do
world.my first method
garfield 's details
properties
methods
function
create new variable
capture pose
color =
opacity = 1 (100%)
vehicle = world
skin texture = <None>
fillingStyle = solid
pointOfView = position: 0.17, 0, 0.
isShowing = true
Seldom Used Properties
Sounds
ADD OBJECTS
world.my first method
world.my first method No parameters
create new parameter
No variables
create new variable
While true
Do in order
garfield move up 1 meter more...
garfield move down 1 meter more...
Wait 0.25 seconds
Do in order
Do together
If/Else
Loop
While
For all in order
For all together
Wait
print
//

Why Alice?

- Camera, light
- Model loading, texture mapping
- Model based coordinate systems, model transforms
- Extensive gallery of 3D models (528 in our system)

alice.org

WordNet

- Large lexical database of English

- Synsets of nouns, verbs, adjectives and adverbs.

- Semantic relations

- Freely available

PRINCETON UNIVERSITY

wordnet.princeton.edu

WordNet

- Main relation is synonymy.
- Synonyms form synsets.
- 117000 synsets.

WordNet

- Synonymy *e.g. board - plank*
- Antonymy *e.g. dry - wet*
- Hyponymy *e.g. dog - canine*
- Hypernymy *e.g. canine - dog*
- Meronymy *e.g. window - building*
- Holonymy *e.g. building -window*
- Troponymy *e.g. lisp - talk*
- Entailment *e.g. snore - sleep*

WordNet

Semantic Relation	Syntactic Category
Synonymy	N, V, Aj, Av
Antonymy	Aj, Av
Hyponymy	N
Hypernymy	N
Meronymy	N
Holonymy	N
Troponymy	V
Entailment	V
N: Nouns, V: Verbs, Aj: Adjectives, Av: Adverbs	

Table 3.1: Semantic Relations in WordNet

CoreNLP

- NLP tools
- Parser, NER, POS tagger, CoRef Resolution
- Open source

nlp.stanford.edu

POS Tagger

Penn Treebank Tagset			
CC	Coordinating conjunction	SYM	Symbol
CD	Cardinal number	TO	to
DT	Determiner	UH	Interjection
EX	Existential there	VB	Verb, base form
FW	Foreign word	VBD	Verb, past tense
IN	Prep. or subordinating conj.	VBG	Verb, gerund or present participle
JJ	Adjective	VBN	Verb, past participle
JJR	Adjective, comparative	VBP	Verb, non-3rd person singular present
JJS	Adjective, superlative	VBZ	Verb, 3rd person singular present
LS	List item marker	WDT	Wh-determiner
MD	Modal	WP	Wh-pronoun
NN	Noun, singular or mass	WP$	Possessive wh-pronoun
NNS	Noun, plural	WRB	Wh-adverb
NNP	Proper noun, singular	#	
NNPS	Proper noun, plural	$	
PDT	Predeterminer	”	
POS	Possessive ending	(	
PRP	Personal pronoun	)	
PRP$	Possessive pronoun	,	
RB	Adverb	.	
RBR	Adverb, comparative	:	
RBS	Adverb, superlative	“	
RP	Particle		

Table A.1: Penn Treebank POS Tags

Parser

- Outputs phrase structure tree

- Stanford dependencies

The cat is on the table.

The/DT cat/NN is/VBZ on/IN the/DT table/NN ./.

```
(ROOT
 (S
  (NP (DT The) (NN cat))
  (VP (VBZ is)
   (PP (IN on)
    (NP (DT the) (NN table))))
  (. .)))
```

```
det(cat-2, The-1)
nsubj(is-3, cat-2)
root(ROOT-0, is-3)
det(table-6, the-5)
prep_on(is-3, table-6)
```

