CSL Cognitive Systems Laboratory

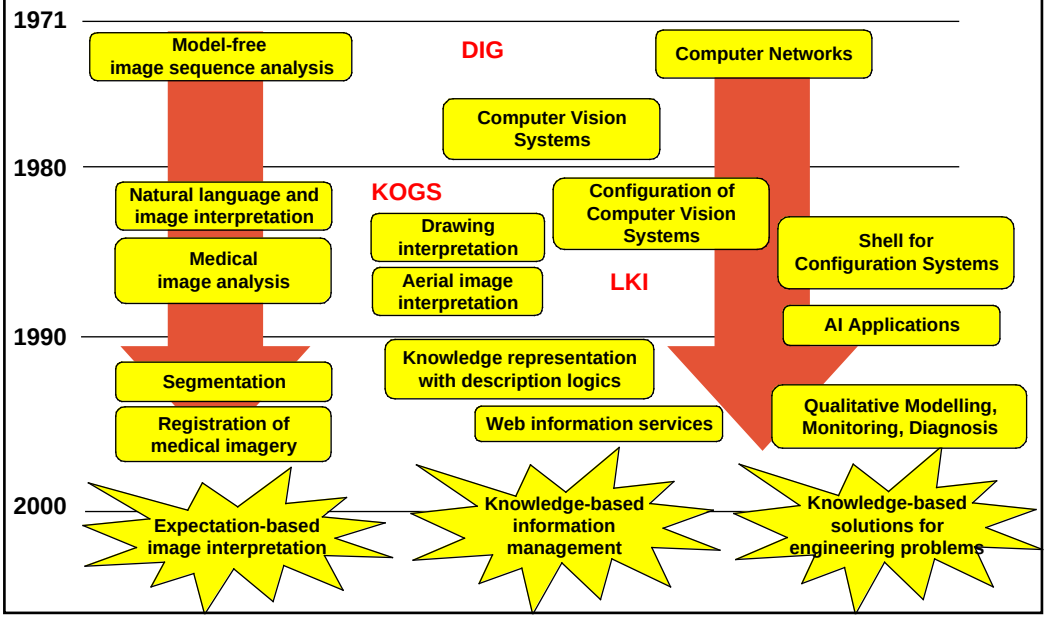
Kick-off Meeting CogVis
- CSL -

Bernd Neumann
(for the rest of the team)

Cognitive Systems Laboratory
Hamburg University
Germany

CSL Cognitive Systems Laboratory

CSL History



CSL Cognitive Systems Laboratory

The CSL Project Team

University staff (supporting)

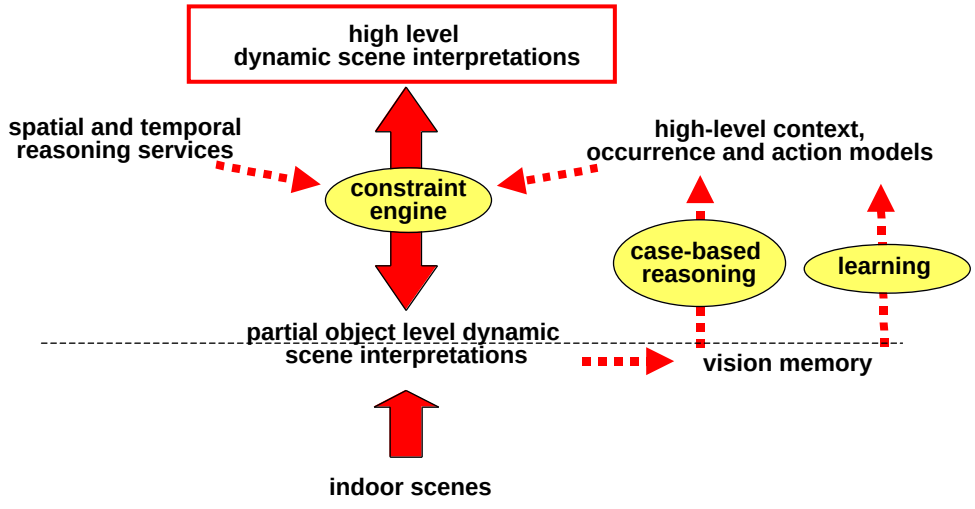
- Soenke Frantz
- Ullrich Koethe
- Sven Utcke
- Bernd Neumann

Project staff

- Christian Deike
- Amar Isli (1/2)
- N.N.

