SST/SysML2 Semantic Assets and Debt : Space Modeling, Part 2

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Overview

- **Space Modeling**
  - **Review (ad/22-03-12)**
  - **Spatial “meets”**
  - **Surrounding**
  - **Bounding shapes**
  - **Shape library**
- **Items and Parts**
- **Summary**

Semantic credit card

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  - **Review (ad/22-03-12)**
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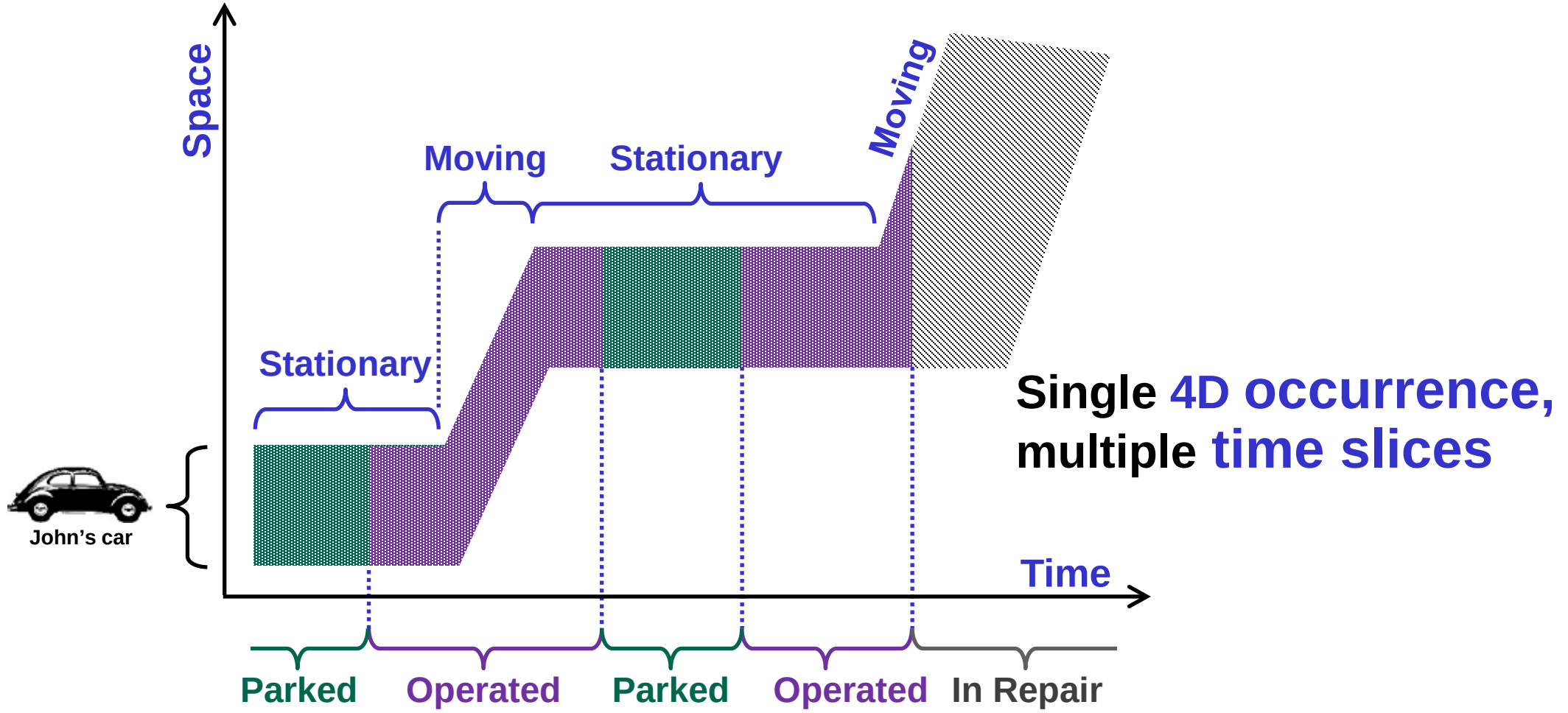
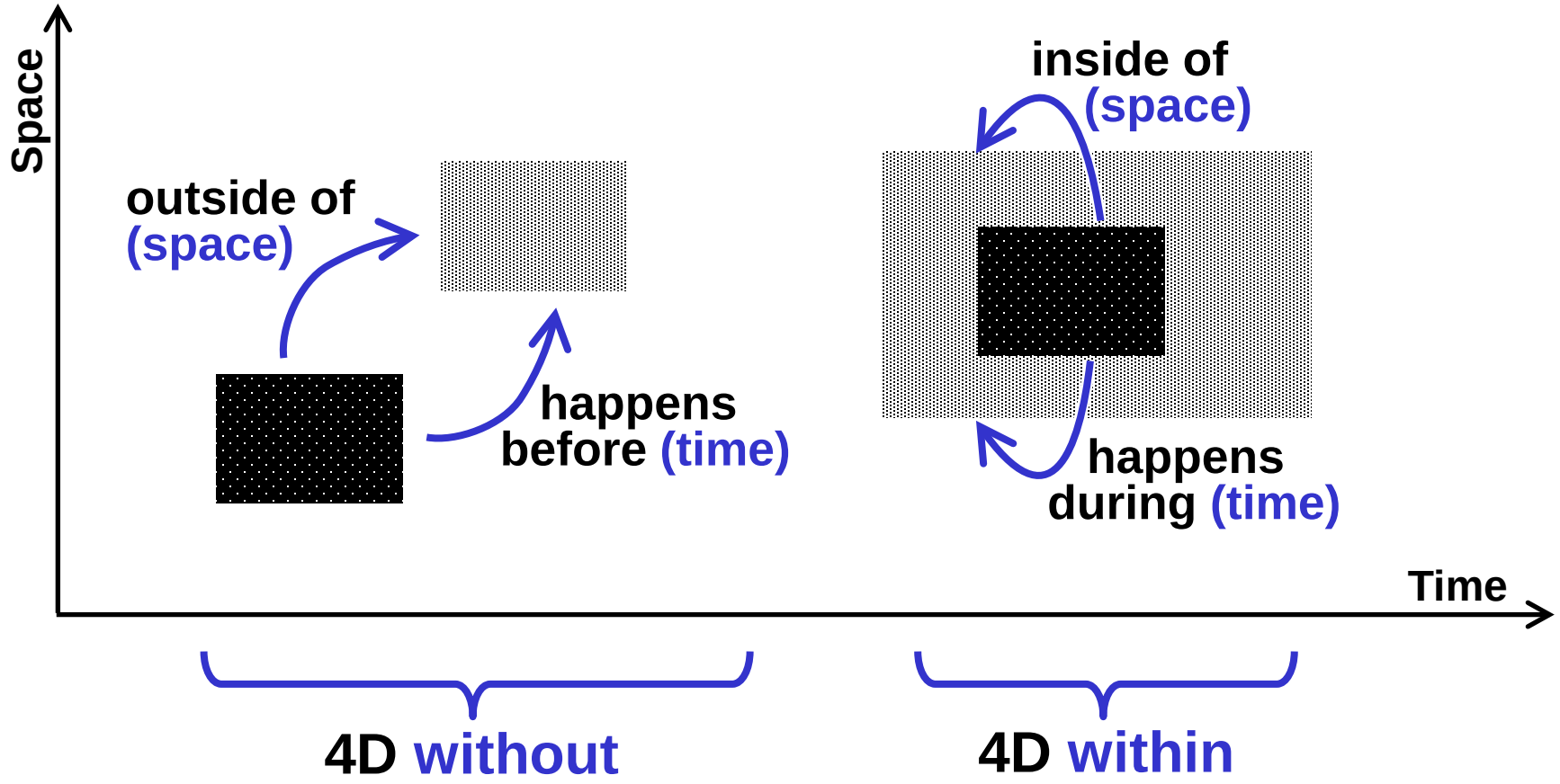
Time & Space: 4D (SST Occurrences)



Single 4D occurrence, multiple time slices

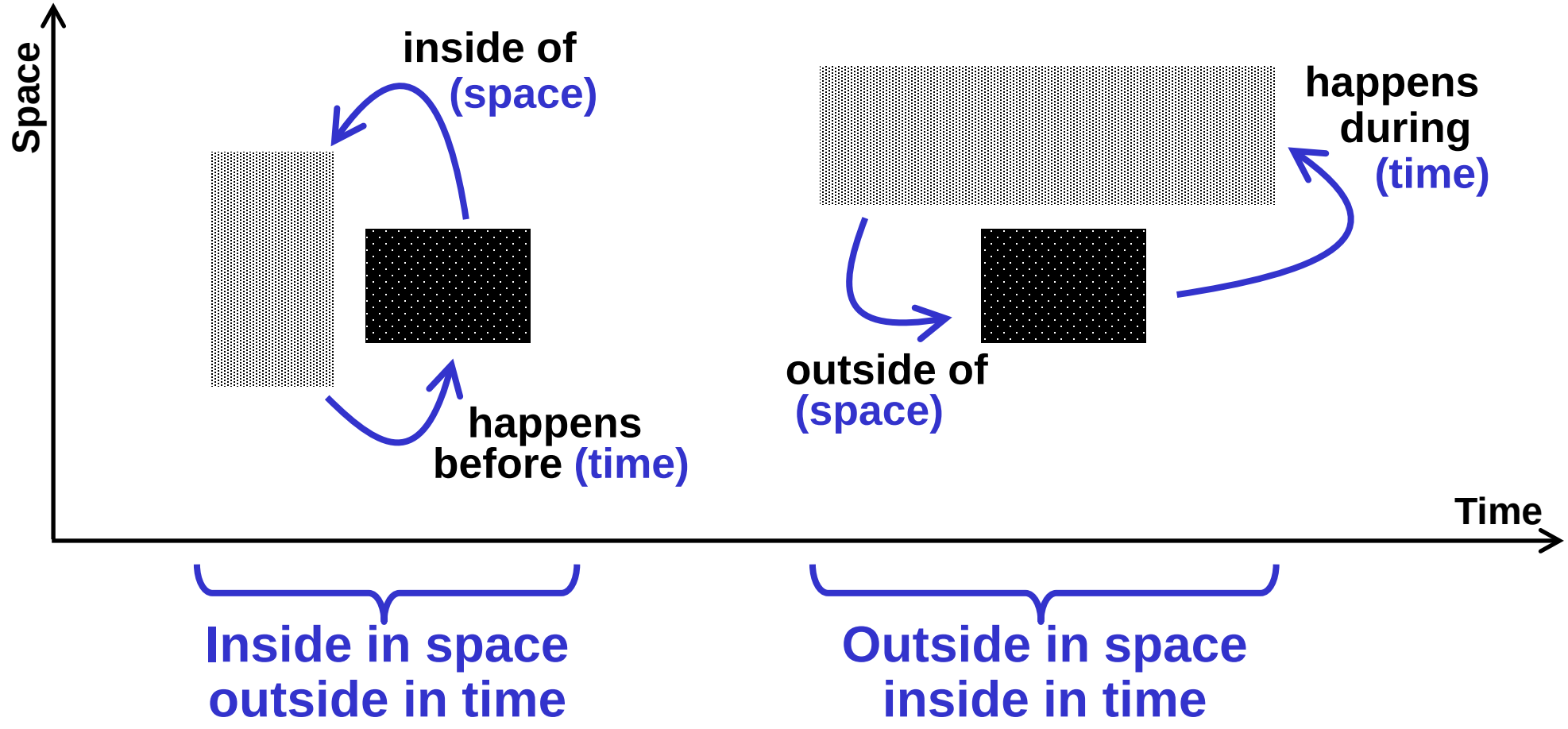
§ "Occupying" space, "taking up" time, all at once.

4D: “Exclusion” and “Inclusion”



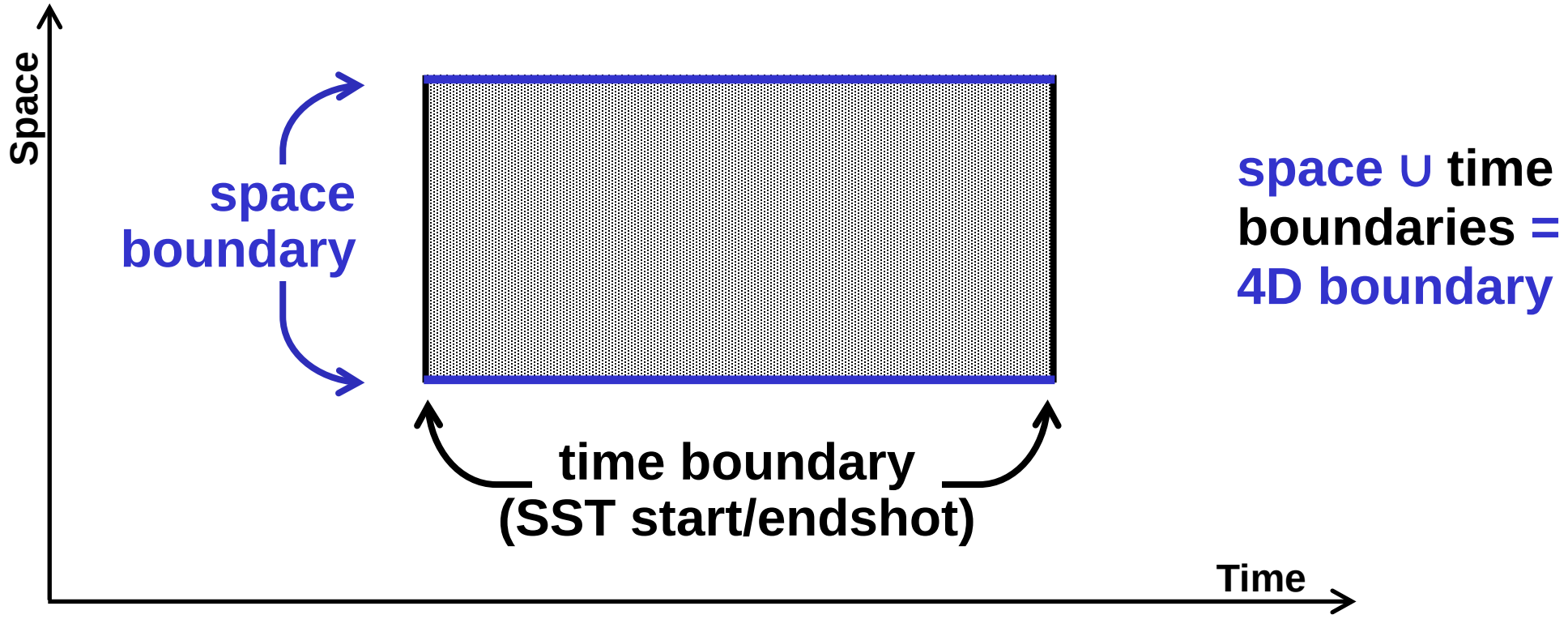
- Completely separate in 4D or completely included
  - Specialized to time and space separation/inclusion.