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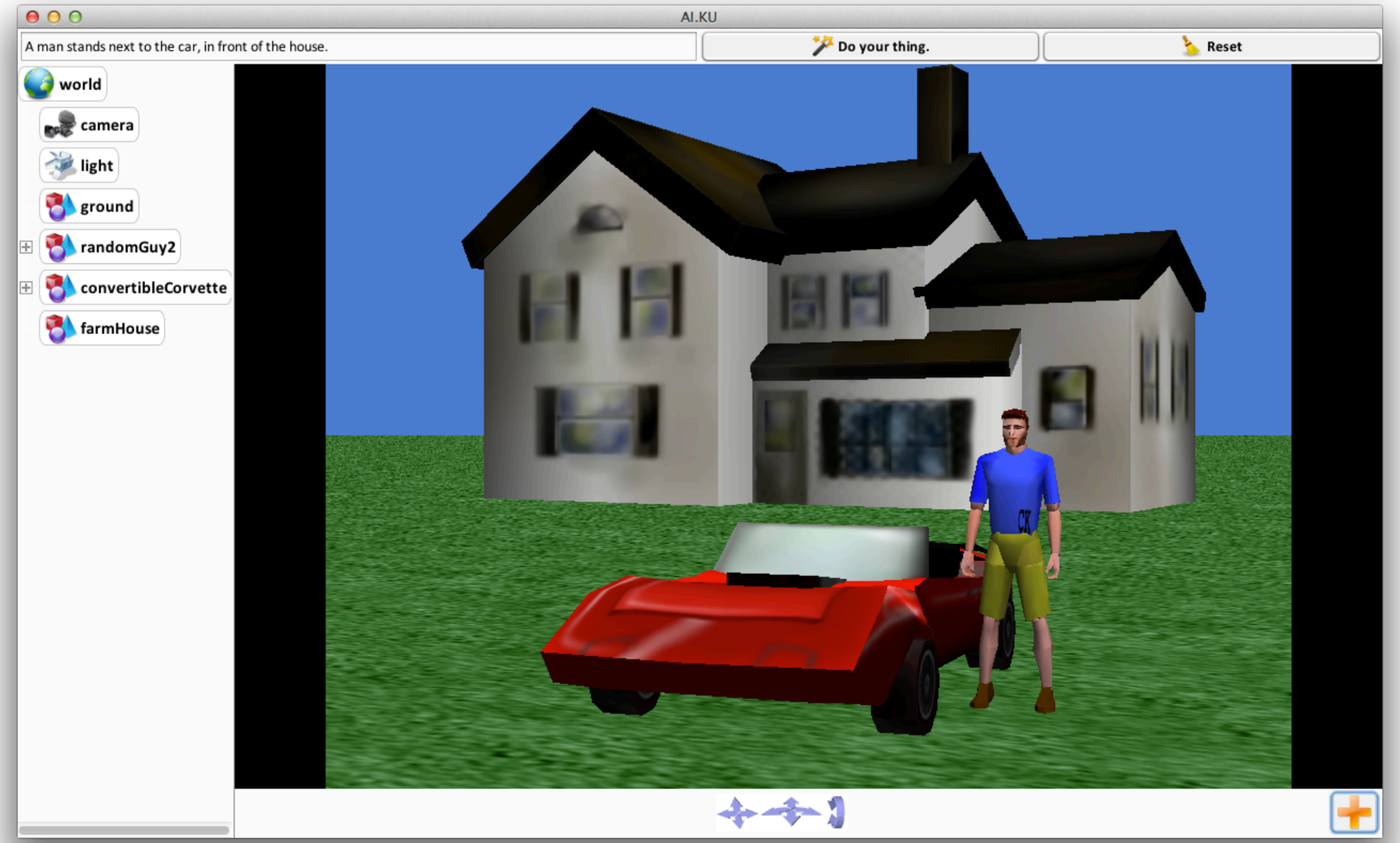
The System


AI.KU
A man stands next to the car, in front of the house.
Do your thing.
Reset
world
camera
light
ground
randomGuy2
convertibleCorvette
farmHouse