CSL Cognitive Systems Laboratory

Research "Road Work Ahead"



CSL Cognitive Systems Laboratory

Basic Ingredients for Representing Occurrence Models

- relational structure
- taxonomy
- partonomy
- spatial relational language
- temporal relational language
- object appearance models

CSL Cognitive Systems Laboratory

Occurrence Model for Automatic Load Transport

Predicate:	**transport-load**
	:is-a occurrence-model
	:local-name tl
Arguments:	**(?dtv :is-a stacker)**
	(?rm :is-a room)
	(?stat :is-a station)
Time marks:	**(tl.B tl.E)**
Component events:	**(er :is-a (enter-room ?rm ?dtv er.B er.E))**
	(fs :is-a (free-station ?stat fs.B fs.E))
	(ul :is-a (unload ?dtv ?stat ul.B ul.E))
	(ex :is-a (exit-room ?rm ?dtv ex.B ex.E))
Temporal relations:	**(tl.B + 10 ≤ tl.E)**
	(tl.E - 12 ≤ tl.B)
	(er :before ul)
	(ul :before ex)
	(ul :starts-within fs)
	(tl.B = er.B)
	(tl.E 0 ex.B)

CSL Cognitive Systems Laboratory

What are primitive occurrences?

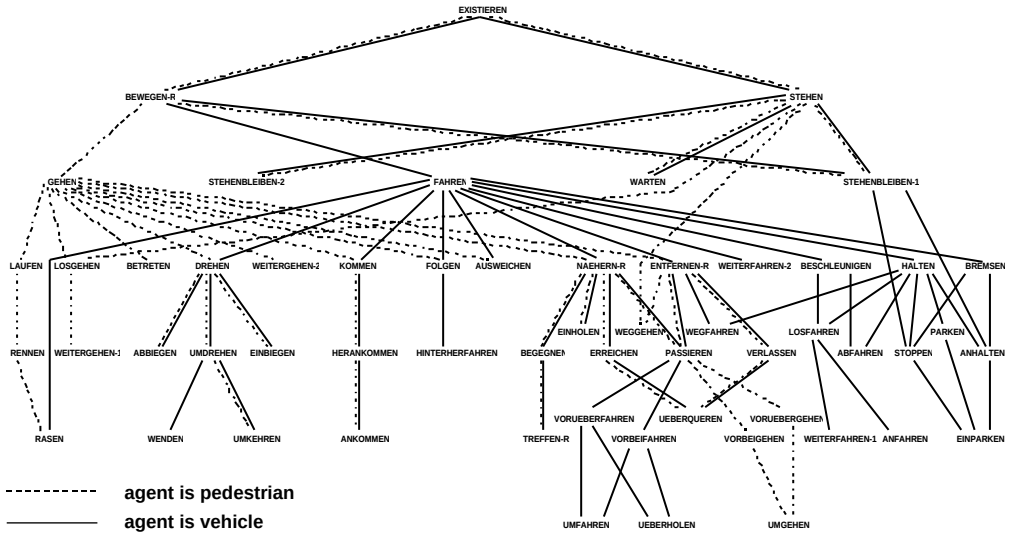
"primitive occurences" = dynamic scene observations
at a low interpretation level,
e.g. moving blobs

Approach followed in previous work:

Qualitative constancies of
- **distances**
- **orientations**
- **temporal derivatives thereof**

