Using Image Schemata to Represent Meaningful Spatial Configurations

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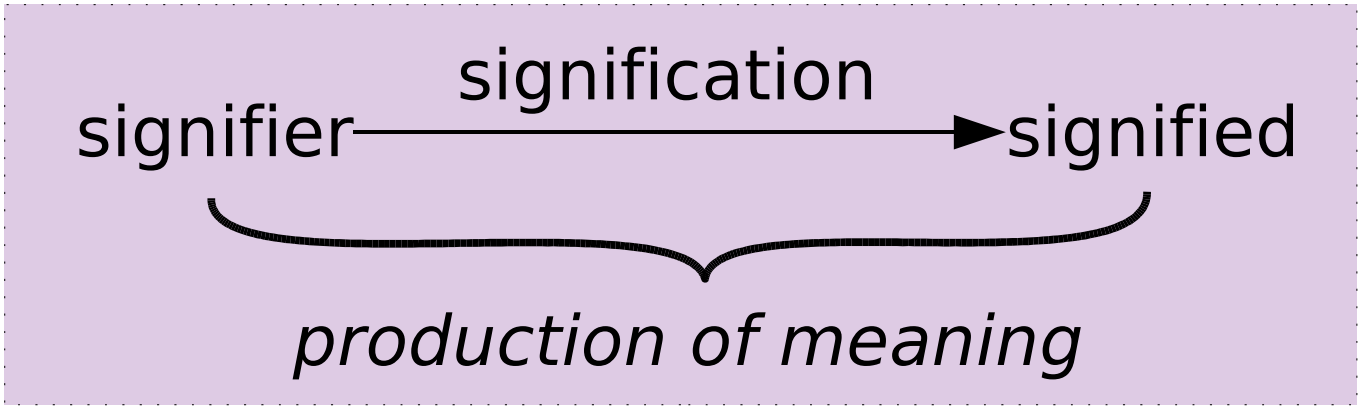
Spatial Semantics

about meaning

of space / things in space

about **conventions** (in linguistics)



but **motivated** in relation to space!

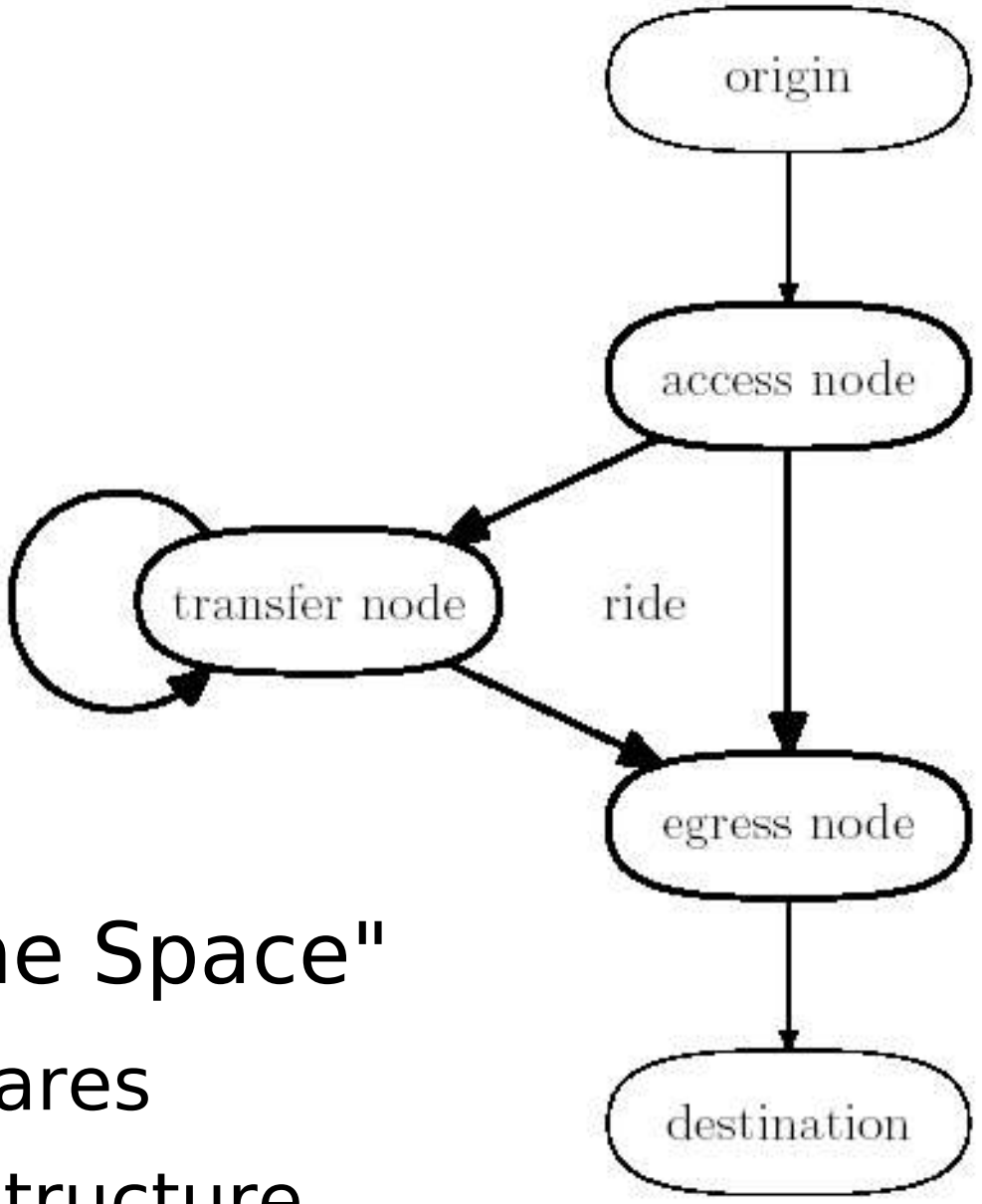
Spatial Configuration

- open space
- objects
- boundaries
- gateways
- no network
- etc.

has a **meaning**
to moving **agents**

Background

Wayfinding in
public transport



At access, transfer,
egress nodes: "Scene Space"

- platforms, halls, squares
- usually no network structure
- meaning to traveller!