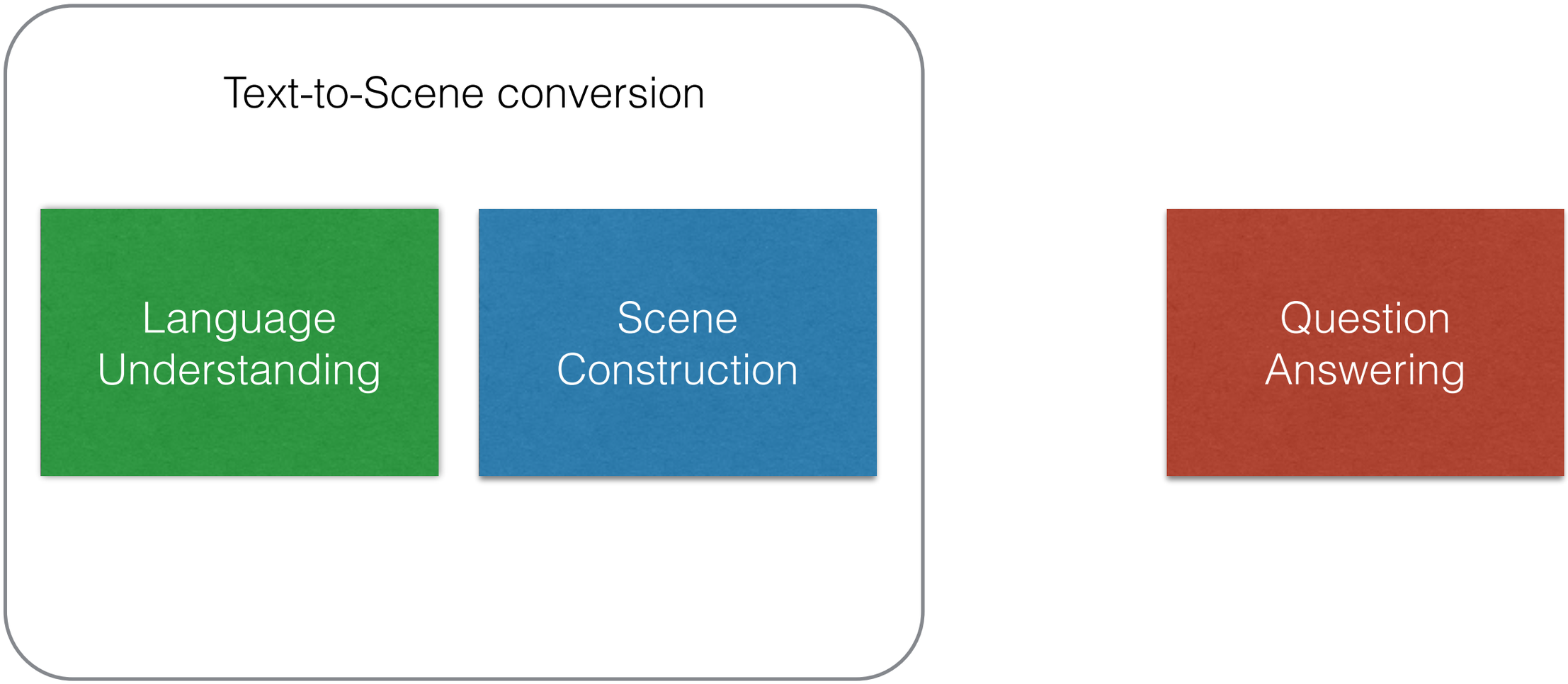
The System

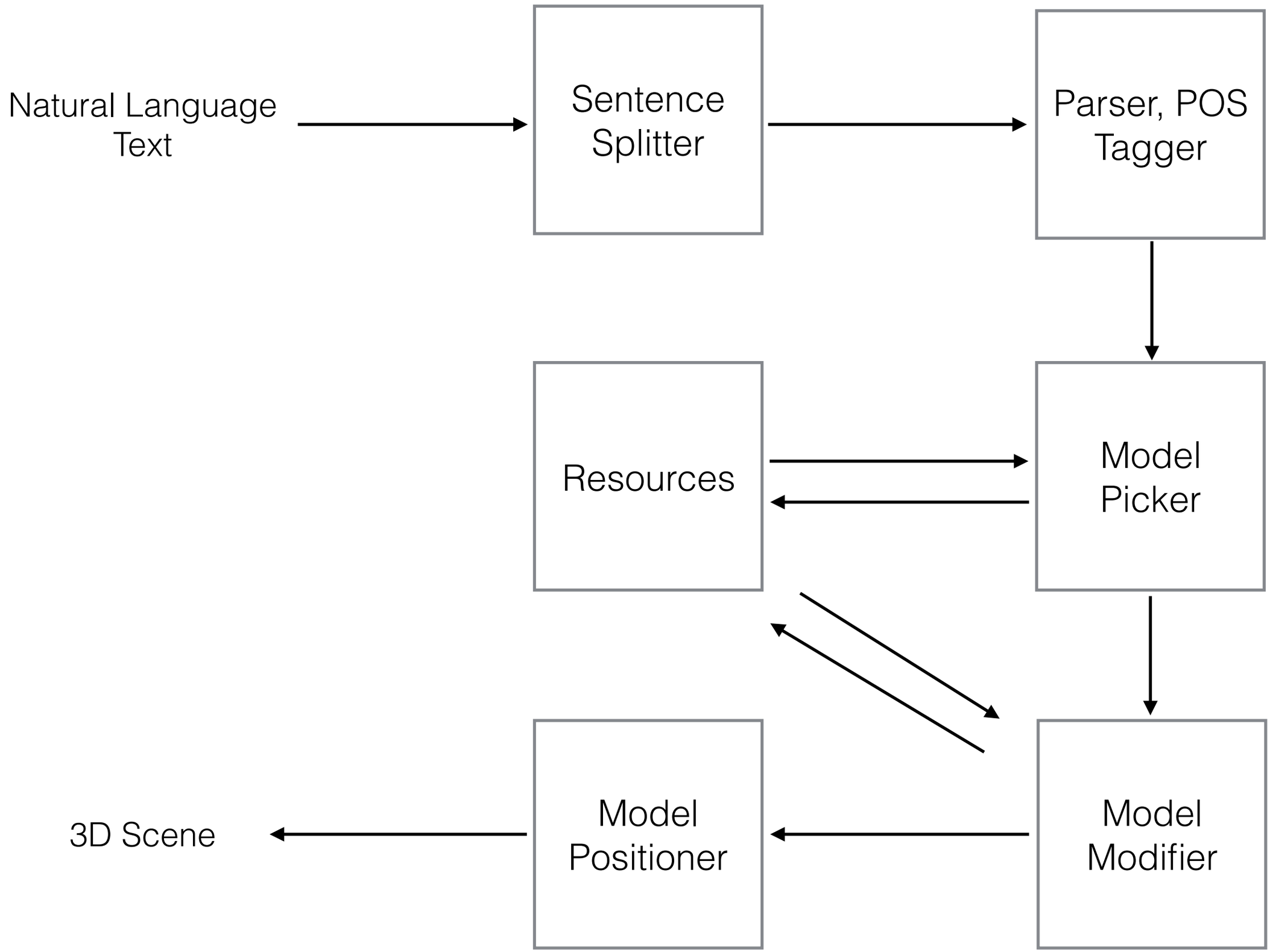
Language Understanding

Scene Construction

Question Answering

The System


Text-to-Scene conversion
Language Understanding
Scene Construction
Question Answering