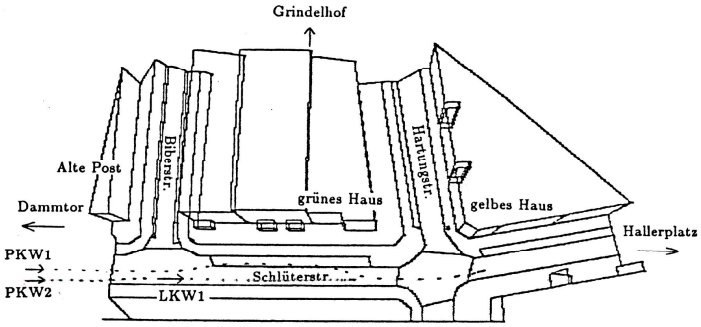
CSL Cognitive Systems Laboratory

Verb hierachy for object motion in street traffic



CSL Cognitive Systems Laboratory

Scene interpretation in NAOS



DIE SZENE ENTHAELT DREI BEWEGTE OBJEKTE: ZWEI PKWS UND EINEN LKW.

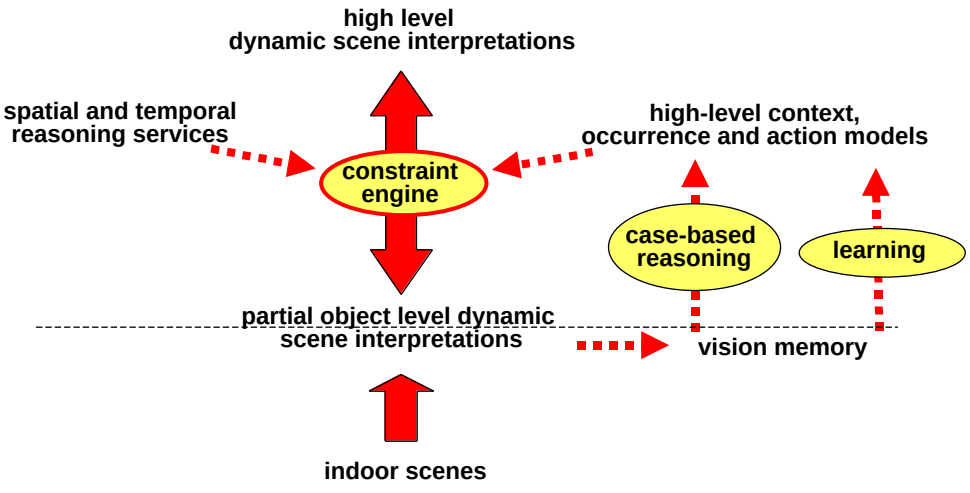
EIN GELBER PKW FAEHRT IN RICHTUNG HALLERPLATZ. DABEI UEBERHOLT ER DEN LKW AUF DER SCHLUETERSTRASSE. DER GELBE PKW RAST VON DER ALTEN POST VOR DAS GELBE HAUS. ER ERREICHT DIE HARTUNGSTRASSE. ER HAELT AN. ER HAELT.

EIN SCHWARZER PKW ERREICHT DIE SCHLUETERSTRASSE. ER NAEHERT SICH DEM LKW VON DER ALTEN POST. DER SCHWARZE PKW FAEHRT IN RICHTUNG HALLERSTRASSE.

DER LKW FAEHRT VON DER ALTEN POST VOR DAS GRUENE HAUS. DABEI STOPPT ER VOR IHM. ER HAELT. ER FAEHRT IN RICHTUNG DAMMTOR WEITER. ER ENTFERNT SICH VON DEM GELBEN PKW. DER LKW HAELT AN. ER HAELT.