Inclusion: Time xor Space, Not Both



- Separate in time, not space, or vice-versa
  - Both imply 4D without

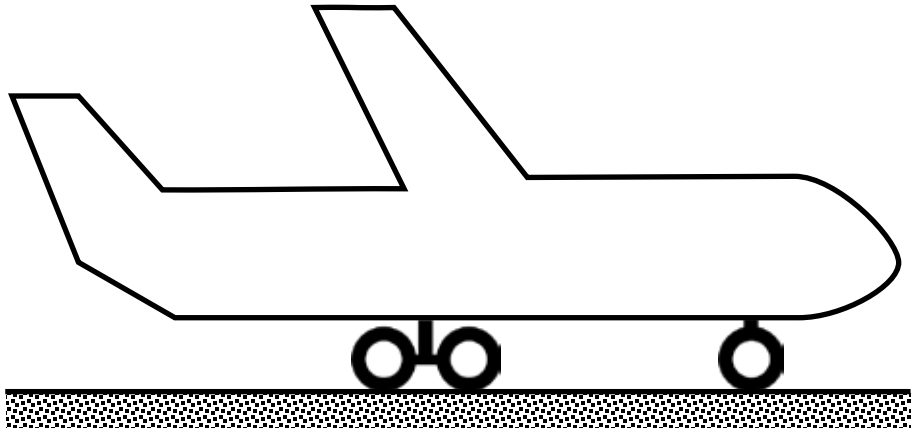
“Shapes” ≡ Spatial Boundaries

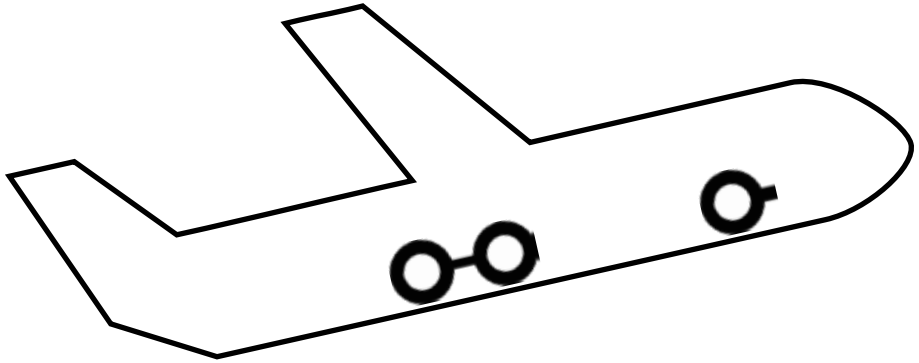


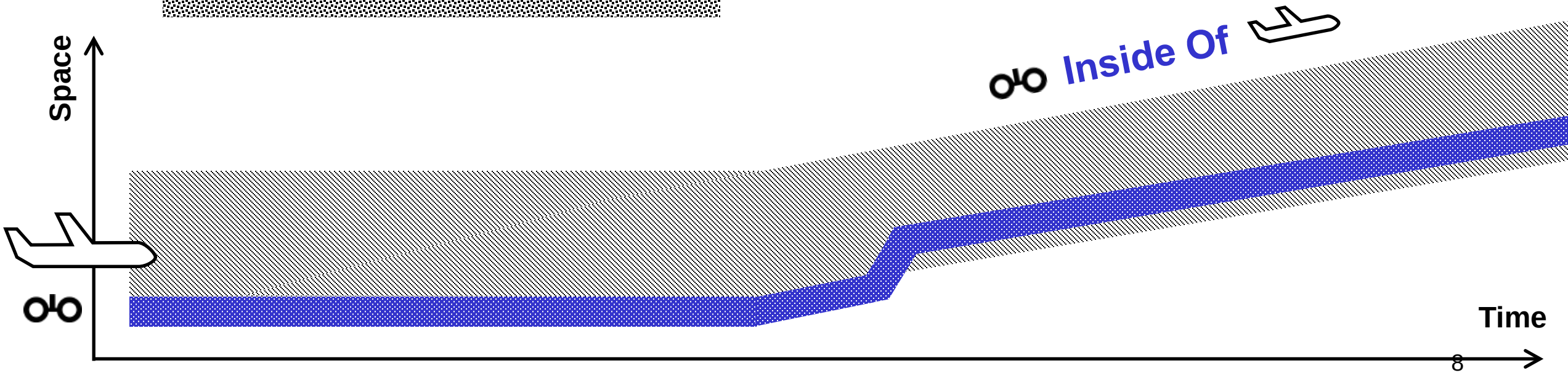
space ∪ time boundaries = 4D boundary

- Space boundary analogous to start/endShots ...
  - What’s the space version of time slices?

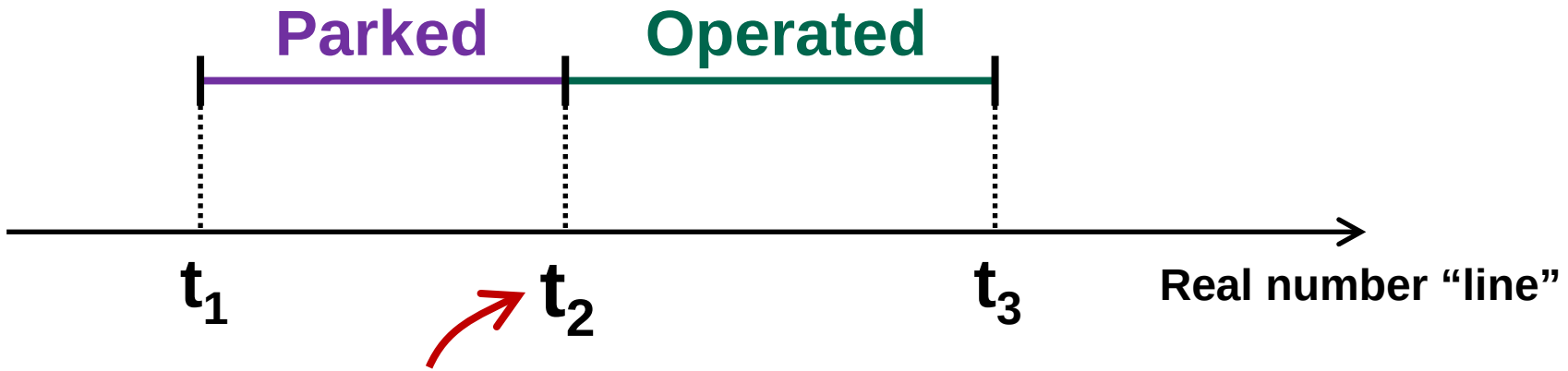
Qualitative Space Requirements







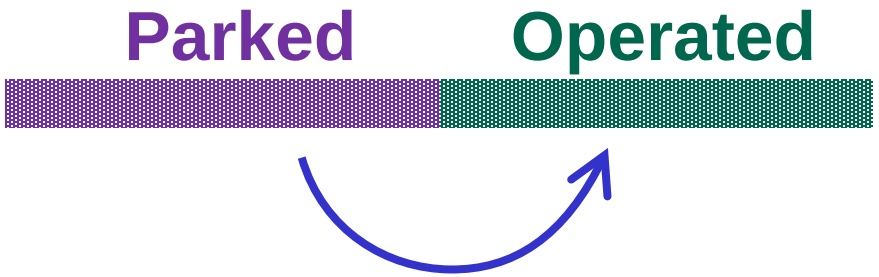
Quantitative Time Intervals Problem



Is the car parked or operated at t_2 ?

- **Intervals share the same number?**
- **Contradict each other.**

Qual Time: Logical Solution



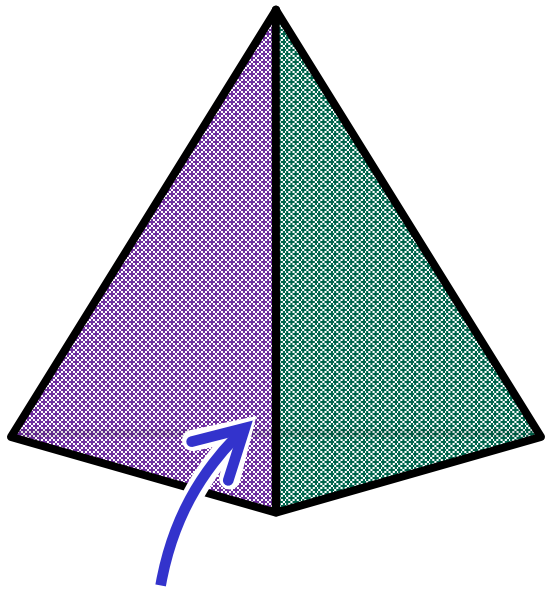
Happens Just Before

≡

No periods happen
after Parked and before Operated

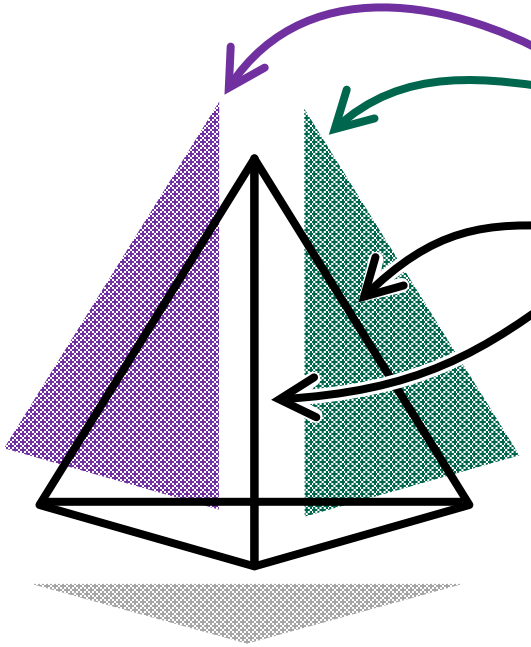
- **A special kind of Happens Before**
  - **No time periods after the earlier one and before the later one.**
- **No contradiction**
  - **Parked and Operated apply to completely separate periods.**

Space Modeling



What color is this edge?

Quant

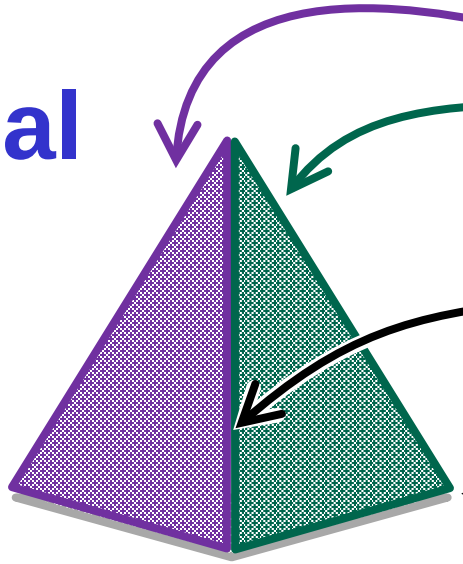


Open sets of surface points

bounded by the same lines with …

either no color or contradictory colors

Qual

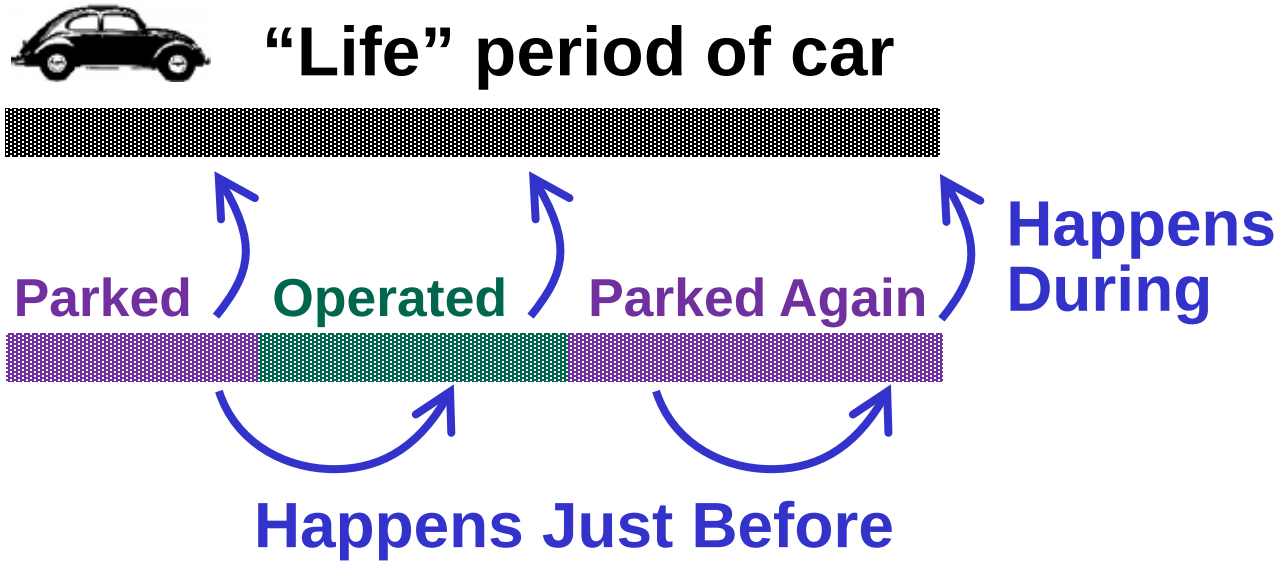


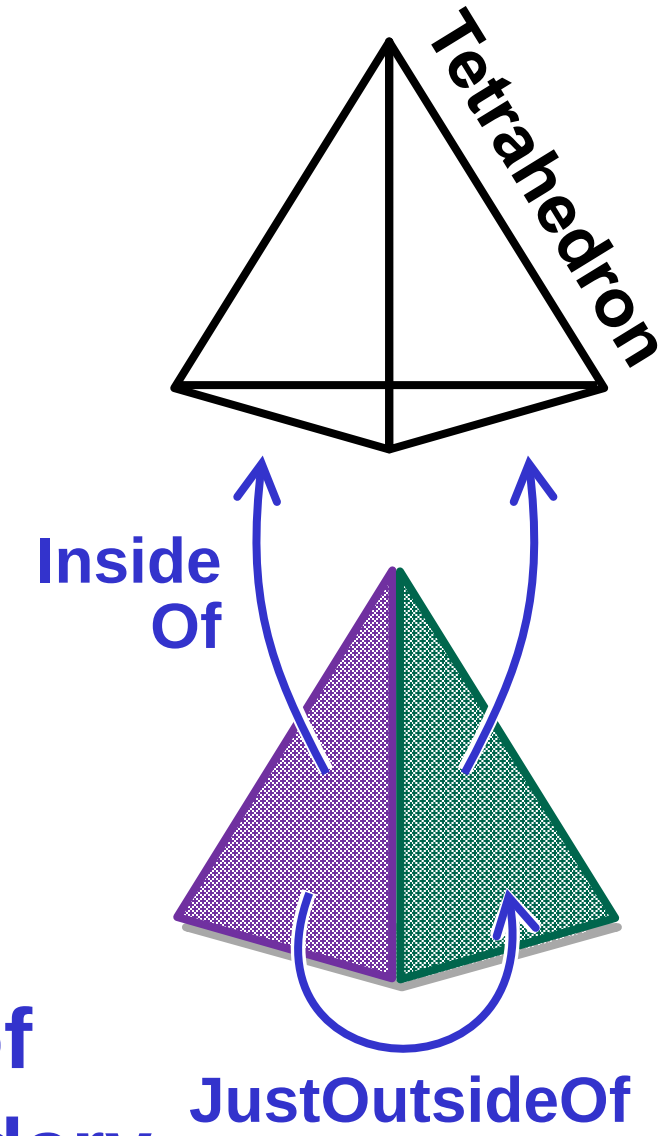
Spatial regions with their own boundary lines and colors

and no other regions in between

- Same problem …
- … same solution.