TASK

build a **model** that captures the link:
spatial configuration --> meaning

APPROACH

image schemata, assuming that they provide semantics for whole spaces (hypothesis, to be confirmed)

RESULT

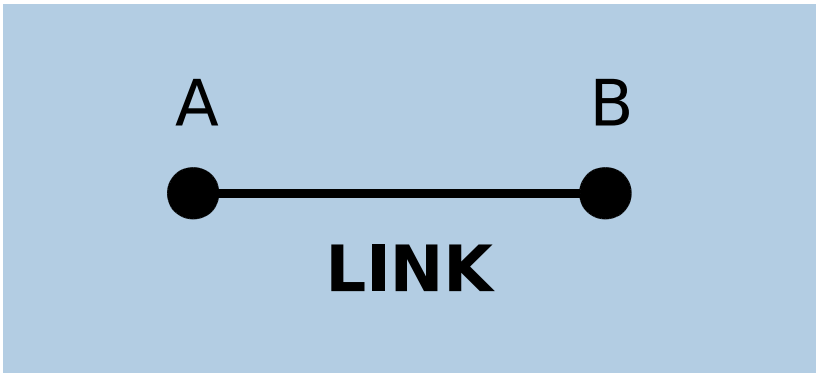
conceptual model of spatial meaning, based on image schemata, awaiting its implementation...

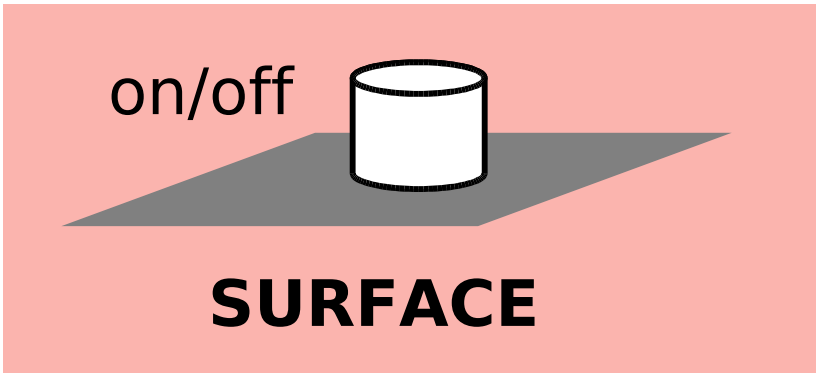
FOCUS

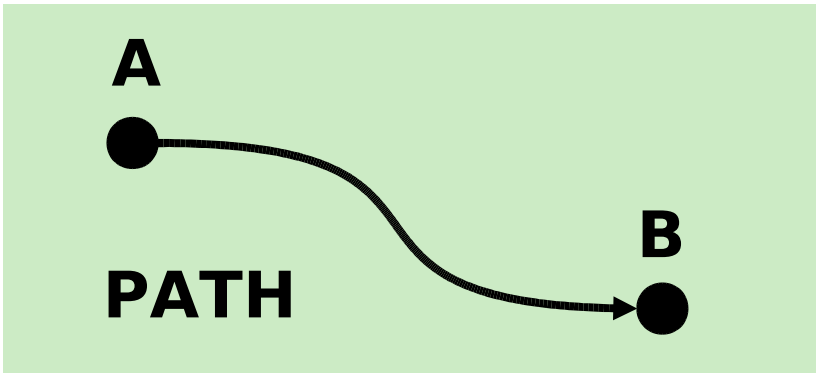
combination of image schemata to match spatial configurations

Image Schemata

- patterns in the mind
- abstracted from bodily experience
- parts and relations
- independent of concepts
- structure perceptions
- help making sense!







and many more...

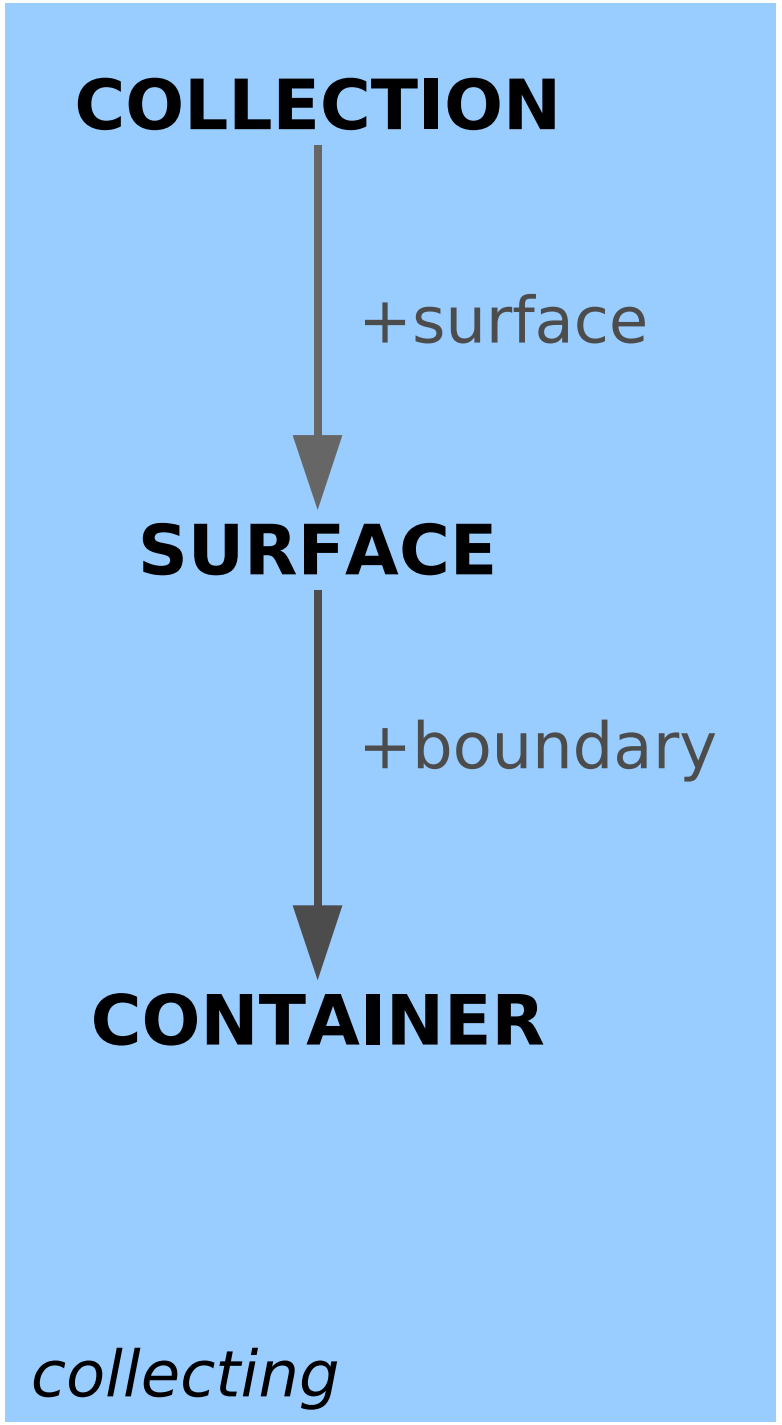
Mark Johnson, 1987: *The Body in the Mind...*