CSL Cognitive Systems Laboratory

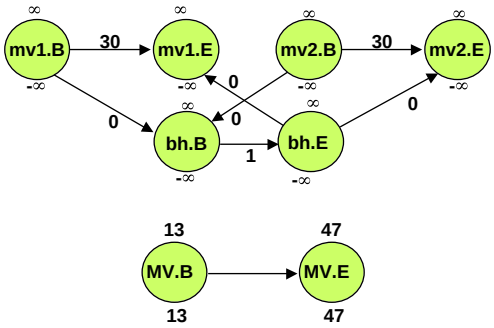
Research "Road Work Ahead"



CSL Cognitive Systems Laboratory

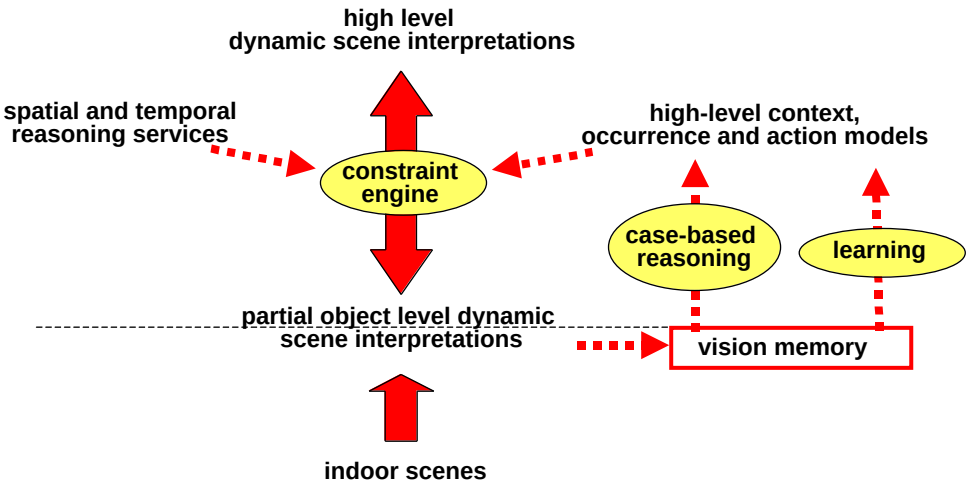
Temporal constraint propagation

Merging model-based and scene-based temporal constraints



CSL Cognitive Systems Laboratory

Research "Road Work Ahead"



CSL Cognitive Systems Laboratory

Vision memory

Current state

- **No common sense without memory (Waltz 82)**
- **Vision memory not yet explored extensively**
- **Use of models and probabilities reflects experiences**

Vision tasks not yet supported

- **Model-free recognition, e.g. of shapes seen before**
- **Experience-based situated vision, e.g. associating observer motion with visual phenomena**
- **Learning probabilities and adjusting parameters from experiences**
- **Prediction of low-level visual phenomena from high-level information, e.g. knowing what imagery to expect from an unfolding event**

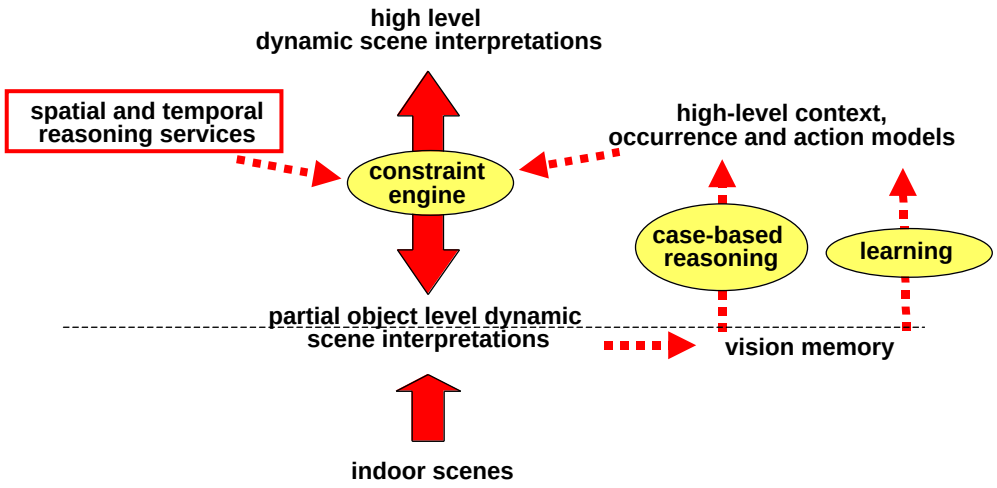
CSL Cognitive Systems Laboratory

Challenges for designing a vision memory

- **Associating relevant multilevel and multimodal information**
  Image features, scene features, task information, ego-motion, spatial and temporal context, language, etc.
- **Transforming experiences into generalised memory patterns**
  - Abstracting from irrelevant features and parts
  - Representing likelihoods, correlations, causality
- **Providing useful indexing structures**
  - Similarity-based access
  - Probabilistic part-whole reasoning
  - Mapping symbols into signals