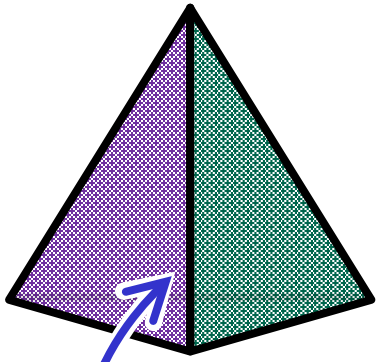
Qual Time and Space: Similarities



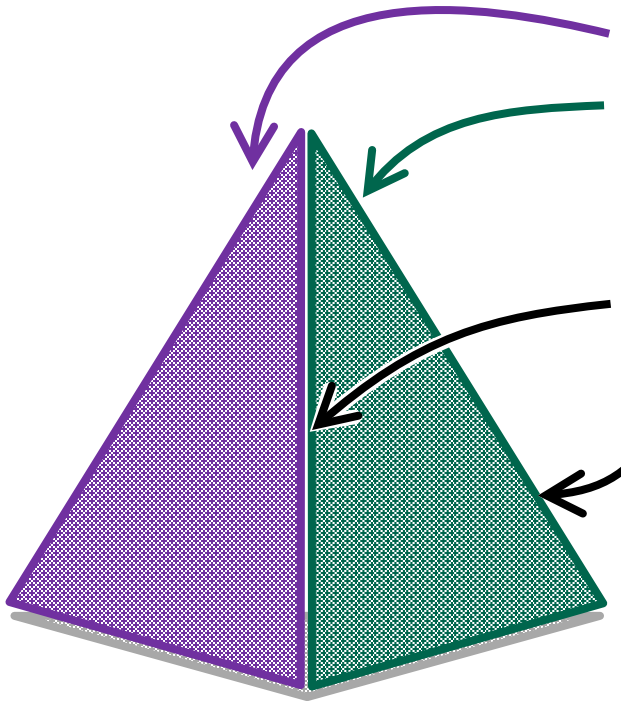


- Time period ~ space region
- Happens during ~ inside
- Happens before ~ outside
- Happens just before ~ just outside of
- Time period start/end ~ space boundary

Topo Cells Should "Touch"



What color is this edge?



Spatial regions with their own boundary lines and colors

and no other regions in between

- Need "just outside of"
  - Like RCC external connection, but without overlap.

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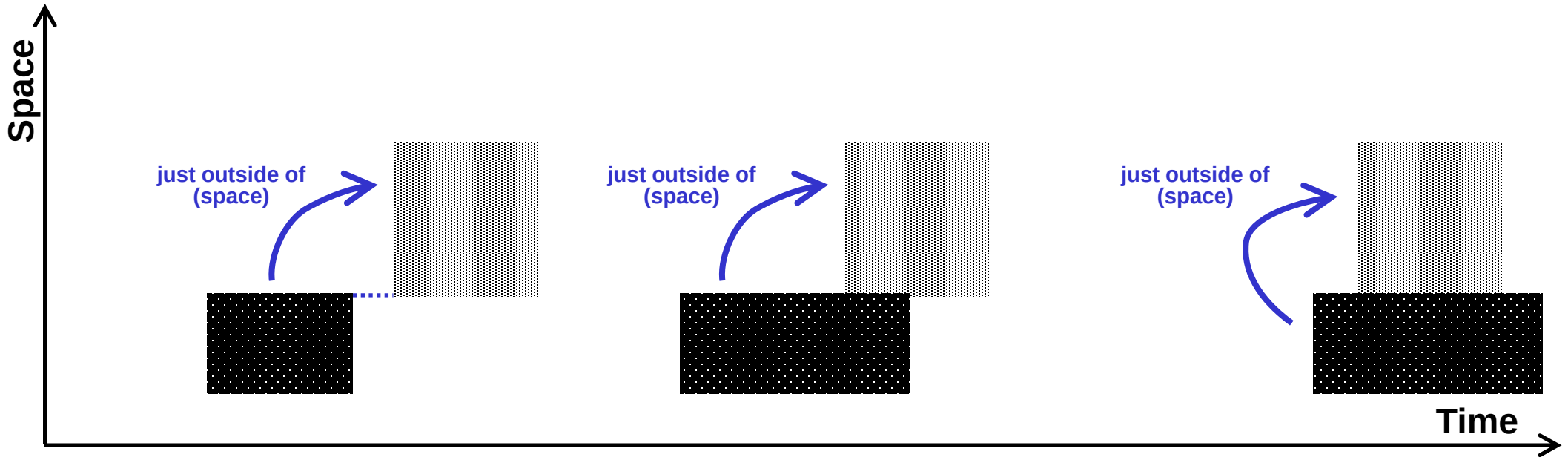
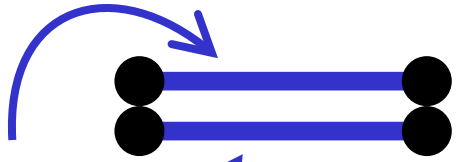
JustOutsideOf



- **Analogous to HappensJustBefore**
  - **even if spatially separated.**

Mating (“completely” JOOf)

2 x 1 dim



not closed

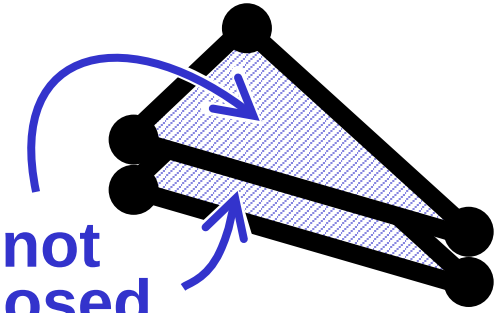
(could) union to

1d boundary (closed)

surface with no interior

1 x 2 dim

2 x 2 dim



not closed

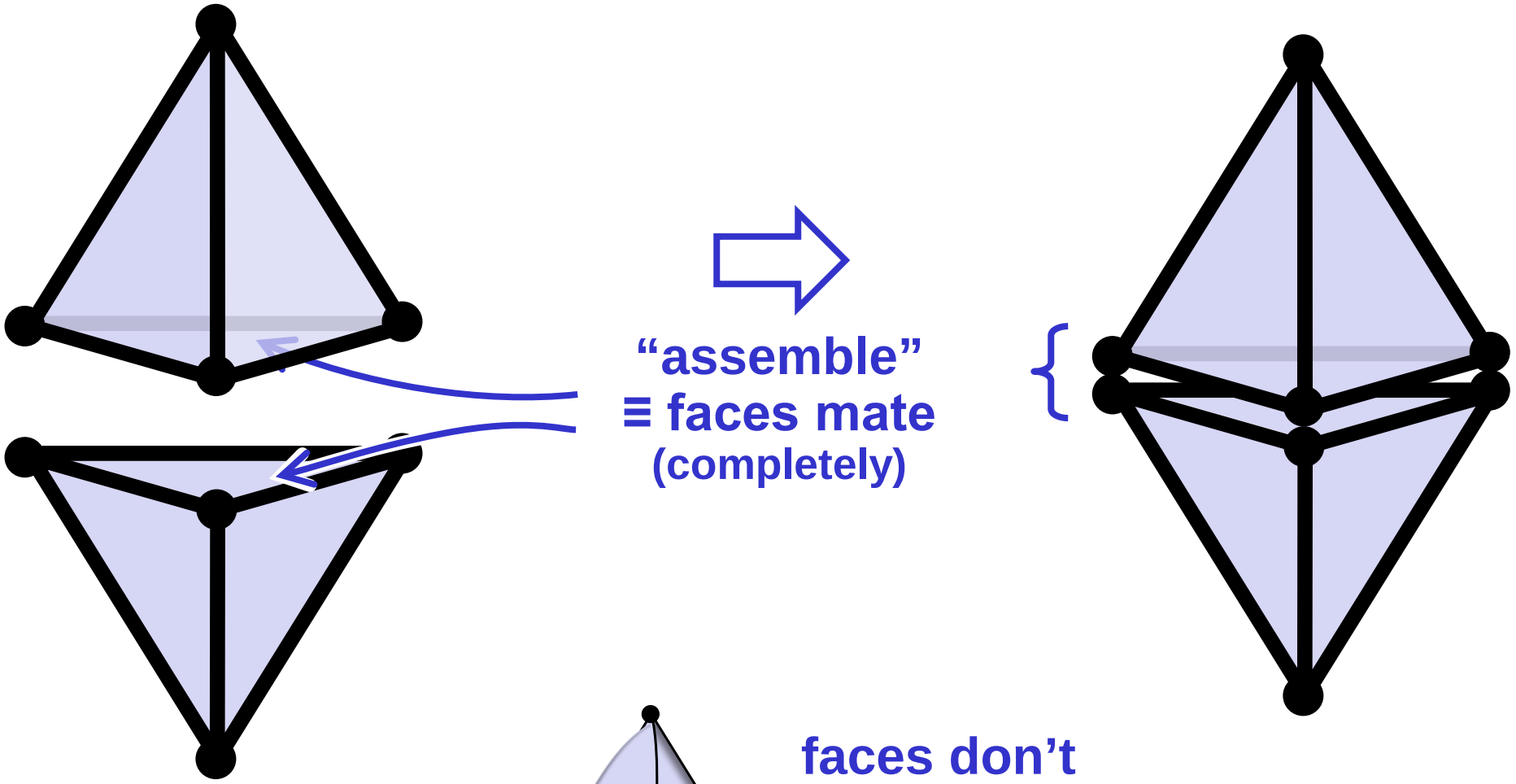
(could) union to

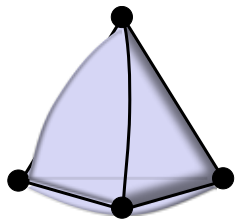
2d boundary (closed)

body with no interior

1 x 3 dim

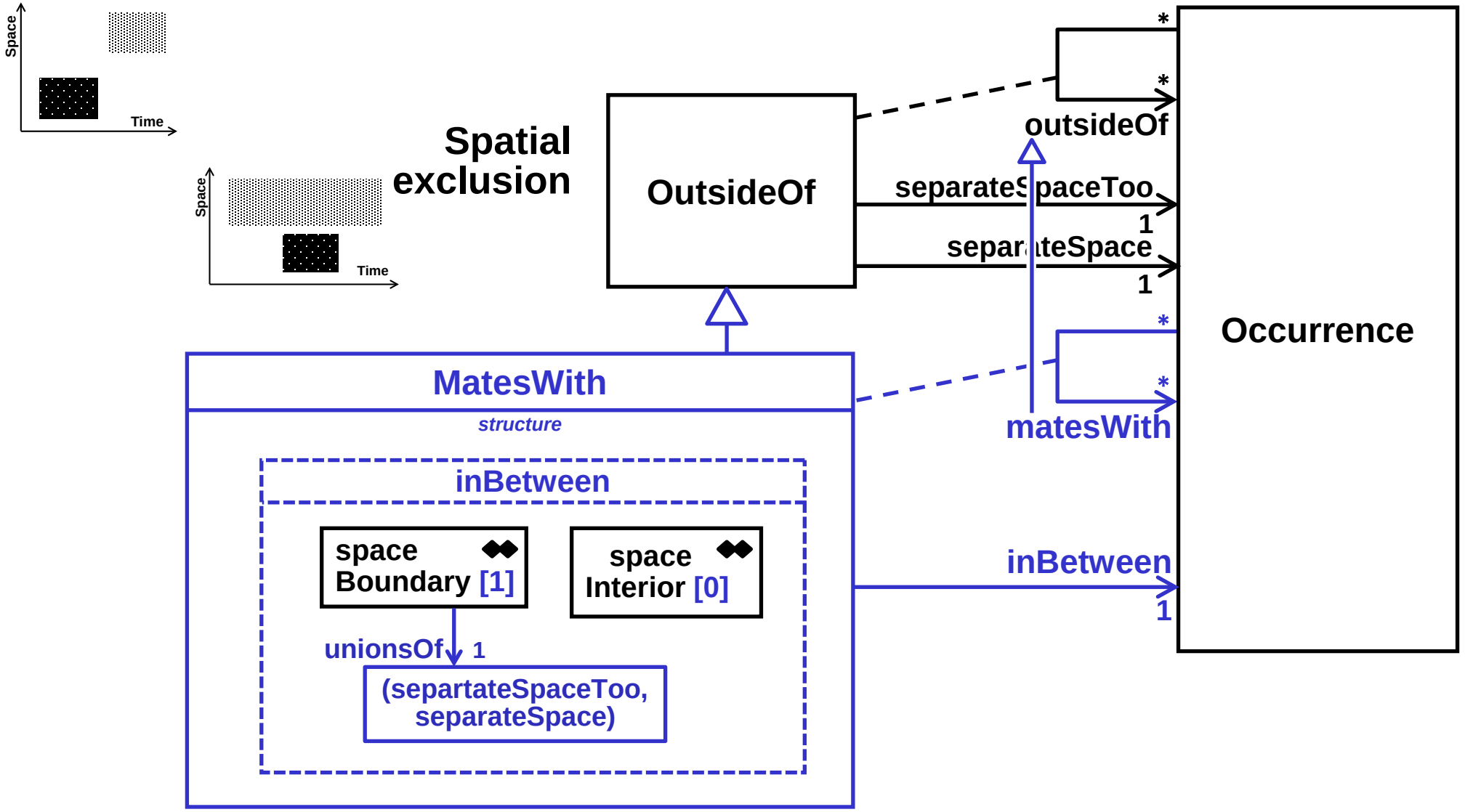
2D Mating, 3D JustOutsideOf ("assembly")