Natural Language Text
Sentence Splitter
Parser, POS Tagger
Resources
Model Picker
3D Scene
Model Positioner
Model Modifier

Language Components

- Nouns
- Adjectives
- Prepositions

Nouns

- Nouns correspond to 3D models

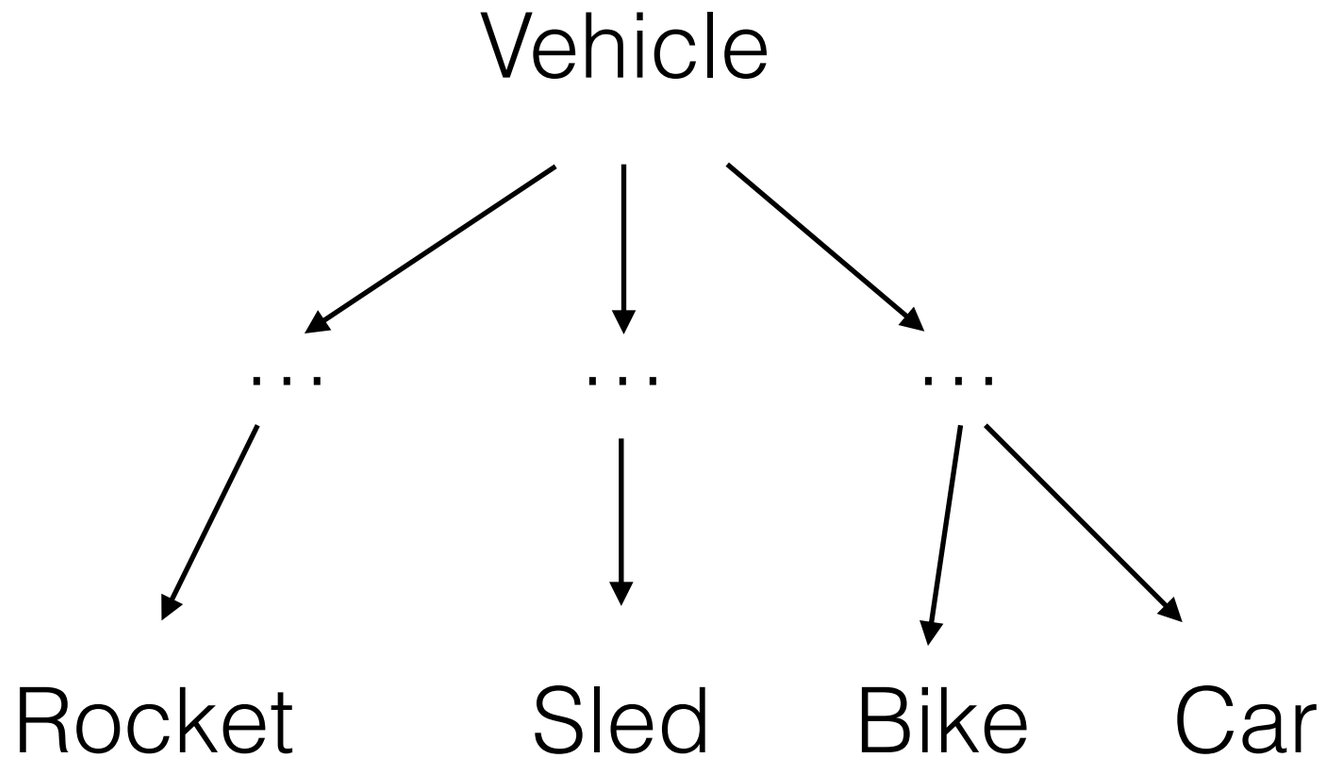
Problems about nouns

- May refer to non-physical entities.
- Might be too general.
- A physical entity can be referred in multiple ways.
- A noun phrase may refer to a single object or a noun can refer to more than one object.