CSL Cognitive Systems Laboratory

Research "Road Work Ahead"



CSL Cognitive Systems Laboratory

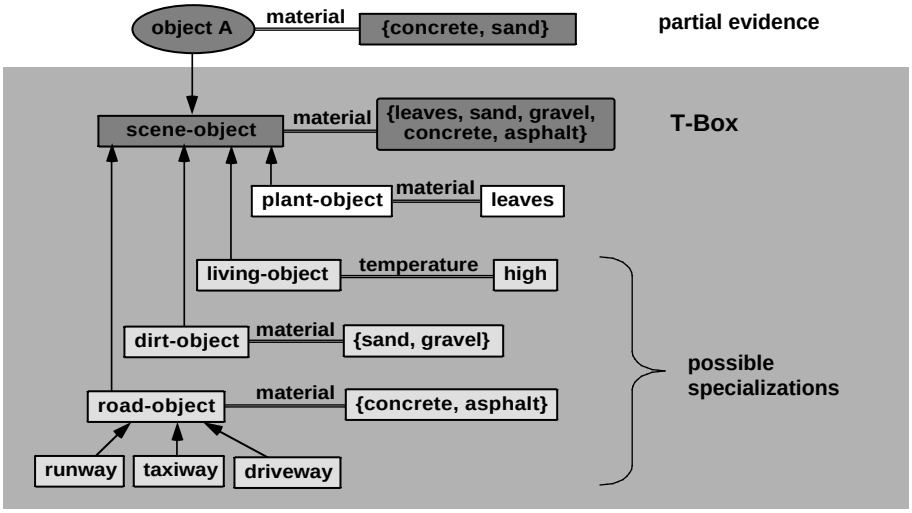
Hypothesizing possible concept specializations

Extension of description logic reasoning service for hypothesis generation:

- **Which concept hypotheses can be specialized further consistent with existing evidence?**
- **Which additional evidence is required for specialization?**

1. partial evidence => consistent concepts
2. partial evidence + concepts => missing evidence

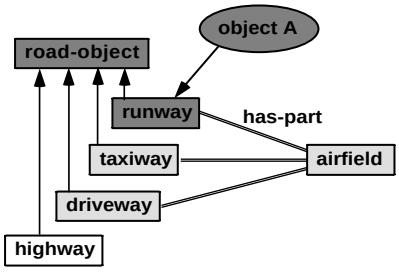
Example for possible concept specializations



Hypothesizing possible aggregats (1)

For which concepts (aggregats) are roll fillers (parts) available?

- **Provide concepts which are consistent with existing role fillers**
- **Which roles provide decisive evidence?**
- **Criteria for ranking hypotheses**

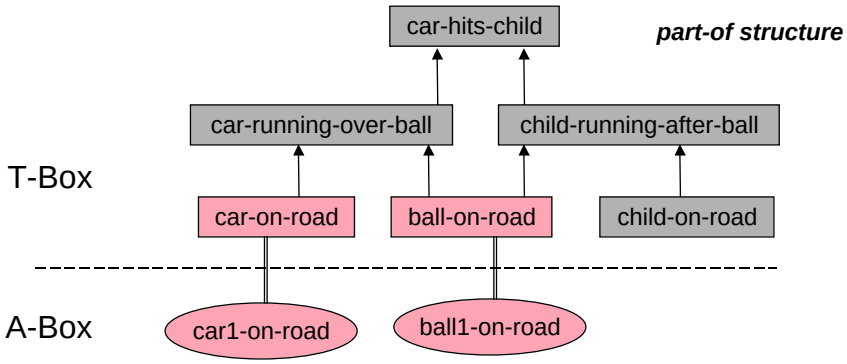


Existing instance runway ***is evidence for*** airfield ***and its further parts*** taxiway ***and*** driveway***.***

Hypothesizing possible aggregats (2)

For which concepts (aggregats) are roll fillers (parts) available?