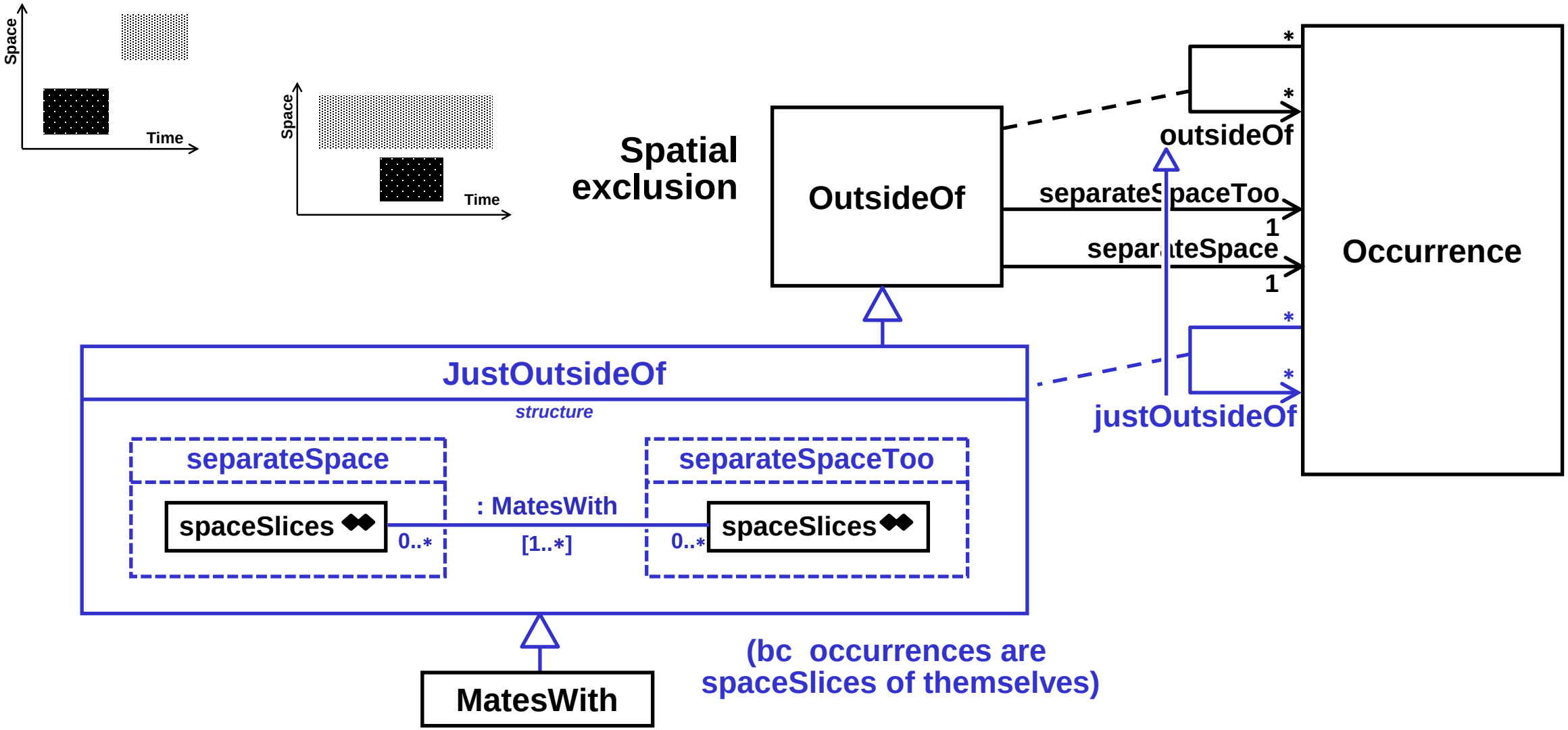


faces don't need to be flat

MatesWith

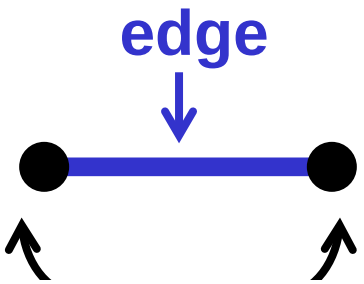

Space
Time
Spatial exclusion
Space
Time
OutsideOf
outsideOf
separateSpaceToo
1
separateSpace
1
*
*
*
*
Occurrence
MatesWith
structure
inBetween
space Boundary [1]
space Interior [0]
unionsOf
1
(separtateSpaceToo, separateSpace)
matesWith
inBetween
1

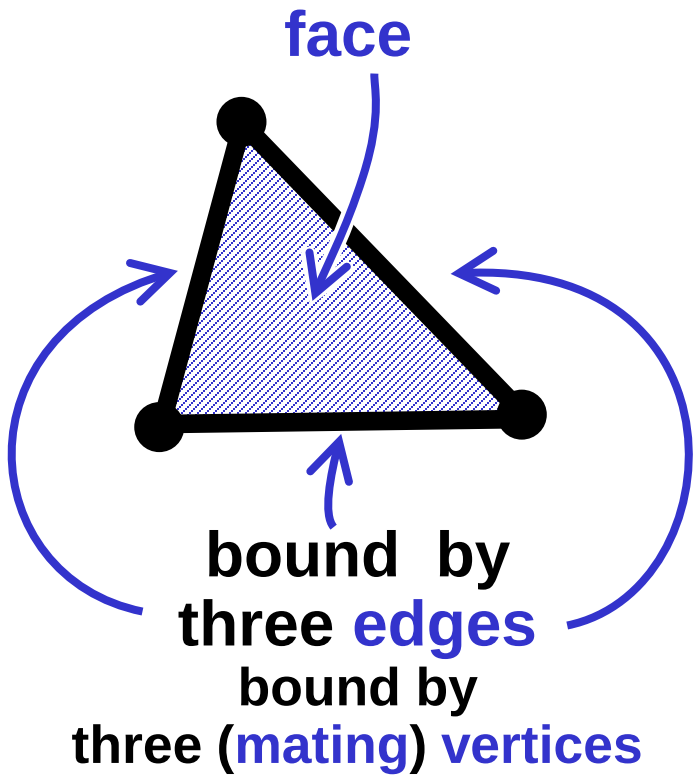
JustOutsideOf

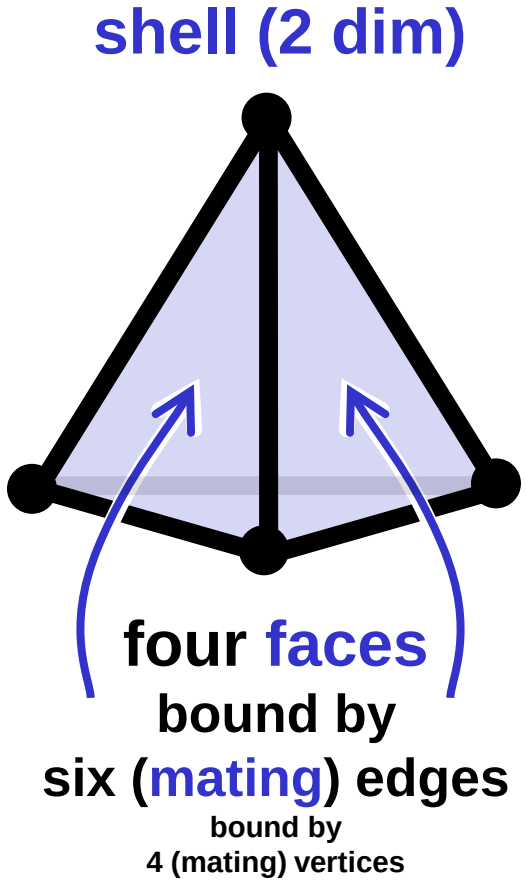


§ **Implies mating slices are of the boundaries.**

Topological “Structure”

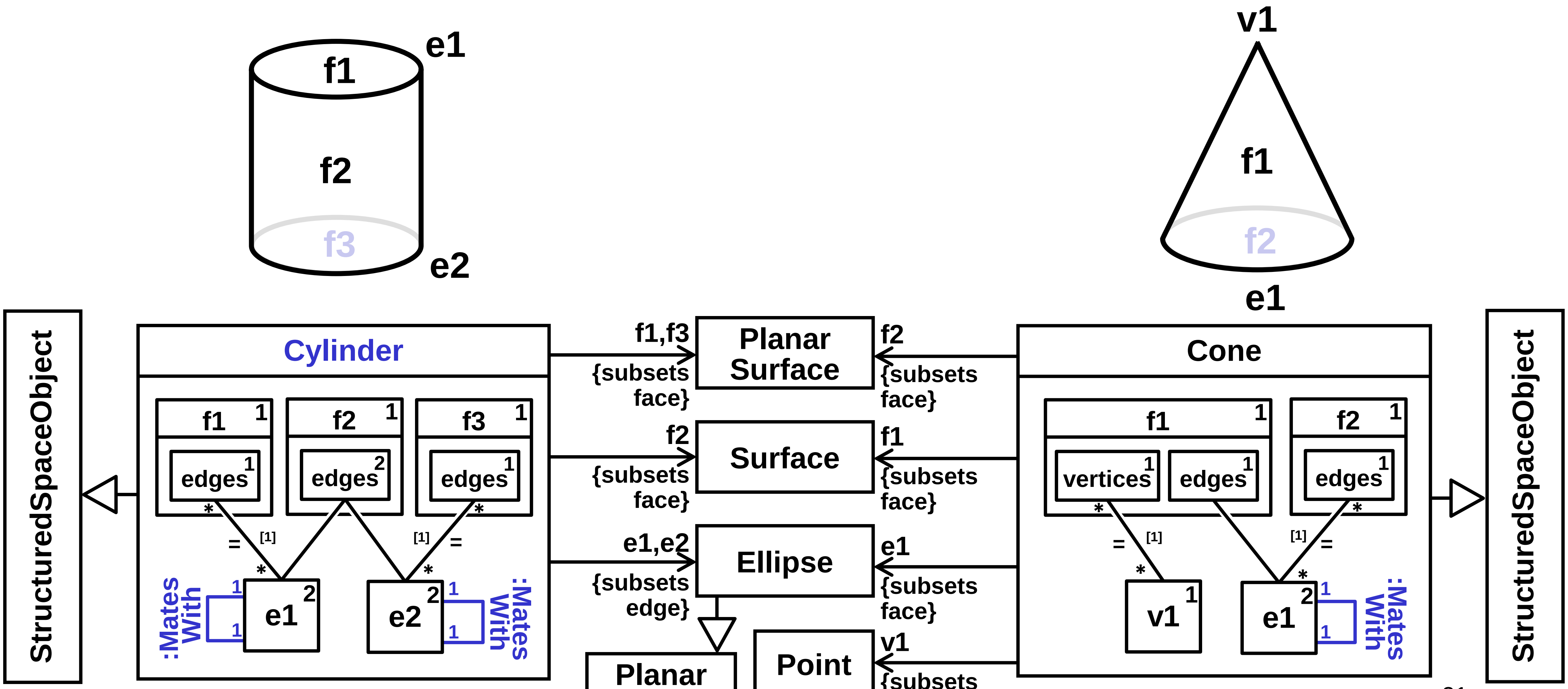






- Vertices, faces, and edges are roles played by
  - points, curves, and surfaces.