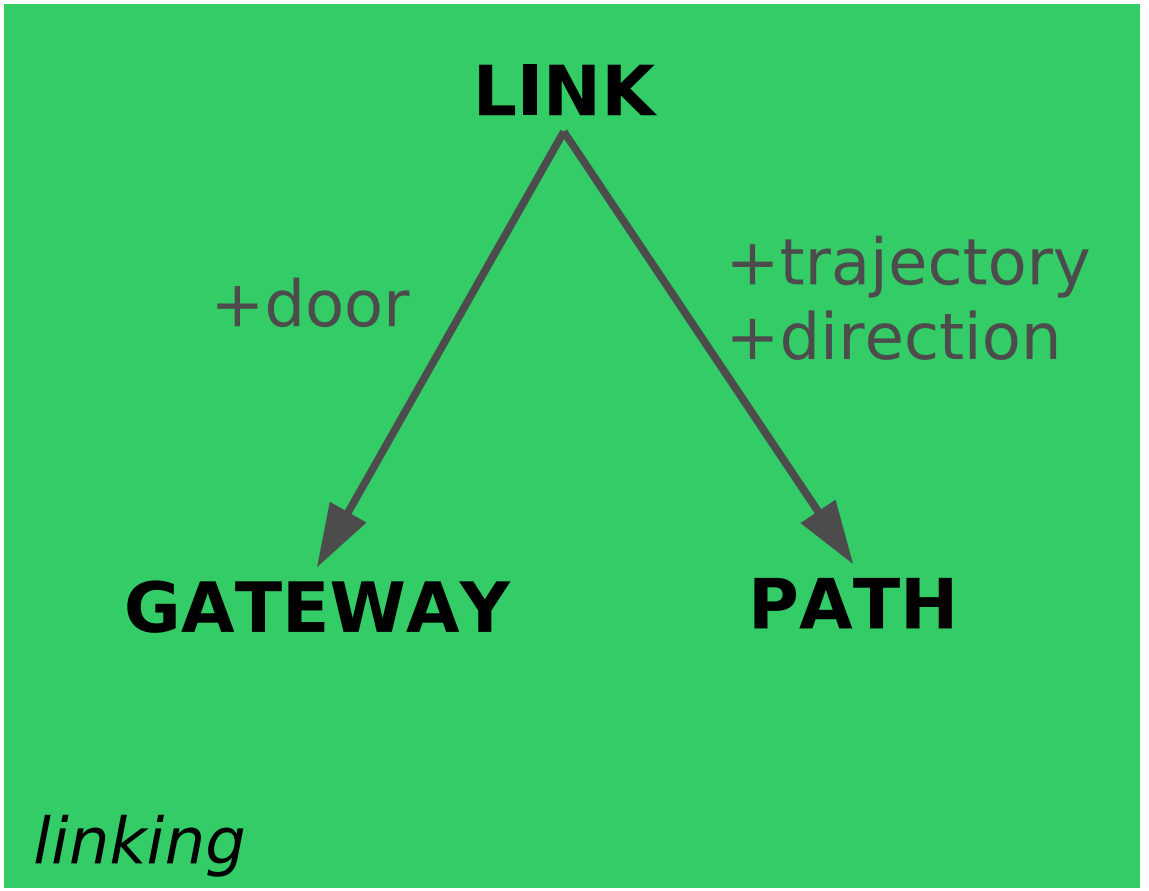
George Lakoff, 1987: *Women, Fire, and Dangerous Things...*

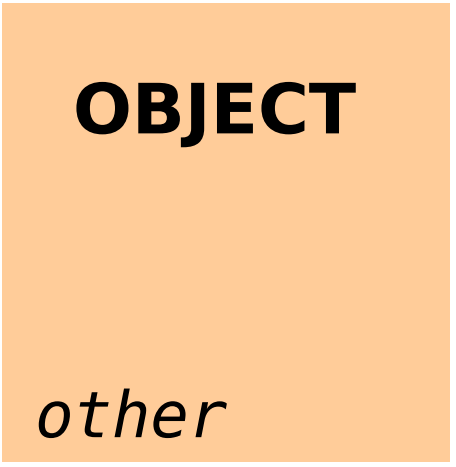
Schema	parts	induced relation
COLLECTION	none	part-of (elem-of)
SURFACE	surface	part-of (on/off)
CONTAINER	ins/outs/bound	part-of (contains)
LINK	none	connect
GATEWAY	"door"	connect
PATH	src, dest, traj.	connect (+left/right)
OBJECT	object	(not considered)

Instances are located in space, structure space
Schemata afford activity, communicate meaning