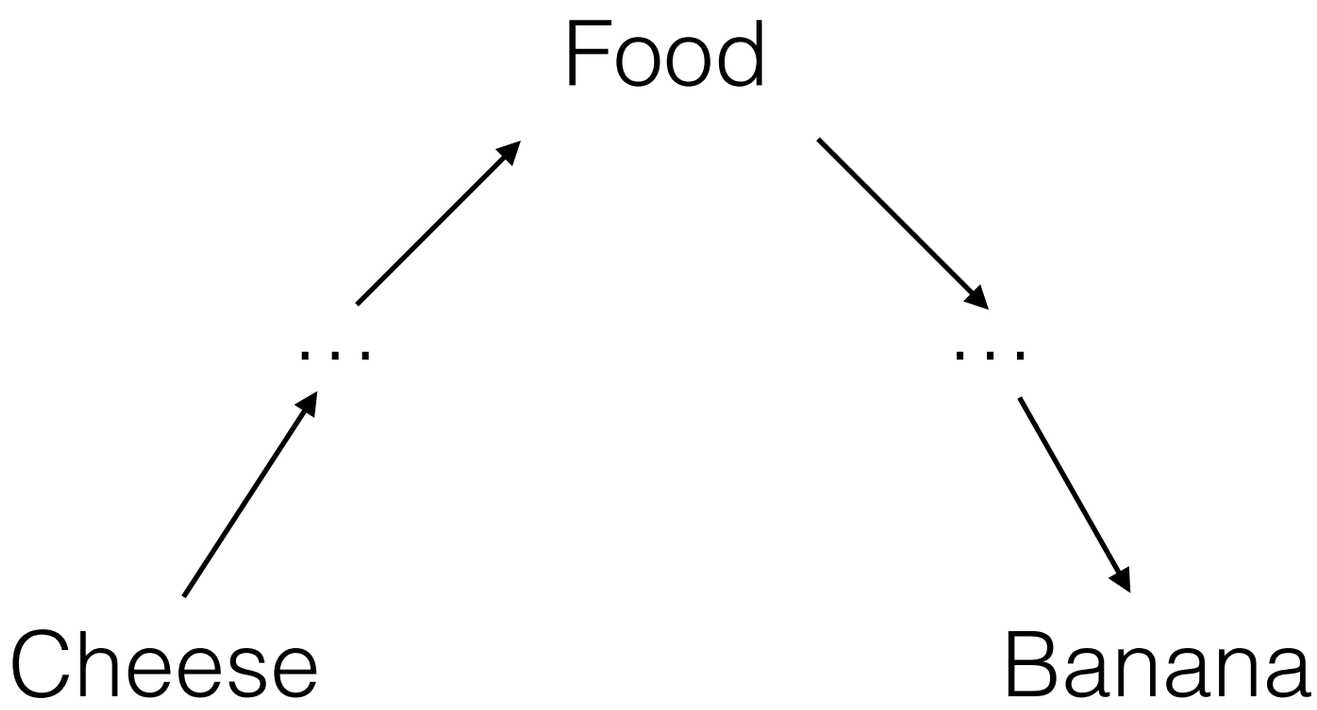
Synset - Model Map

```
<Synset gloss="warm-blooded egg-laying vertebrates characterized by
 feathers and forelimbs modified as wings" hint="bird" id="SID-01503061-N">
  <Model path="Animals/Bird1.a2c"/>
  <Model path="Animals/Bluebird.a2c"/>
</Synset>
<Synset gloss="a piece of furniture with shelves for storing books"
hint="bookcase" id="SID-02870880-N">
  <Model path="Furniture/Bookcase.a2c"/>
</Synset>
```

Hypernym - Hyponym relations



Hypernym - Hyponym relations



Adjectives

- Modify properties of models
- Some adjectives cannot be visualized

Adjectives

Model Properties

- Visibility
- Size
- Position
- Orientation
- Color
- Transparency

Adjectives

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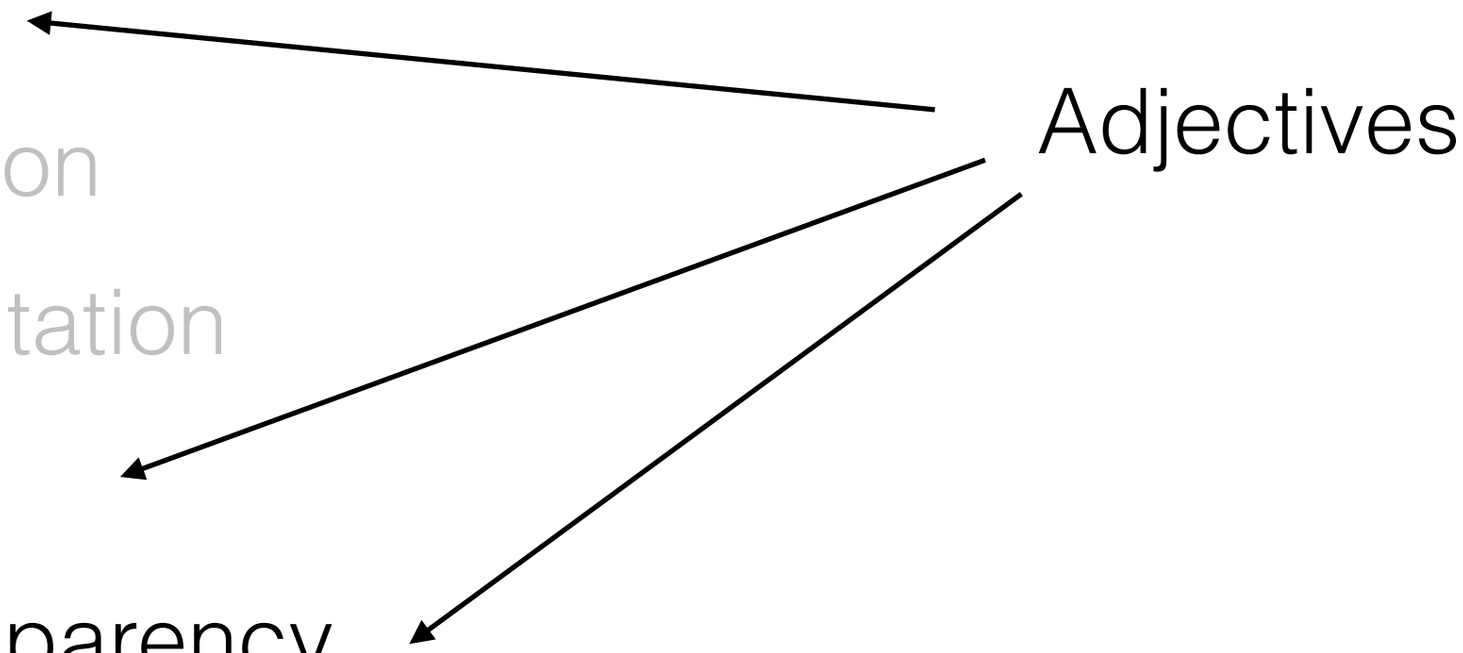