Revised Boundary Structures



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{/innerSpaceDimension = 2}
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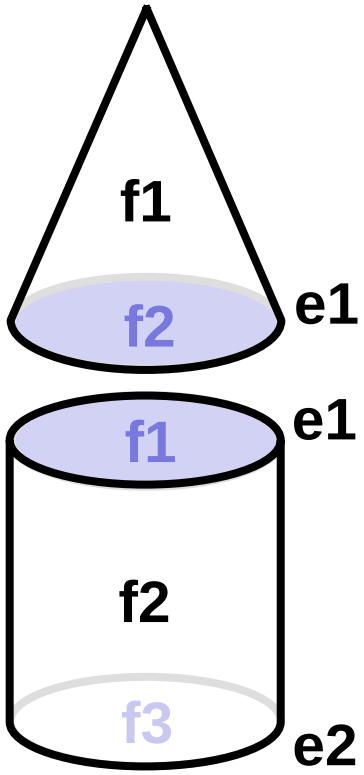
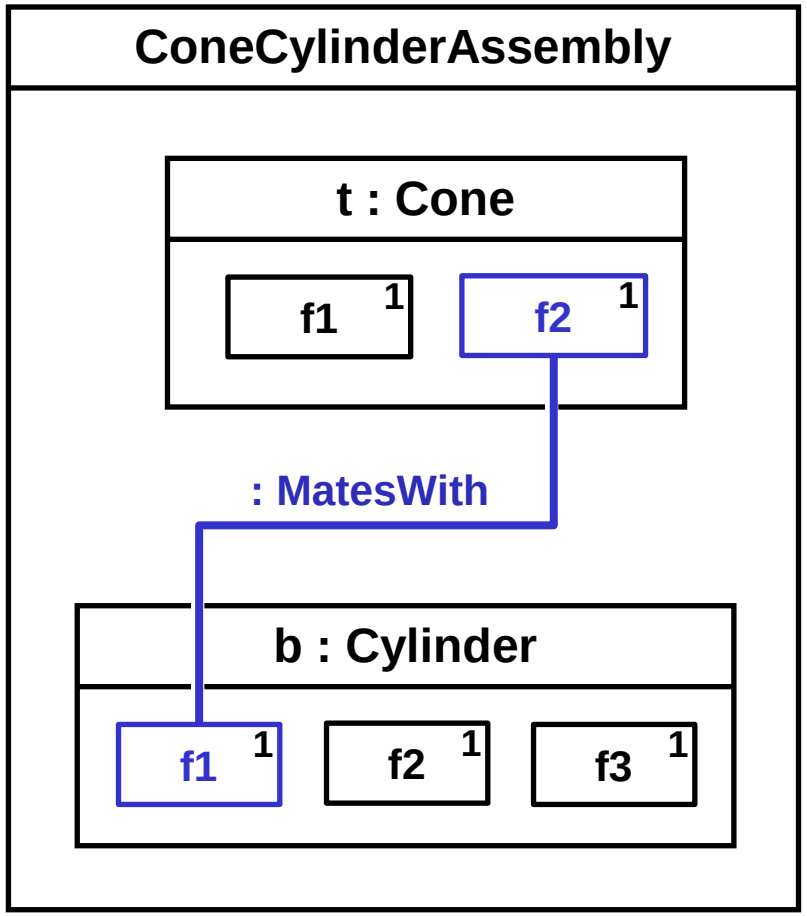
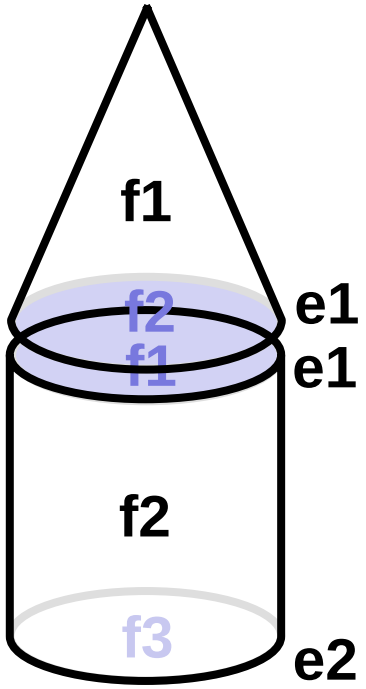
Assembly







§ **Implies b: and t: are JustOutsideOf each other.**

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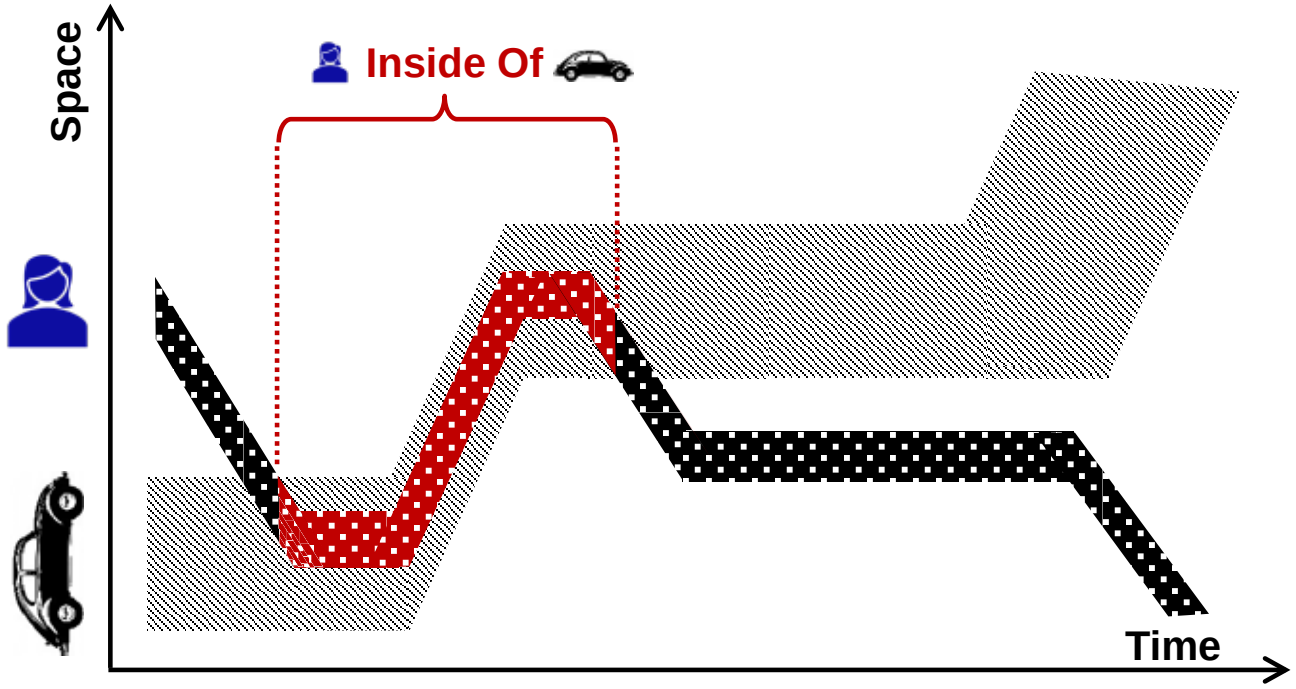
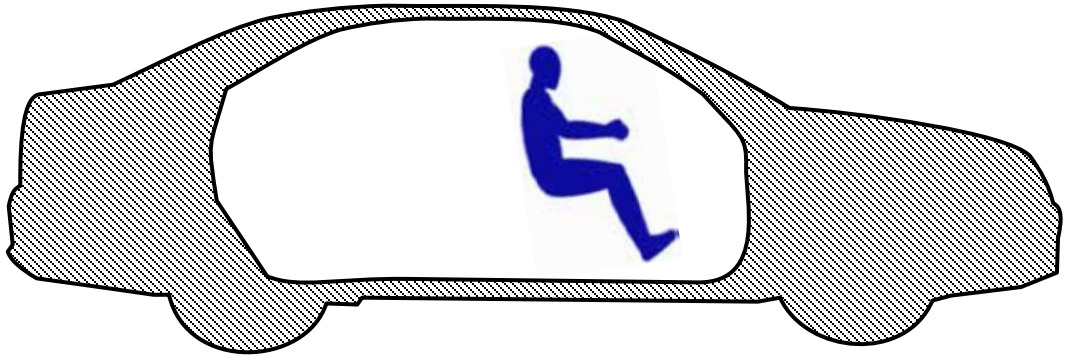
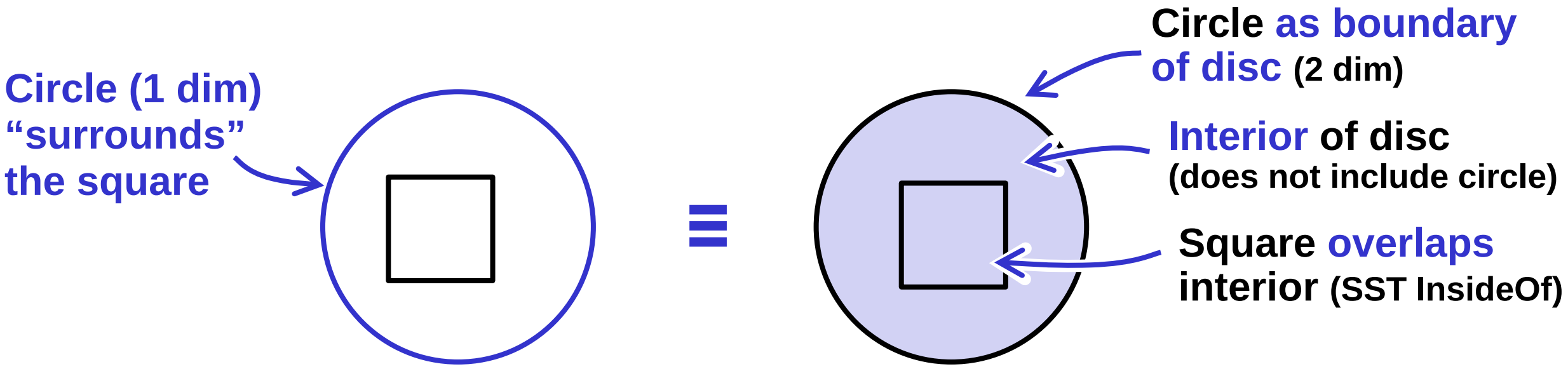
Surrounds, not InsideOf





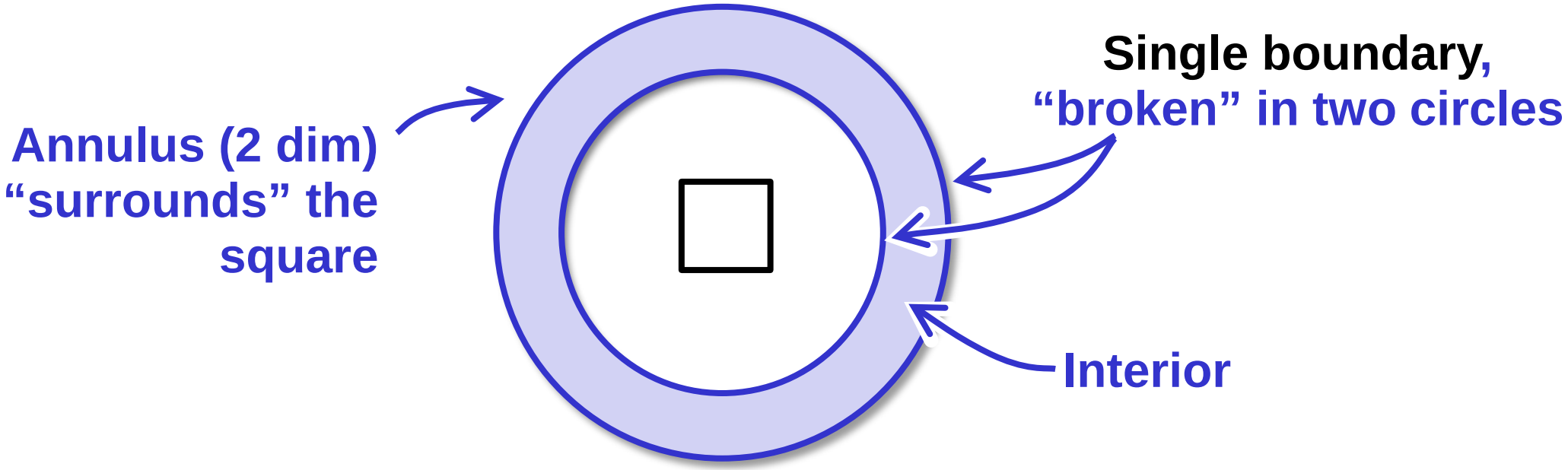
- People in car aren't in its material (metal, glass, etc).
  - They're in a space surrounded by the material.
- Space taken by car doesn't include the passenger compartment.

1) Closed Surrounder, Inner Space



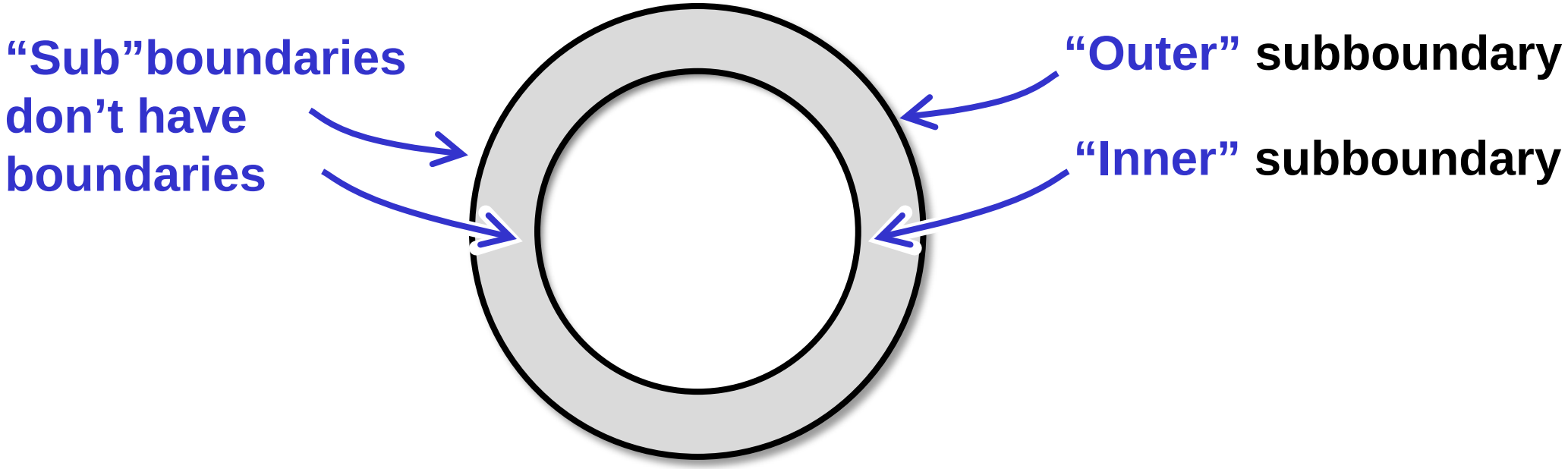
- **Surrounds ≡ SST InsideOf hypothetical interior.**
  - **Square does not overlap the surrounding circle.**
  - **Same as RCC non-tangential proper part.**

2) Open Surrounder, Inner Space ?