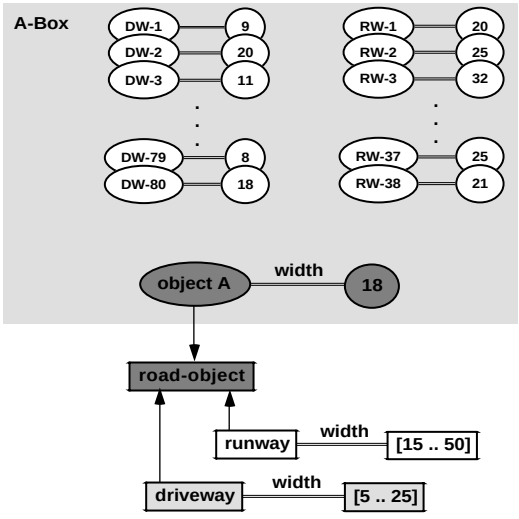
Generating temporal and spatial expectations:



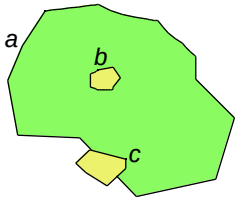
Exploiting A-Box statistics

What are the most probable concepts (aggregates) for given parts (role fillers)?

- **using experiences for predictions**
- **ranking hypotheses**



Hypothesis generation using default rules (1)



World description *W*
a : *country*
b : *area*
c : *area*
(*a*,*b*) : *contains*
(*b*,*a*) : *inside*
(*a*,*c*) : *overlaps*
(*c*,*a*) : *overlaps*

Generate hypotheses for a, b, c

Default rules

$\frac{area \mid country}{country}$

$\frac{area \mid city}{city}$

$\frac{area \mid lake}{lake}$

Default rules *D* closed over *W*

$\frac{a : area \mid a : country}{a : country}$	$\frac{a : area \mid a : city}{a : city}$	$\frac{a : area \mid a : lake}{a : lake}$
$\frac{b : area \mid b : country}{b : country}$	$\frac{b : area \mid b : city}{b : city}$	$\frac{b : area \mid b : lake}{b : lake}$
$\frac{c : area \mid c : country}{c : country}$	$\frac{c : area \mid c : city}{c : city}$	$\frac{c : area \mid c : lake}{c : lake}$

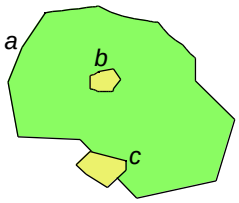
Example: Spatioterminological background knowledge

TBox

$building\_region = area \sqcap \exists\, has\_area\,.$ building_features
$natural\_region = \neg building\_region$
$country\_region \sqsubseteq building\_region \sqcap large\_area$
$city\_region = building\_region \sqcap \neg large\_area$
$river\_region \sqsubseteq natural\_region \sqcap area$
$lake\_region \sqsubseteq natural\_region \sqcap area$
$country = country\_region \sqcap \forall contains\,.\,\neg country\_region \sqcap \forall overlaps\,.\,\neg country\_region \sqcap \forall inside\,.\,\neg country\_region$
$city = city\_region \sqcap \exists inside\,.\,country\_region$
$lake \sqsubseteq lake\_region$
$river \sqsubseteq river\_region \sqcap \forall overlaps\,.\,\neg lake\_region \sqcap \forall inside\,.\,\neg lake\_region \sqcap \forall contains\,.\,\bot$
$river\_flowing\_into\_lake = river \sqcap \exists touches\,.\,\neg lake\_region$