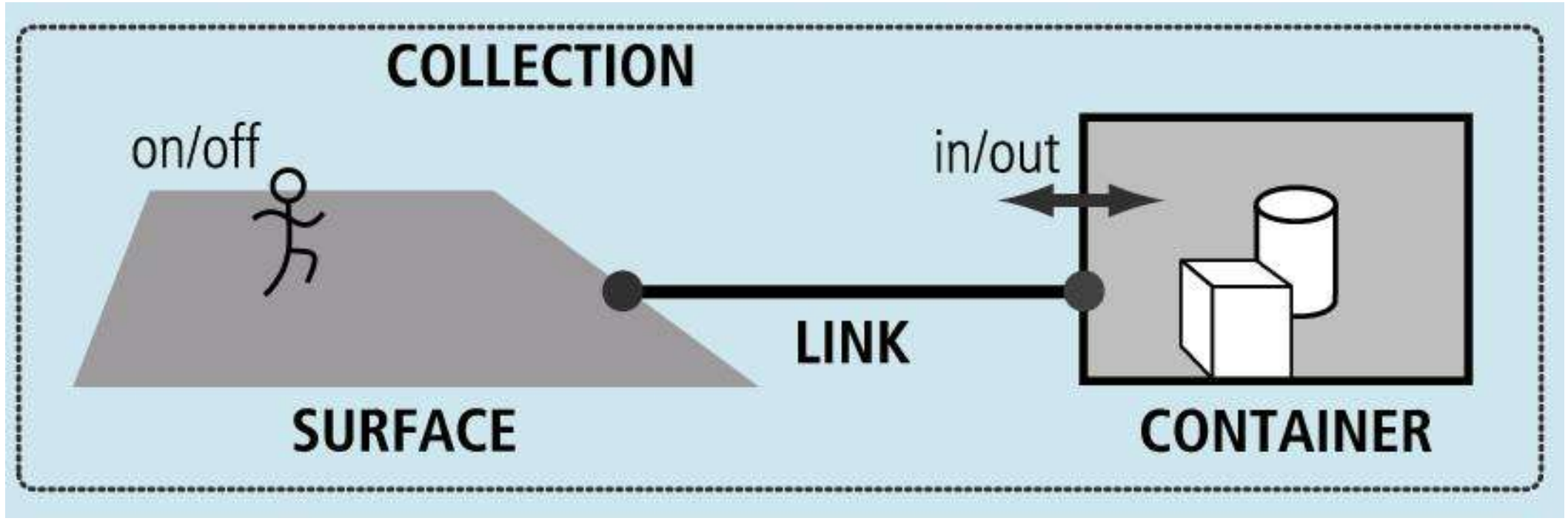
Instances combine in various ways --> describe spat conf --> (next slide)