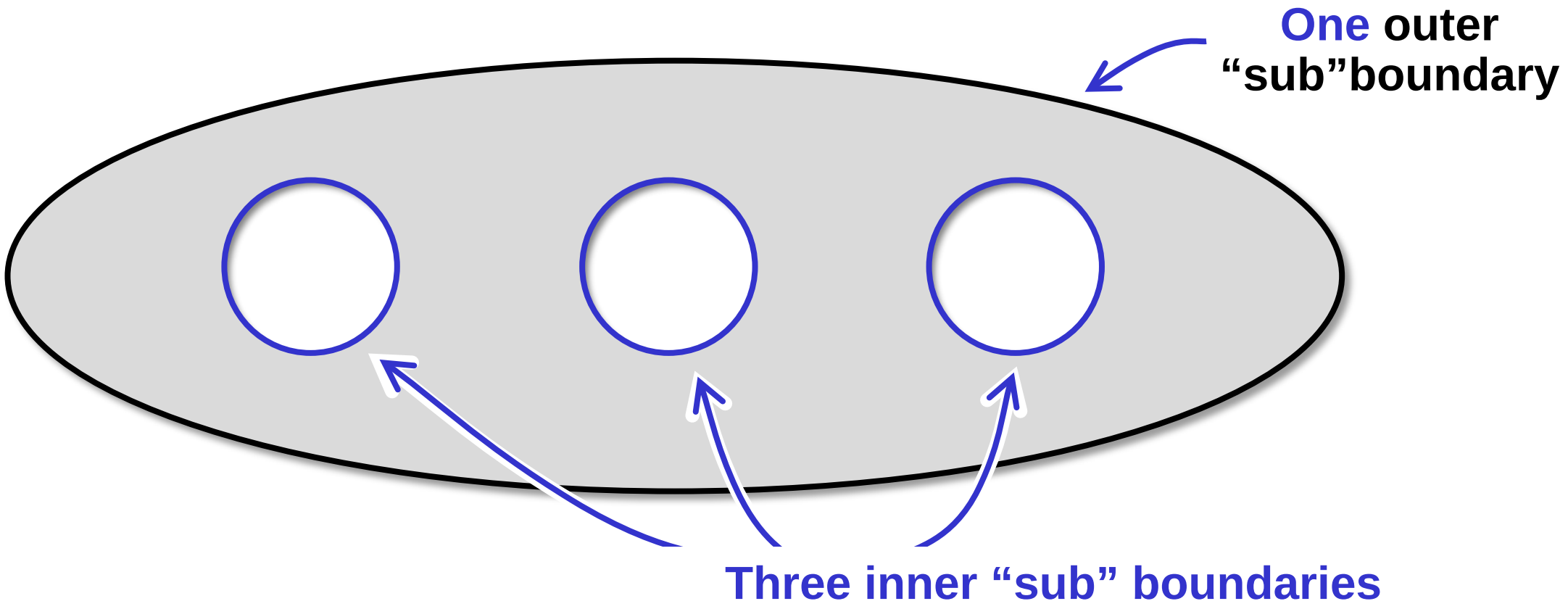
- Boundary = union of two circles (is disconnected).
- Surrounded area is not the interior.
- What is square surrounded by?

Disconnected Boundary, Inner/Outer



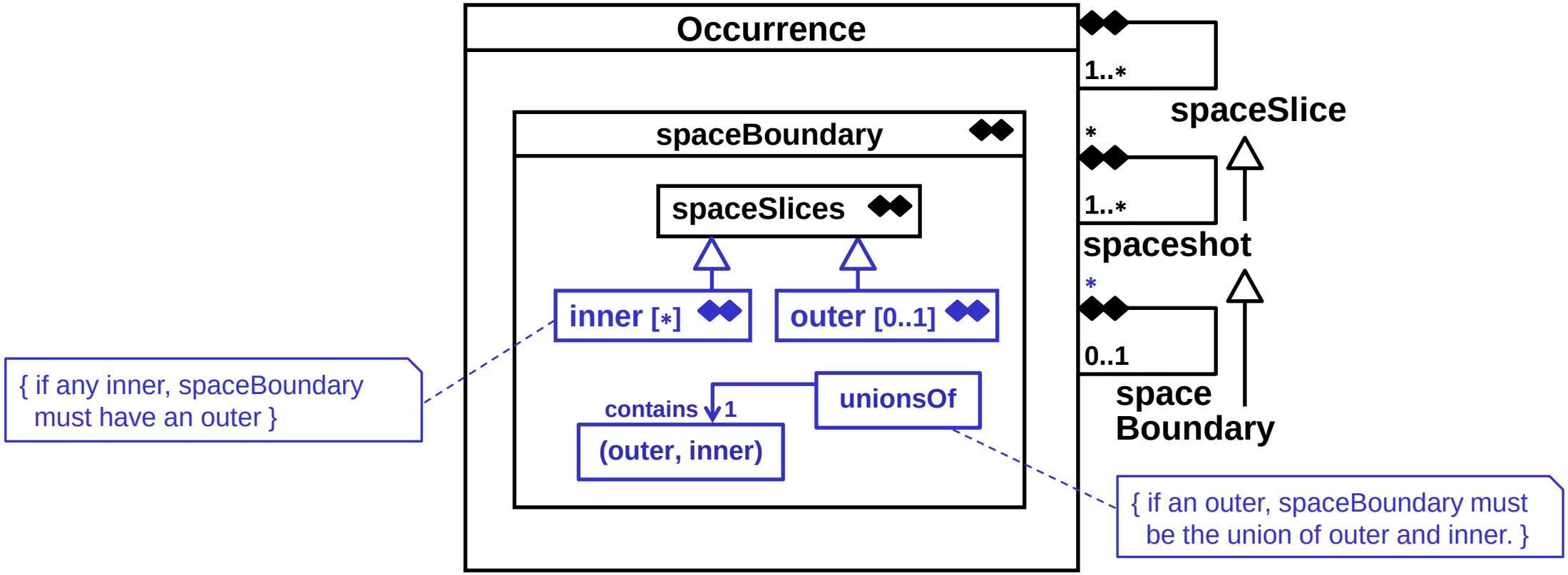
- **Space slices of boundary that have no boundary.**
  - Implies they’re non-overlapping/non-intersecting, disconnected?
- **“Outer” is the one that surrounds the other (“inner”).**

Multiple inner “sub” boundaries



- “Outer” is the one that surrounds all the others (“inner”).

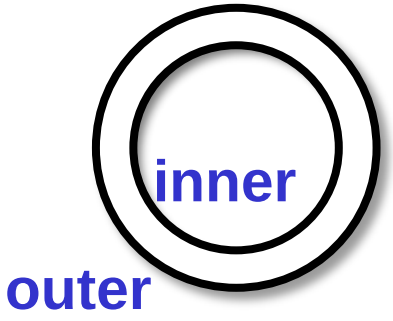
Outer/Inner Space Boundaries

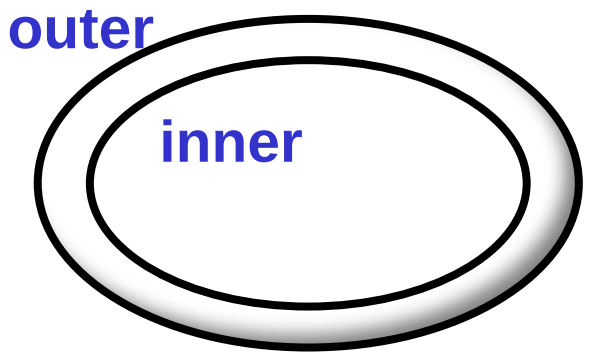


§ **Inner/outer nested under spaceBoundary.**

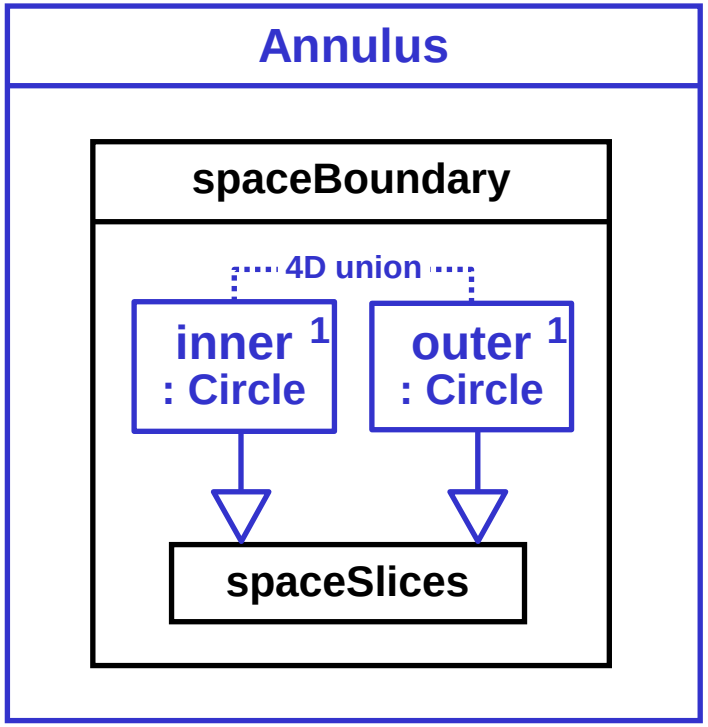
Outer/Inner Space Boundaries

(2D)





(3D)



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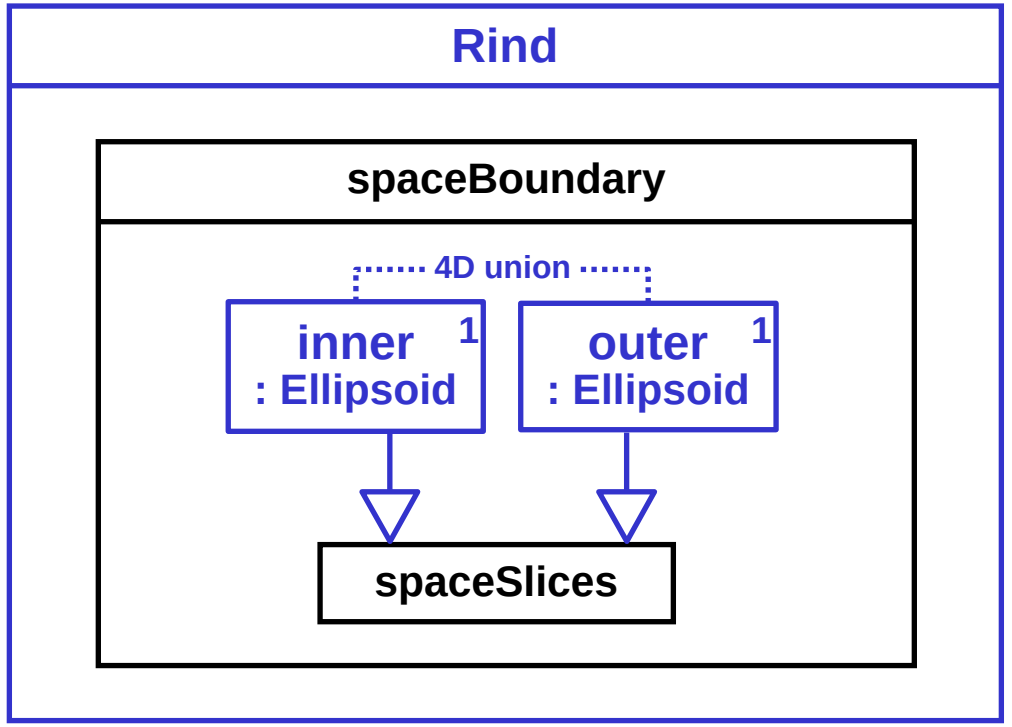

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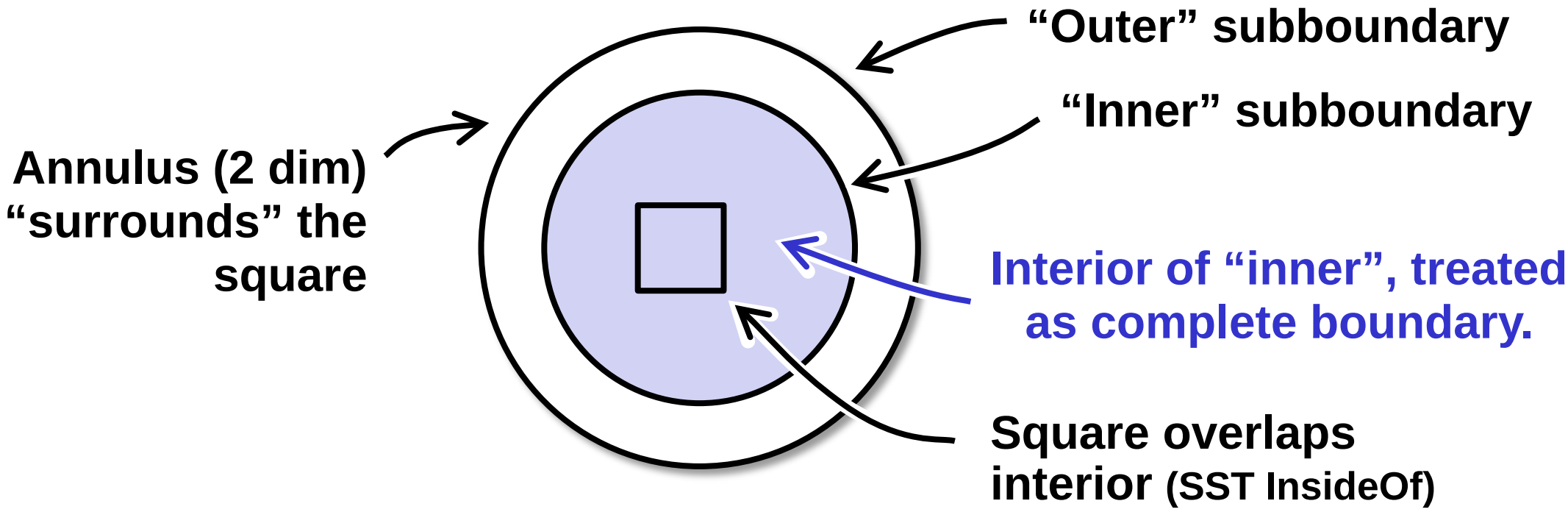
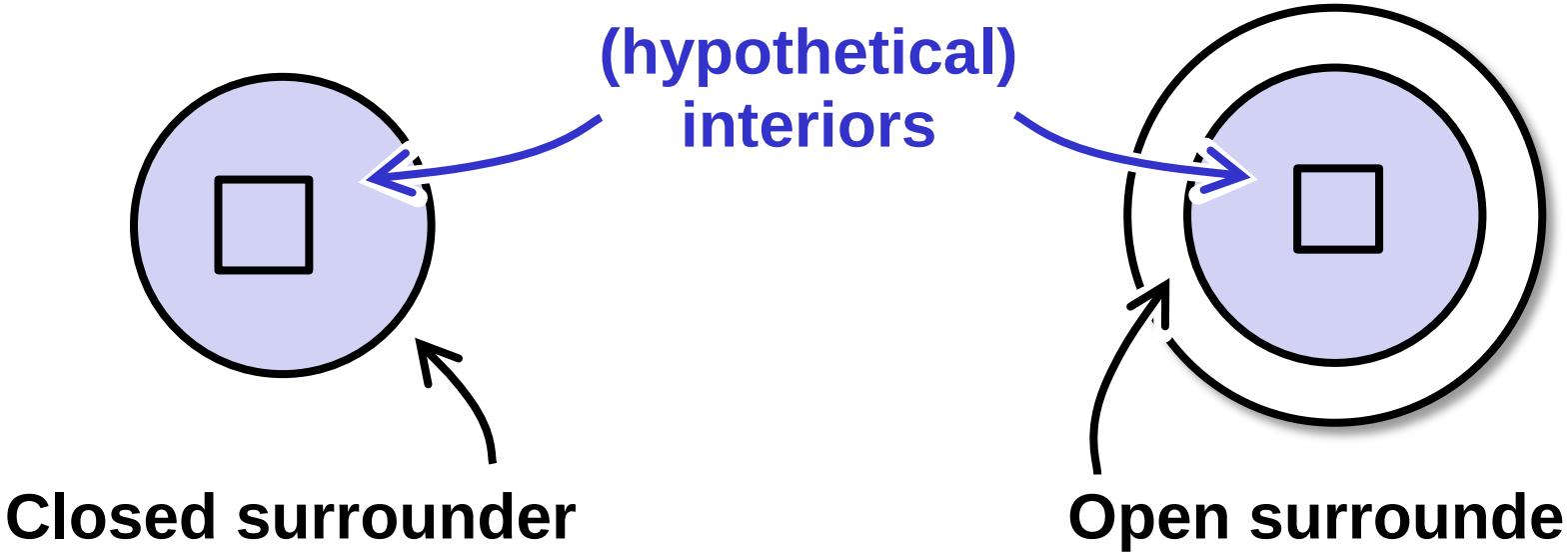
2) Open Surrounder, Inner Space