Adjectives

Model Properties

- Visibility
- Size
- Position
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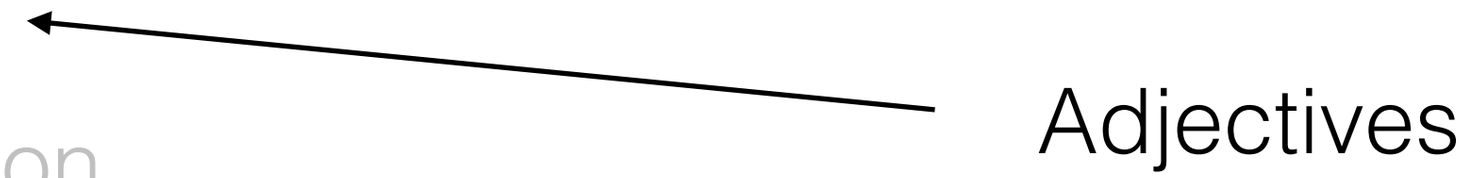


Synset - Scale Map

Adjective Hint	Synset ID	Width, Height, Depth Scale
astronomical	SID-01383582-A	(3.0, 3.0, 3.0)
giant	SID-01385773-A	(2.5, 2.5, 2.5)
huge	SID-01387319-A	(1.5, 1.5, 1.5)
big	SID-01382086-A	(1.2, 1.2, 1.2)
standard	SID-02295998-A	(1.0, 1.0, 1.0)
small	SID-01391351-A	(0.8, 0.8, 0.8)
tiny	SID-01392249-A	(0.5, 0.5, 0.5)
infinitesimal	SID-01393483-A	(0.25, 0.25, 0.25)
tall	SID-02385102-A	(1.0, 1.1, 1.0)
short	SID-02386612-A	(1.0, 0.9, 1.0)
fat	SID-00986027-A	(1.3, 1.0, 1.3)
thin	SID-00988232-A	(0.8, 1.0, 0.8)