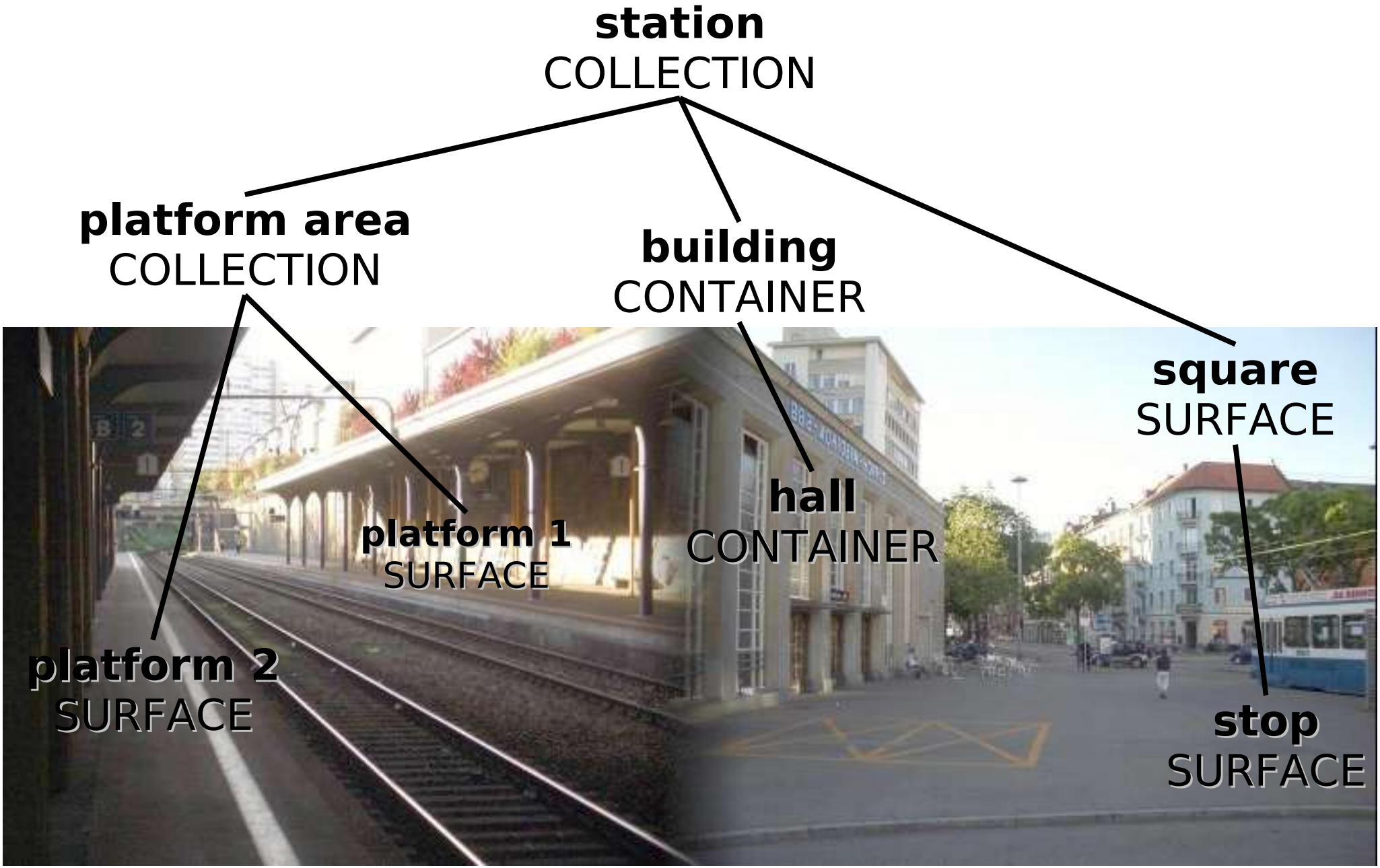
X becomes Y
by adding feature Z


COLLECTION
on/off
in/out
LINK
SURFACE
CONTAINER


STRICK-MEDIATION-SBB

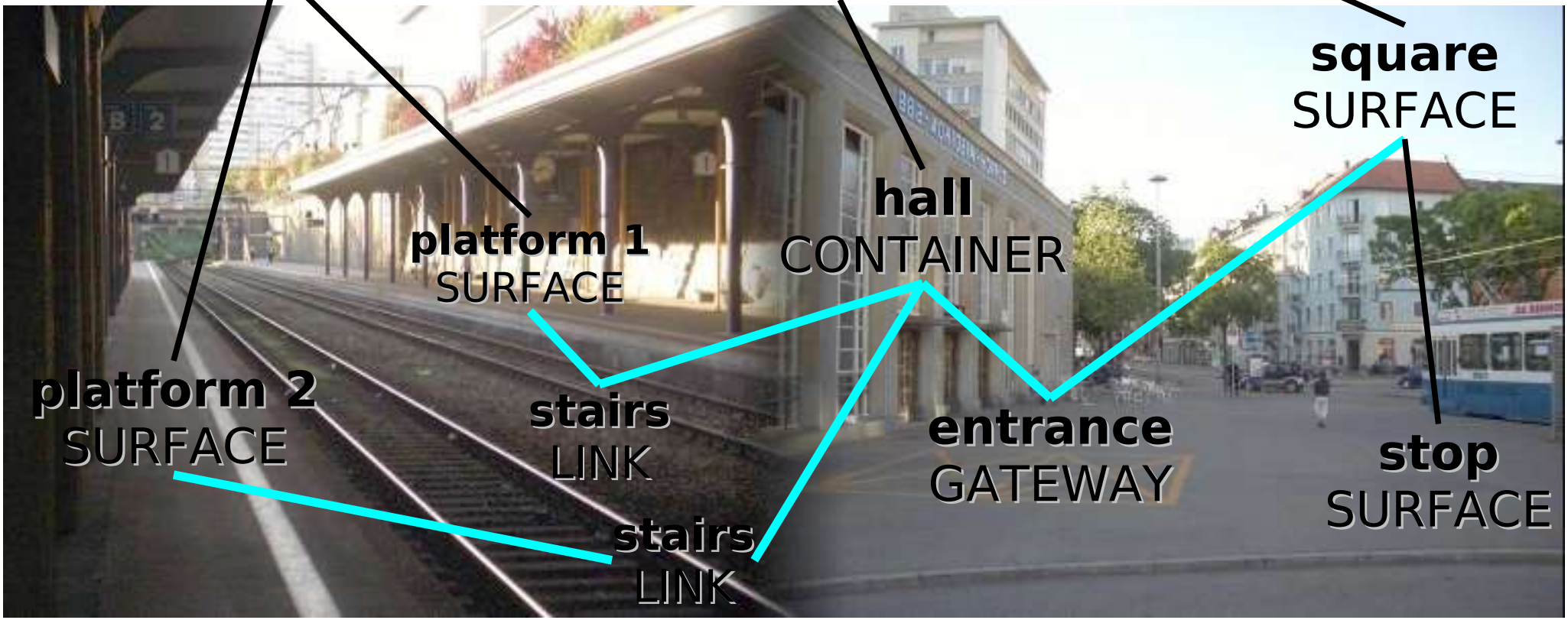

ZU DEN ZÜGEN
Blick
Blick

Collecting elements give rise to a partonomy:



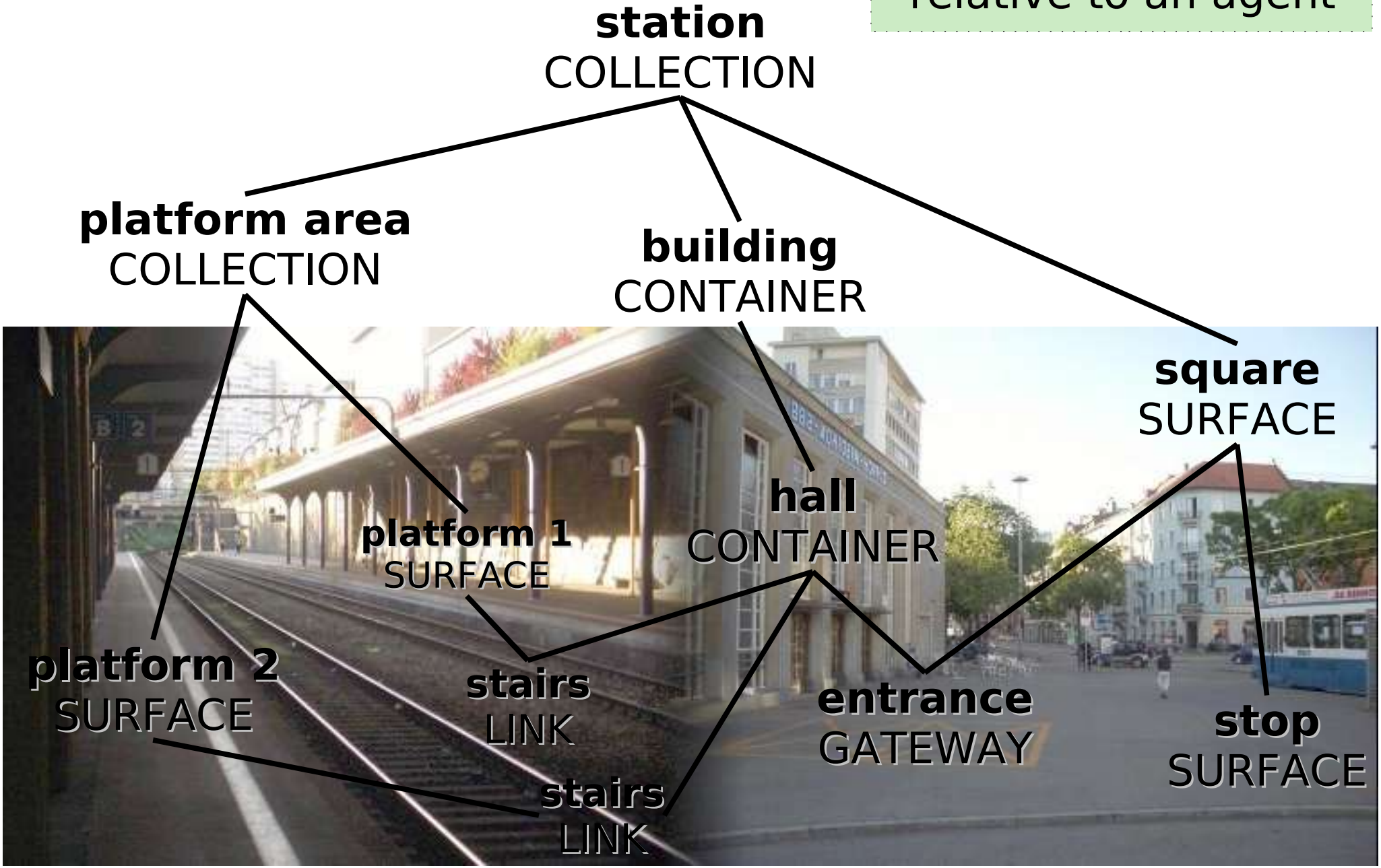
Linking elements extend this partonomy:

LINKs and GATEWAYs are ordinary elements in the partonomy. The formal structure does not change.



Where is the **meaning?**

- in the schemata
- in their arrangement
- relative to an agent



Consistency Rules

Not all posets are meaningful representations.

Consistency Rules
by consequence of the Image Schemata:

1. LINKs and OBJECTs minimal

2. LINKs not maximal

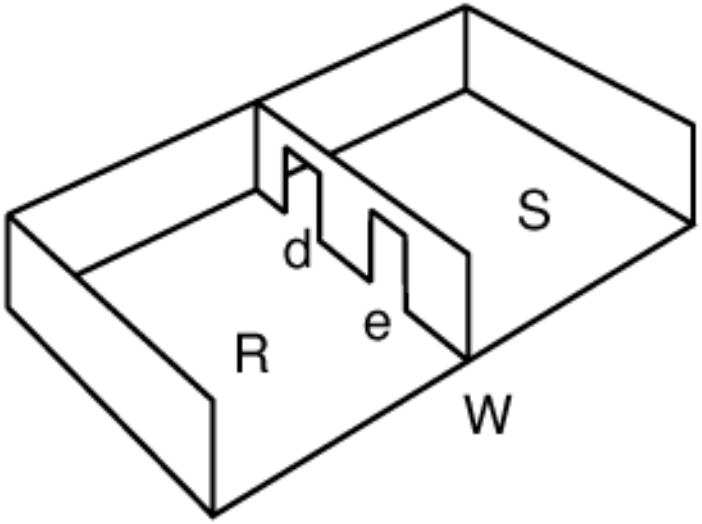
3. CONTAINER must contain a LINK

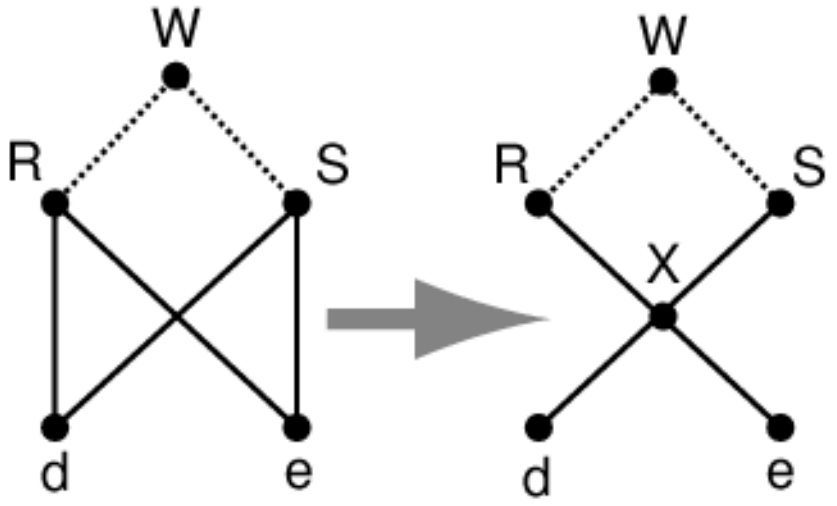
Violation: no longer meaningful / confusing

Consistency Rules (optional)

4. there is a greatest element (study area)

5. poset is (can be made) an upper semilattice





Normal completion: new elements are *plural* forms: here X represents "some doors"

At a smaller scale...

Objects within station: signs, clocks, etc.

Same schemata (except for PATH):

- CONTAINER: no longer "enterable"
- SURFACE: not "stand-on-able", vertical
- LINK: attachment by construction

Text-Adventure game systems:

```
Object -> wicker_cage "wicker cage"
  with  description "It's a small wicker cage"
  has   container open openable transparent;
```

At a larger scale...