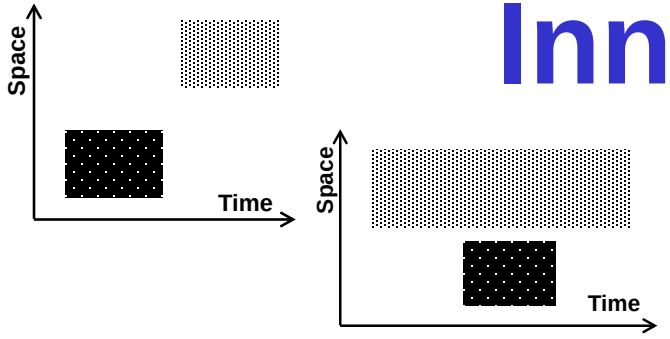
- Surrounds ≡ overlaps hypothetical interior of ...
  - an inner boundary treated as a complete one.
- No inner boundary, can’t surround anything.

1) and 2) Surrounds, Inner Spaces



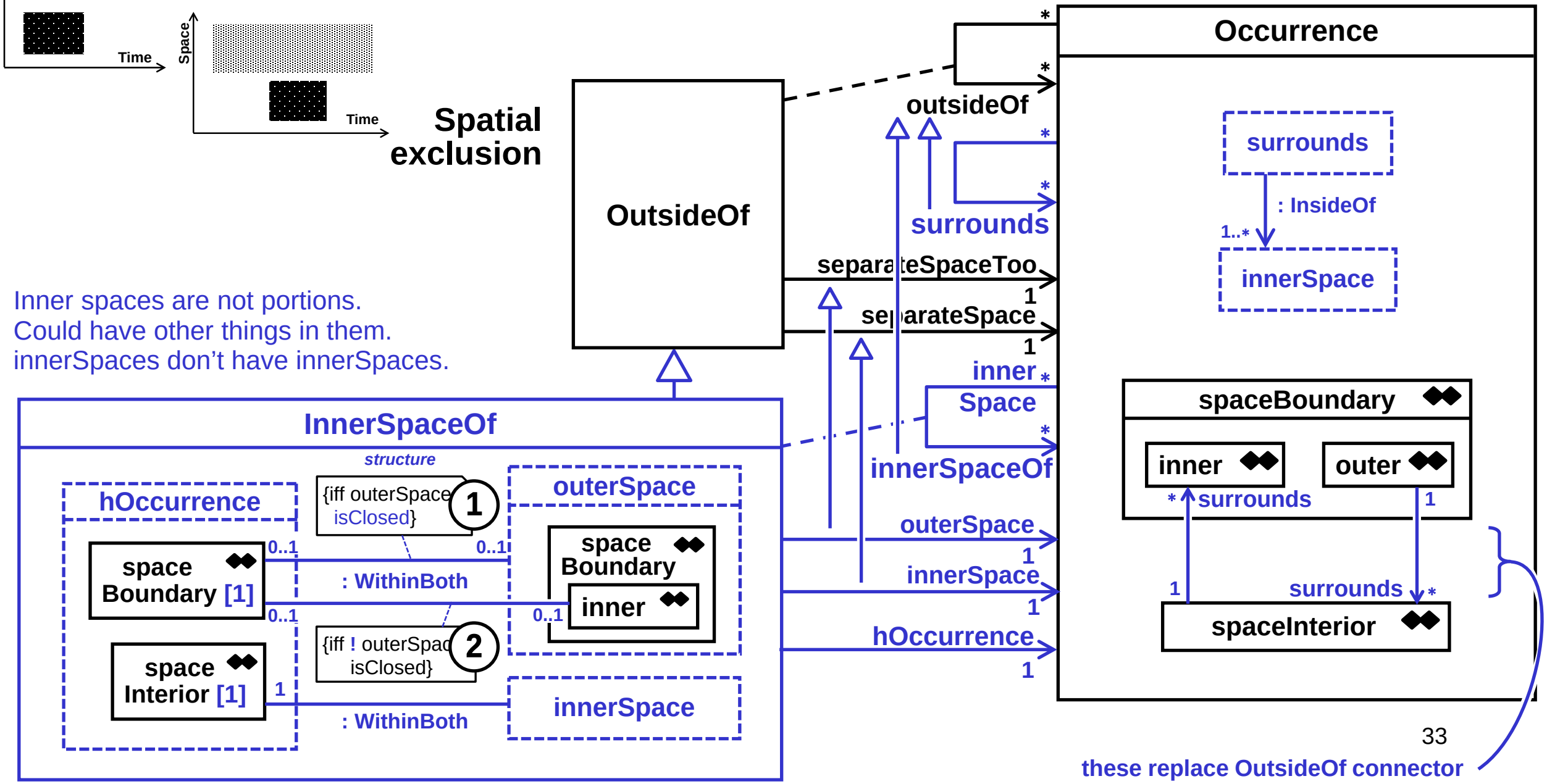
- spaceEnclosed by spaceInterior of hypothetical occurrence that has spaceBoundary =
  1. Surrounder if it is closed
  2. An innerSpaceBoundary of surrounder if it's open.

Inner Space and Surrounds



Spatial exclusion

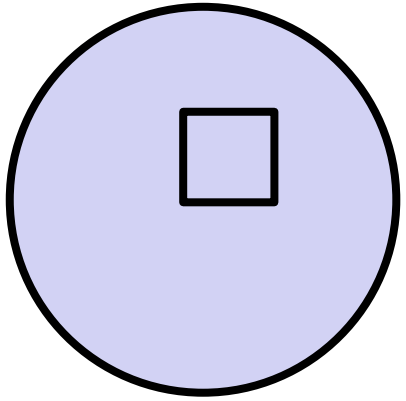
Inner spaces are not portions.
Could have other things in them.
innerSpaces don't have innerSpaces.

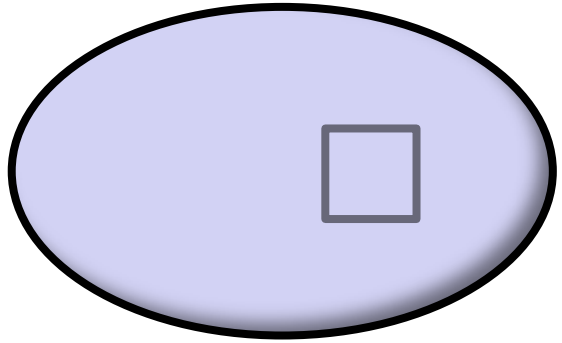


these replace OutsideOf connector

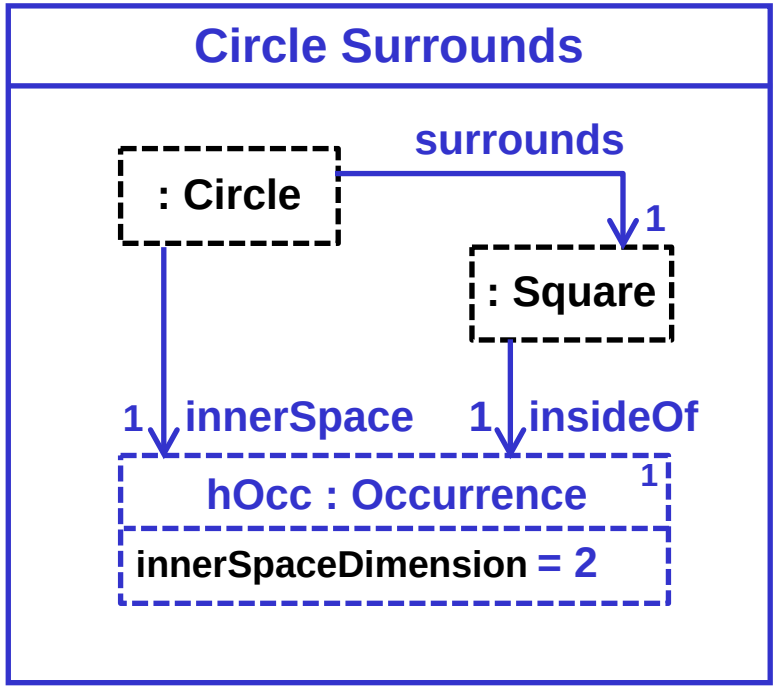
Inner Space and Surrounds, 1) Closed

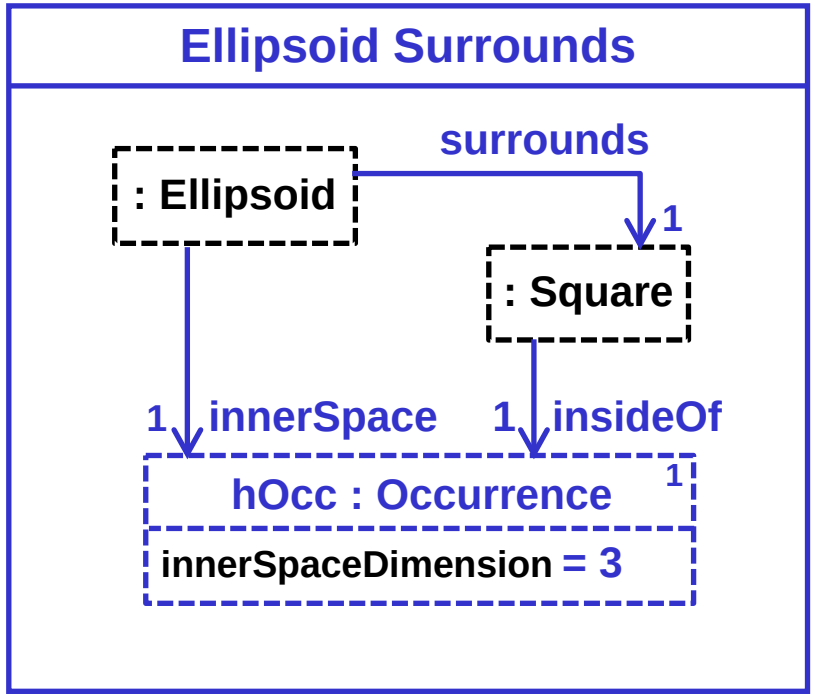
(2D)





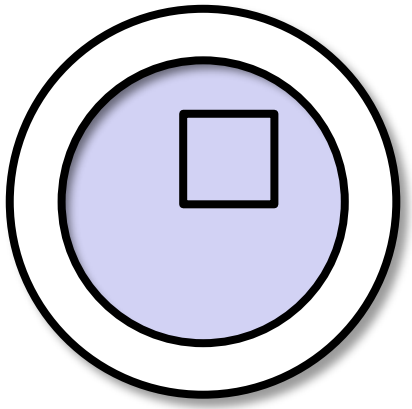
(3D)