Table C.1: Synset - Scale Map For Size Related Adjectives

Prepositions

- Spatial relations
- Modify positions of models

Prepositions

Model Properties

- Visibility
- Size
- Position
- Orientation
- Color
- Transparency

Spatial Relations

on

in

in front of

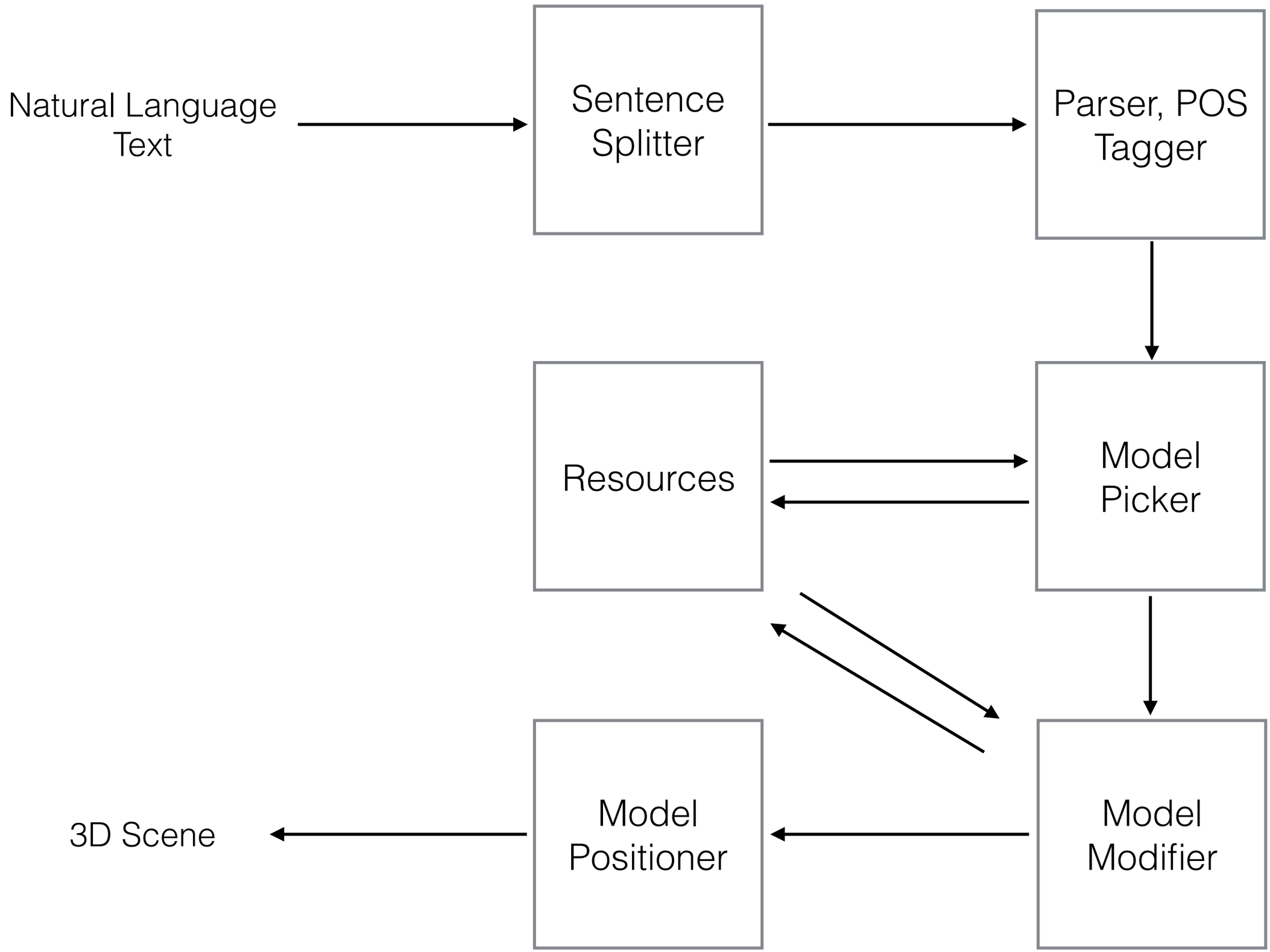
behind

next to

near

above

below


Natural Language Text
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Model Modifier

A giant dog is behind the small cat.

A/DT giant/JJ dog/NN is/VBZ behind/IN the/DT small/JJ cat/NN ./.

```
(ROOT
 (S
  (NP (DT A) (JJ giant) (NN dog))
  (VP (VBZ is)
   (PP (IN behind)
    (NP (DT the) (JJ small) (NN cat))))
  (. .)))
```

```
det(dog-3, A-1)
amod(dog-3, giant-2)
nsubj(is-4, dog-3)
root(ROOT-0, is-4)
det(cat-8, the-6)
amod(cat-8, small-7)
prep_behind(is-4, cat-8)
```

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 (S
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  (. .)))
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A giant dog is behind the small cat.

A/DT giant/JJ dog/NN is/VBZ behind/IN the/DT small/JJ cat/NN ./.

Synset ID - 02086723

Synset ID - 02124272

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 (S
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  (. .)))
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det(dog-3, A-1)

amod(dog-3, giant-2) → SID-01383582-A

nsubj(is-4, dog-3)

root(ROOT-0, is-4)

det(cat-8, the-6)

amod(cat-8, small-7) → SID-01391351-A

prep_behind(is-4, cat-8)

A giant dog is behind the small cat.

A/DT giant/JJ dog/NN is/VBZ behind/IN the/DT small/JJ cat/NN ./.

det(dog-3, A-1)

amod(dog-3, giant-2) → SID-01383582-A

nsubj(is-4, dog-3)

root(ROOT-0, is-4)

(2.5, 2.5, 2.5)

det(cat-8, the-6)

amod(cat-8, small-7) → SID-01391351-A

prep_behind(is-4, cat-8)

(0.8, 0.8, 0.8)

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A/DT giant/JJ dog/NN is/VBZ behind/IN the/DT small/JJ cat/NN ./.

(2.5, 2.5, 2.5)

(0.8, 0.8, 0.8)

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  (. .)))
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nsubj(is-4, dog-3)

root(ROOT-0, is-4)

det(cat-8, the-6)