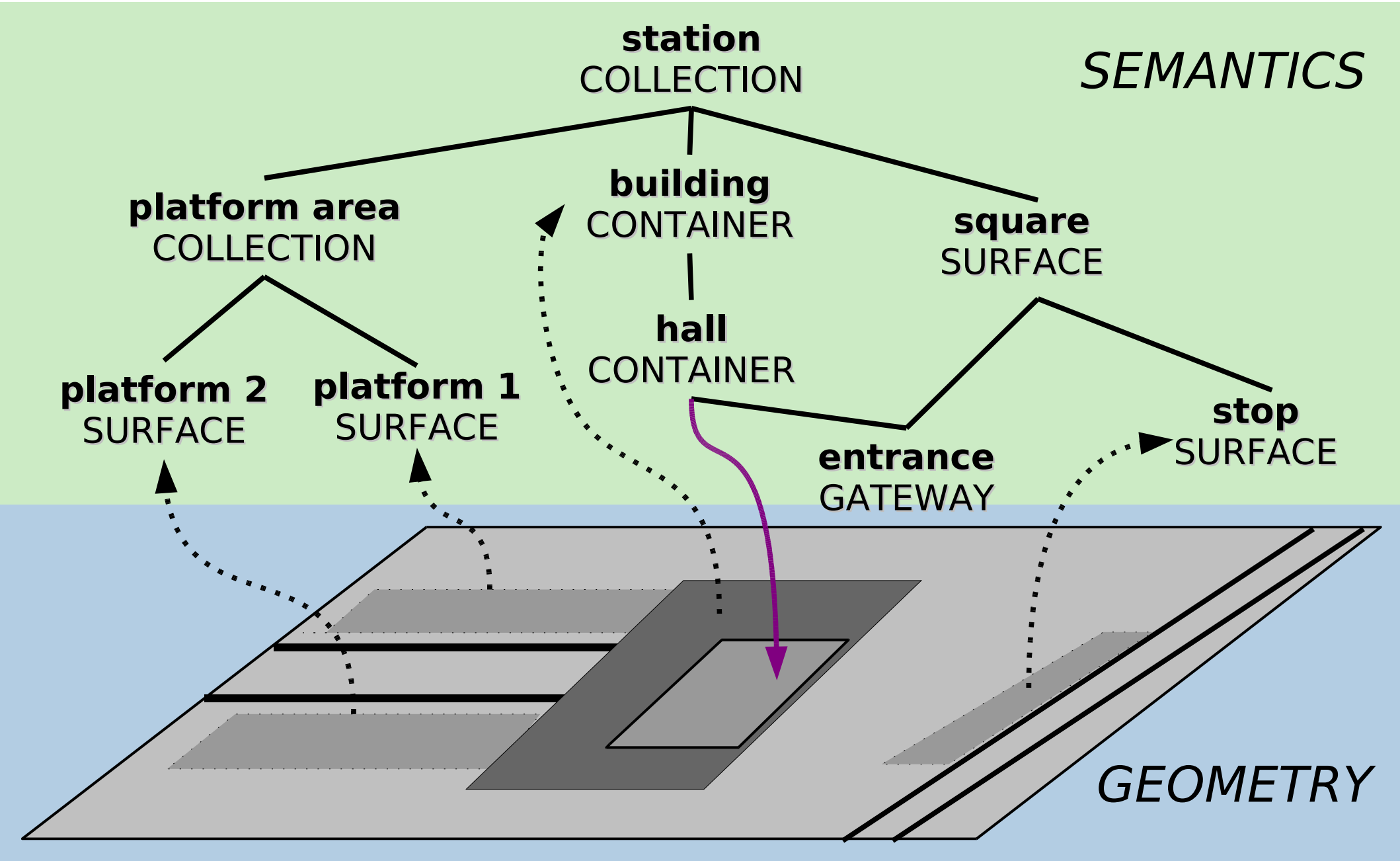
Station in its (urban) environment:

- **network** of streets
- PATH schema is dominant (linking SURF.)
- different type of structure (NwSp)
- calls for different model

Need additional consistency rule:

- x part-of y implies scale(x) ≤ scale(y)

Supplementing GIS



Conclusions

Structure space using Image Schemata (IS):

- basically, a **classification by IS,** grounding
- related to each other: match spat. conf.
- **encode knowledge** (structured access to info)
- **produce meaning** (relating expr to content)

Semantic relations:

- **type-of:** as image schema instances
- **part-of:** by the partonomy
- **connect:** as instances of the linking schemata
- type-of refines part-of: on/SURF, in/CONT

Capture **some** meaning, not all...

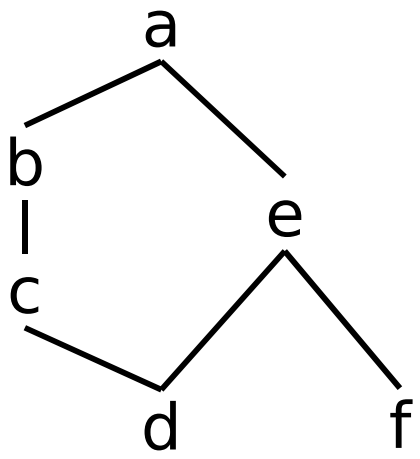
Finally...

Structure: a poset (or semilattice)

Operations: upper/lower bounds, part-of test

Suitable encoding?

- linear extensions: space O(n d)
- bit-vector: space O(n log n)



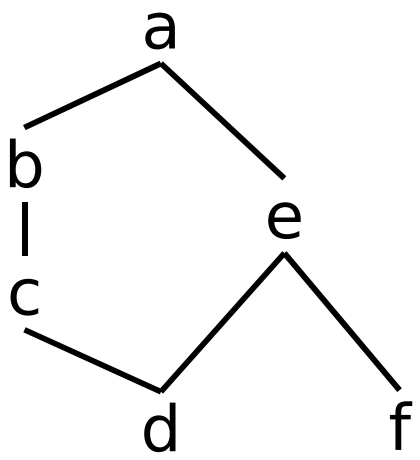
L_1: a > b > c > e > d > f
L_2: a > e > f > b > c > d

z(a)=1,2,3,4
z(b)=1,3,4
z(c)=1,3
z(d)=1
z(e)=1,2
z(f)=2

Questions?

Questions?