CSL Cognitive Systems Laboratory

Hypothesis generation using default rules (2)



World description *W*
a : country
b : area
c : area
(a,b) : contains
(b,a) : inside
(a,c) : overlaps
(c,a) : overlaps

Extension E1
b : city
c : lake

Extension E2
b : lake
c : lake

2 mutually exclusive extensions E1 and E2

Default rules

$\frac{area \mid country}{country}$

$\frac{area \mid city}{city}$

$\frac{area \mid lake}{lake}$

Default rules *D* closed over W

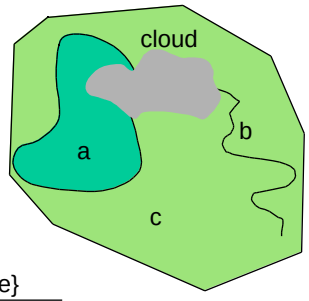
$\frac{a : area \mid a : country}{a : country}$ $\frac{a : area \mid a : city}{a : city}$ $\frac{a : area \mid a : lake}{a : lake}$

$\frac{b : area \mid b : country}{b : country}$ $\frac{b : area \mid b : city}{b : city}$ $\frac{b : area \mid b : lake}{b : lake}$

$\frac{c : area \mid c : country}{c : country}$ $\frac{c : area \mid c : city}{c : city}$ $\frac{c : area \mid c : lake}{c : lake}$

Example: River flowing into lake

ABox
a : lake
b : river
c : country



Default rules

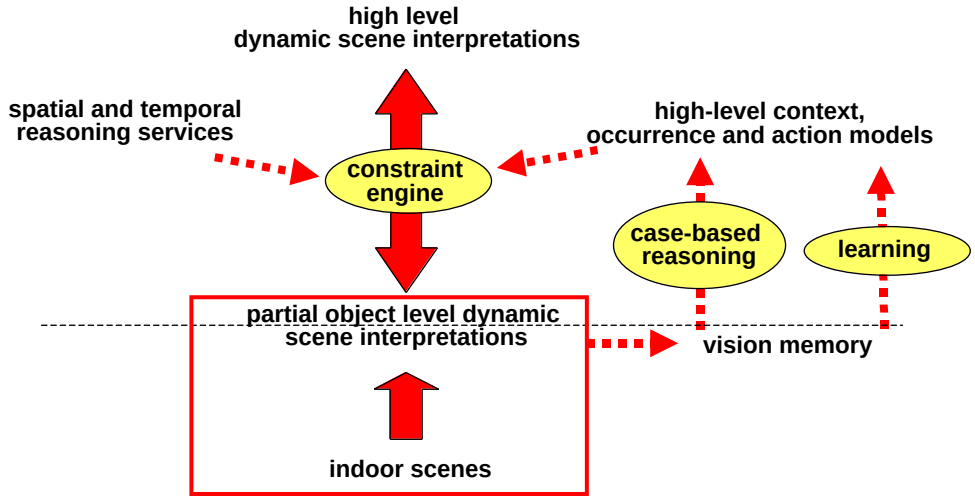
$\frac{\{ X: lake, Y: river\_flowing\_into\_lake \} \mid \{ (X, Y) : touches \}}{\{ (X, Y) : touches \}}$

$\frac{\{ X: river, Y: country, (X, Y) : inside\} \mid \{X : river\_flowing\_into\_lake\}}{\{X : river\_flowing\_into\_lake\}}$

Extension
a : river_flowing_into_lake
(a, b) : touches

CSL Cognitive Systems Laboratory

Research "Road Work Ahead"



CSL Cognitive Systems Laboratory

Experiments

- Human actions as playground for learning
- Experimental multi-camera infrastructure to provide image sequence segmentation
- Service robotics application perspective
- Instructions to bridge object recognition shortcomings

Conclusion

- **We will address several basic problems at the borderline of Computer Vision and AI**
- **We are still in the process of narrowing down problems and selecting particular approaches**