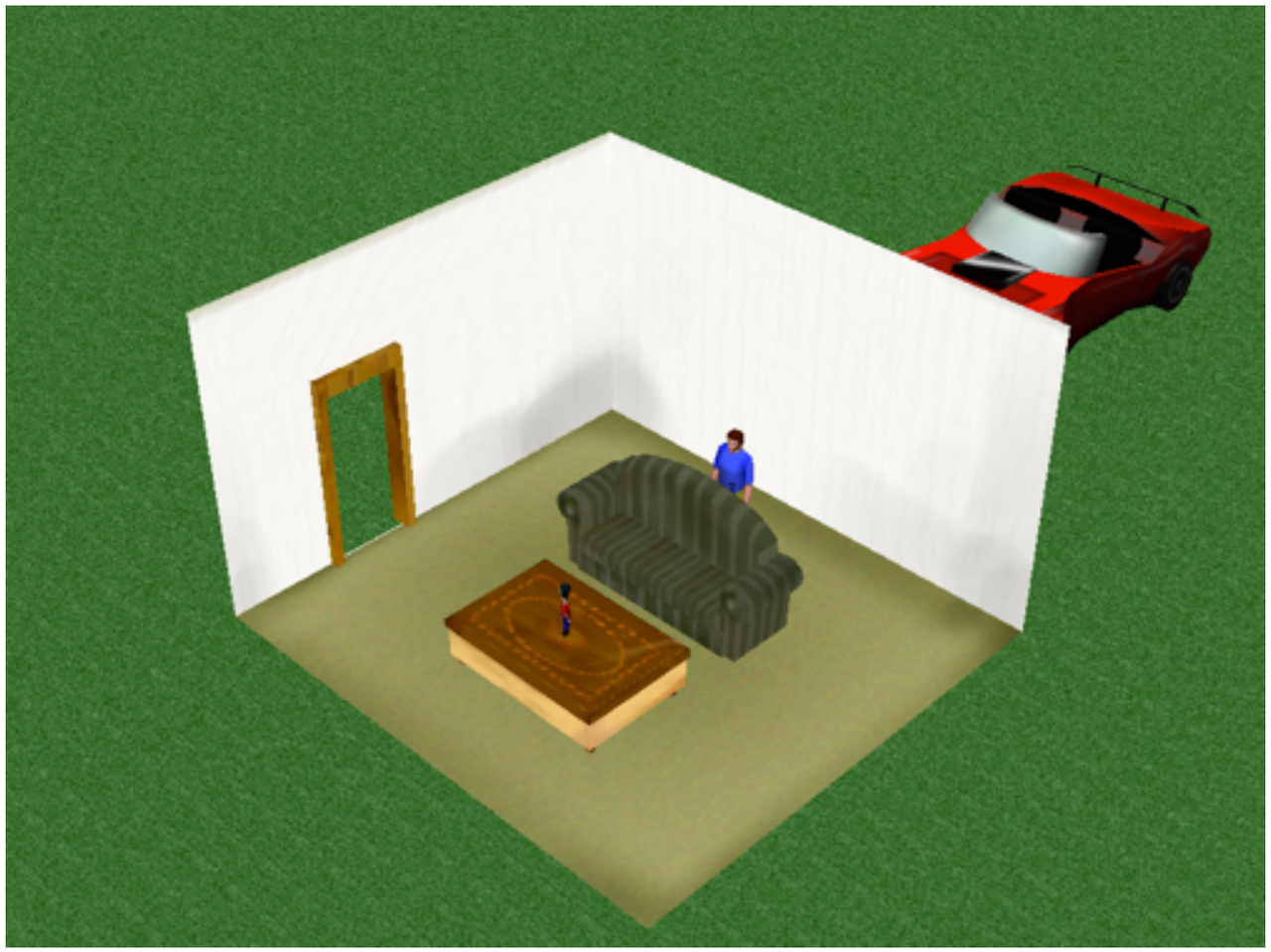
amod(cat-8, small-7)

prep_behind(is-4, cat-8)

placeBehind(*dog, *cat)

```
placeBehind(modelA, modelB)
 center(modelA) = center(modelB)
 orientation(modelA) = orientation(modelB)
 amount = (1.5 * depth(B) + depth(A)) * 0.5
 moveBackward(modelA, amount)
```

Scene Construction



There is a room. A sofa is in the room. A table is in front of the sofa.

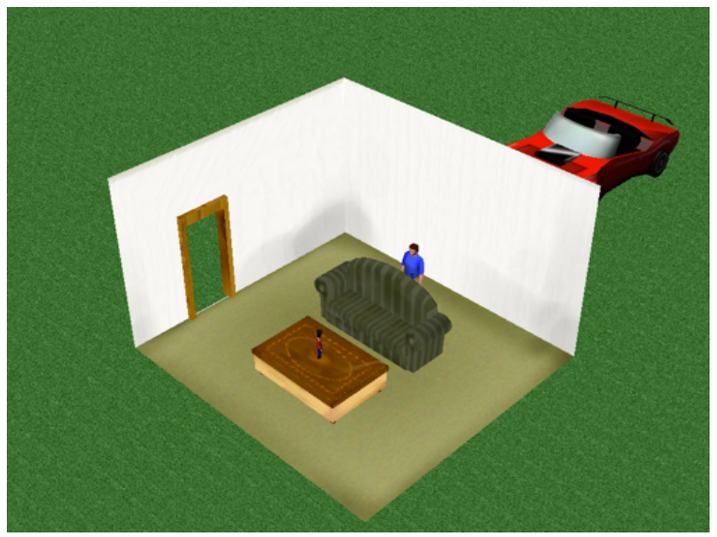
A man is behind the sofa. A toy is on the table. A car is behind the room.

Question Answering

- Position of a model
- Test spatial relation
- Test visibility by another object

Question Answering

Where is the room?	It is in front of the car.
Where is the sofa?	It is in the room, in front of the man, behind the table.
Is toy on the table?	Yes.
Is man in the room?	Yes.
Is car in the room?	No.
Is sofa in front of the table?	No
Can man see the sofa?	Yes.
Can man see the car?	No.



Question Answering

- The system is capable of answering questions even though the particular spatial relation is never mentioned in the text.

Conclusions

- A language visualization system design with rich vocabulary and extensive model gallery

- A new way of solving spatial inference problems

Future Work

- Handle verbs
- Animations, path planning, physics engine
- Improve q/a system
- A learning system

Questions

?