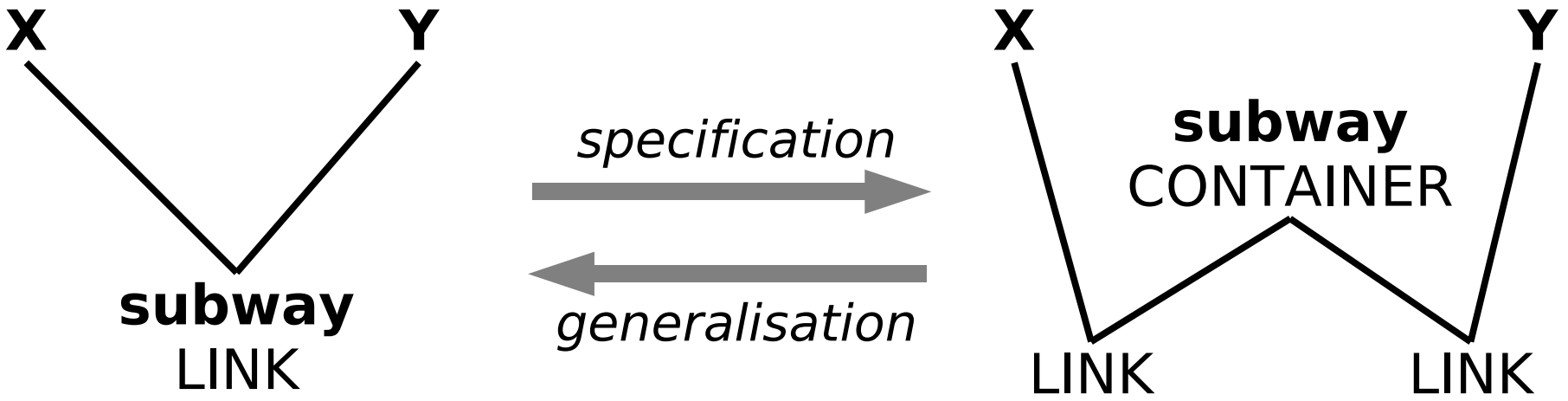
I have one...
How precisely is **knowledge** related to **semantics** and vice versa?

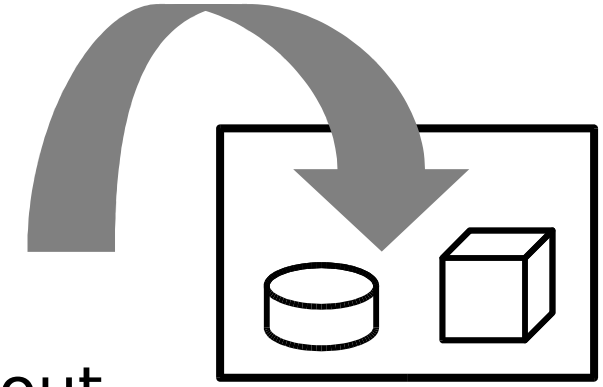


L_1: a > b > c > e > d > f
L_2: a > e > f > b > c > d

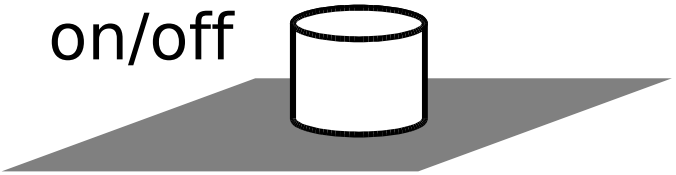
Upper bound of c is a poset: {a,b}
Since x > c for all x in P, x left of c in Li:
L_1: **a** > **b** > c > e > d > f
L_2: **a** > e > f > **b** > c > d

Sup(c,e)=a=min(↑c ∩ ↑e)

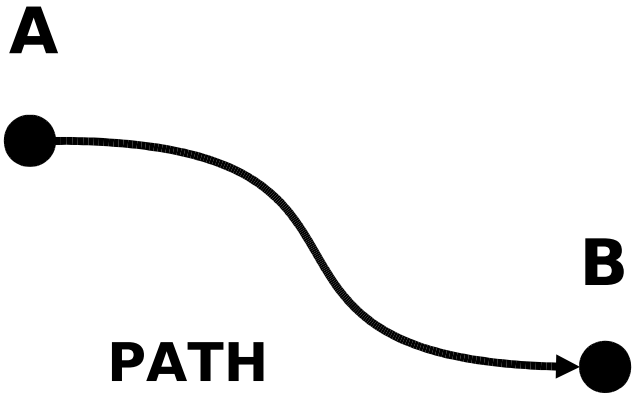




CONTAINER

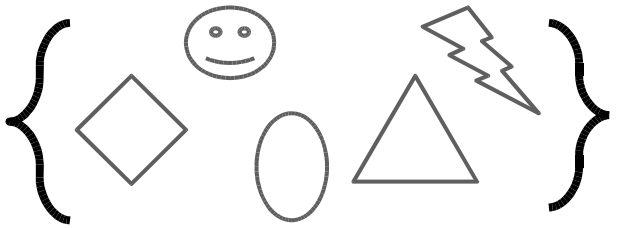


SURFACE

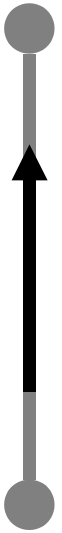


PATH

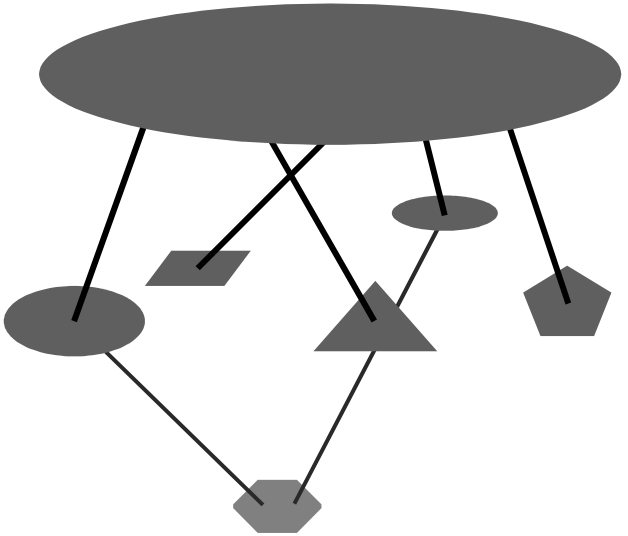
LINK



COLLECTION



VERTICALITY



PART-WHOLE