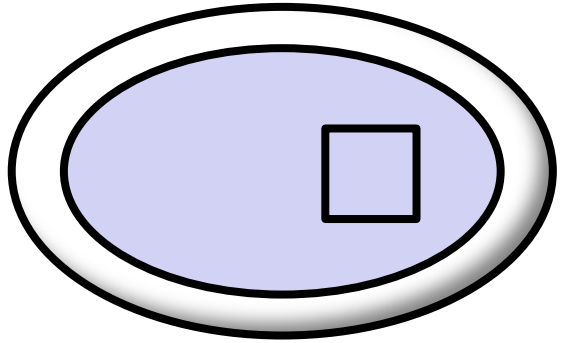




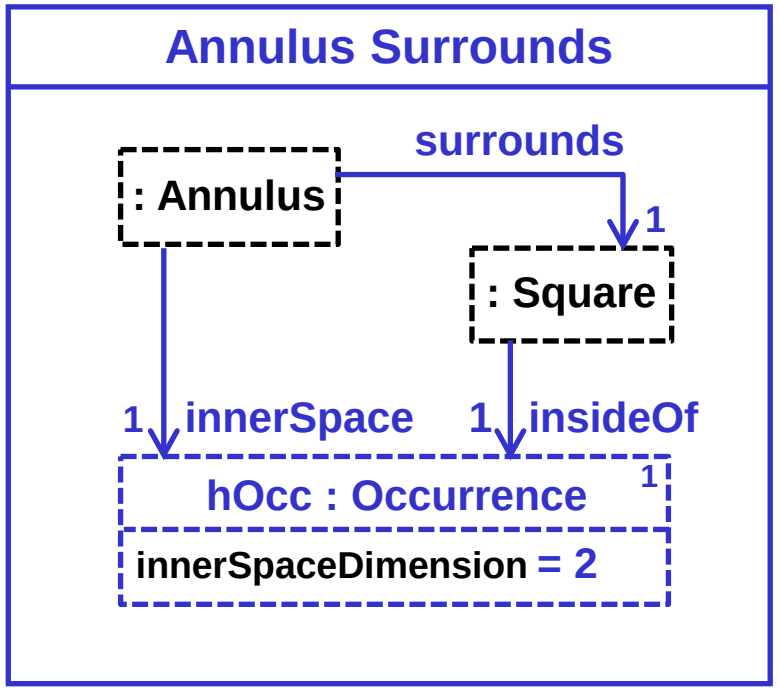
Inner Space and Surrounds, 2) Open

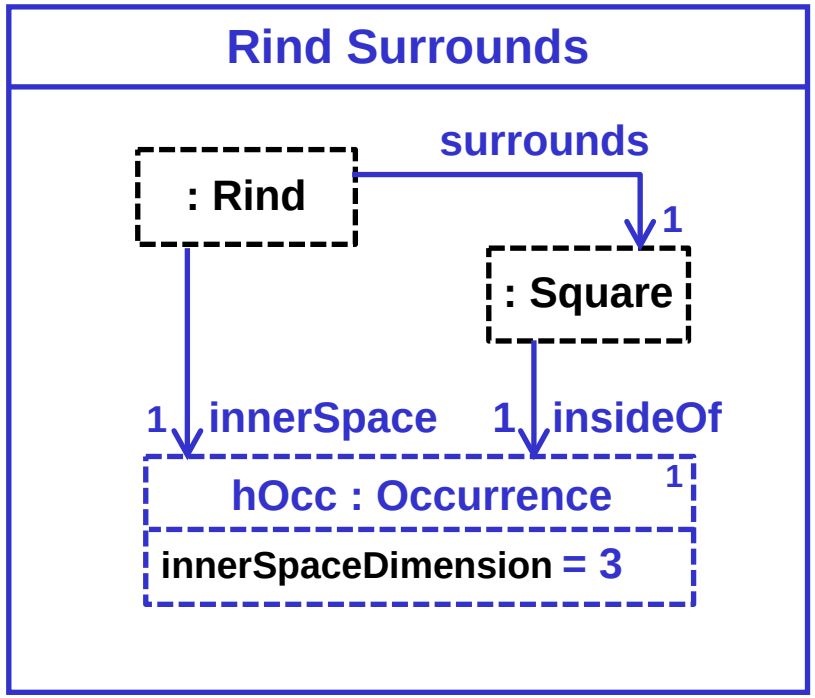
(2D)





(3D)





SysML

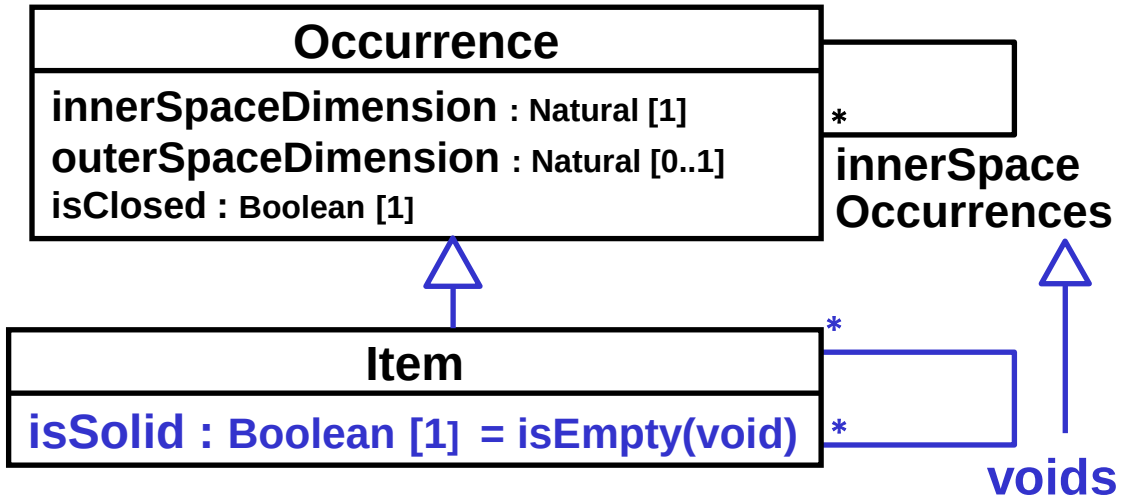
renamed

combined

Kernel	SysML
spaceBoundary	shape
innerSpace Occurrences	voids
JustOutsideOf + HappensWhile	Touches
(do it yourself)	boundingShapes

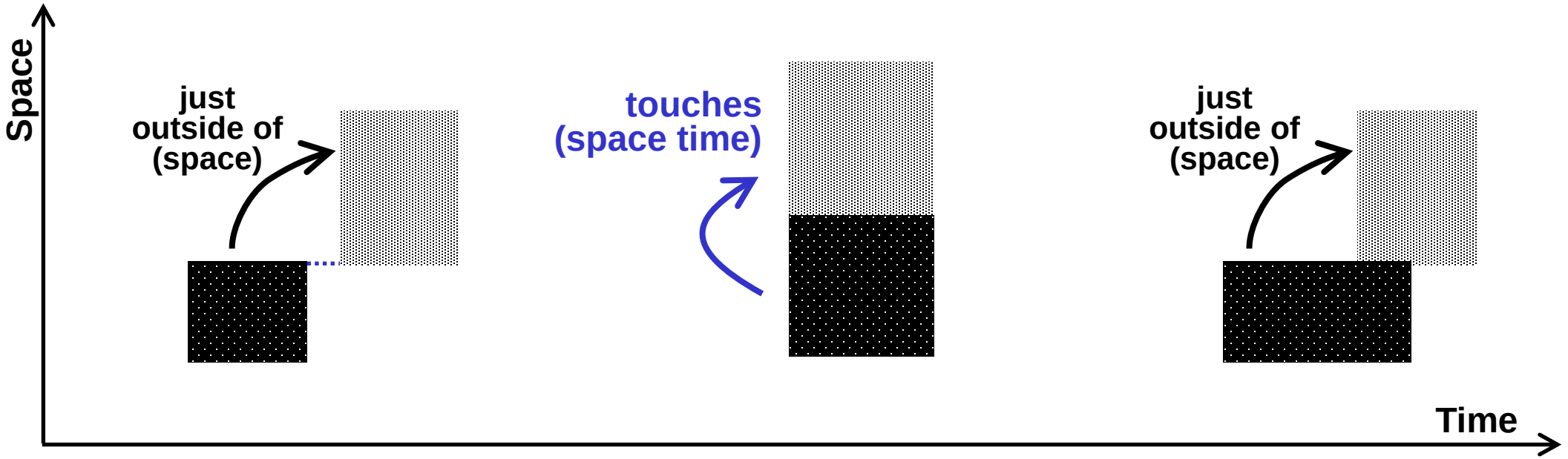
added

Voids



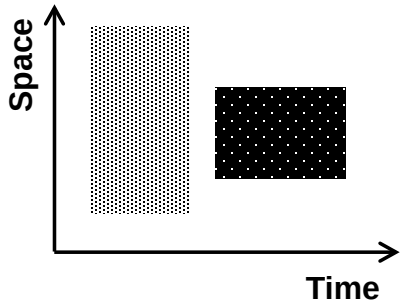
- SysML term for innerSpaceOccurrences.
- Not necessarily empty
  - Could have other things in them.
- isSolid ≡ no voids.

SysML::Touches

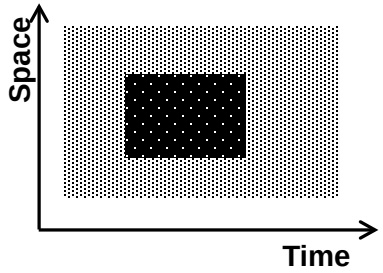


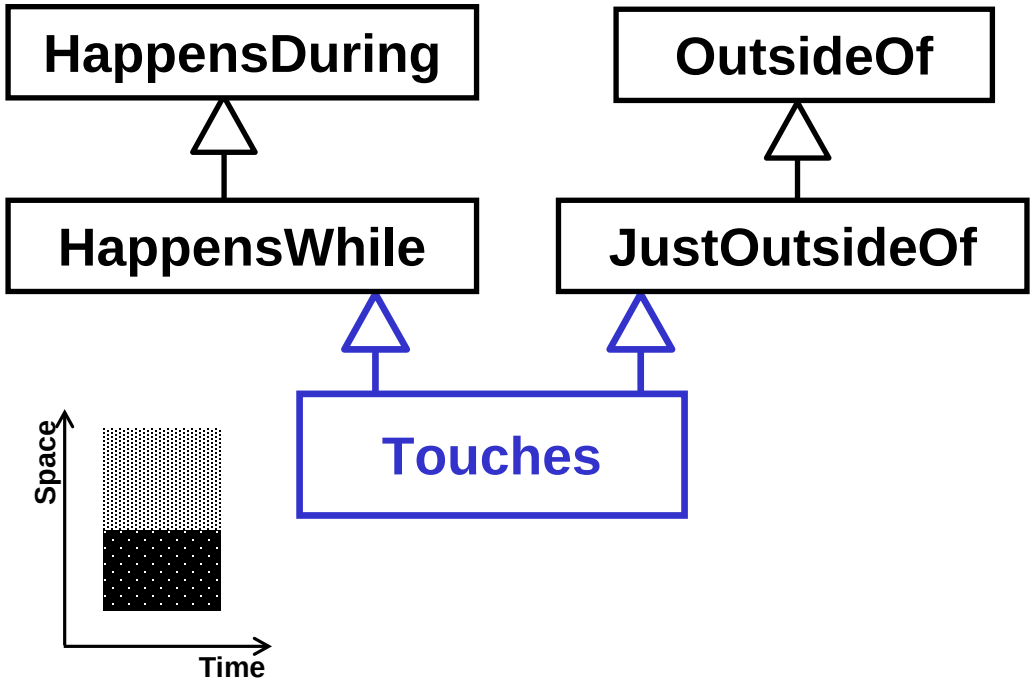
§ **Touches = JustOutsideOf + HappensWhile**

SysML::Touches

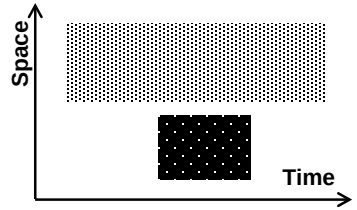


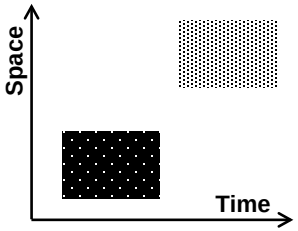
Temporal inclusion





Spatial exclusion



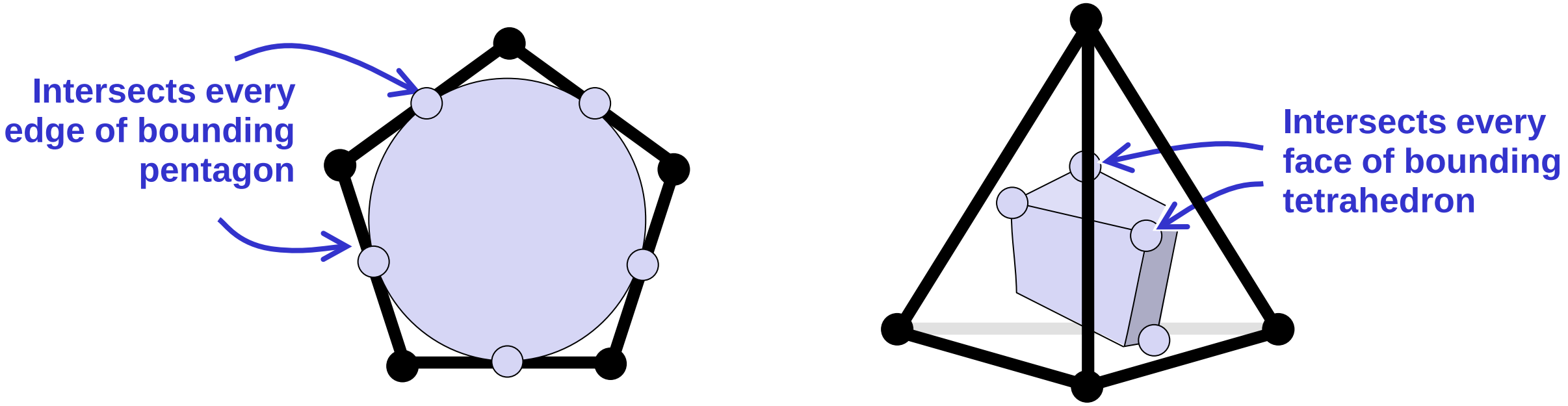


§ = Kernel::JustOutsideOf + HappensWhile.

Overview

- Space Modeling
  - Review (ad/22-03-12)
  - Spatial “meets”
  - Surrounding
  - **Bounding shapes**
  - Shape library
- Items and Parts
- Summary

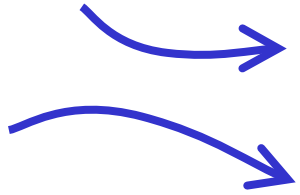
Bounding Shapes

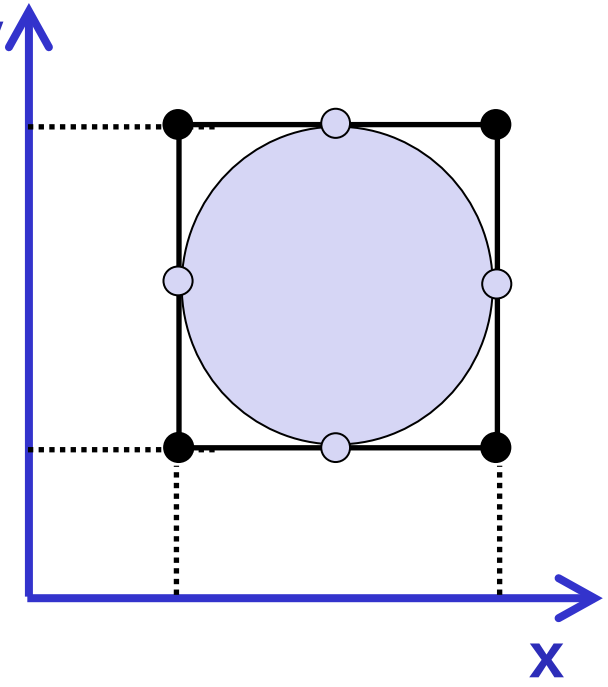


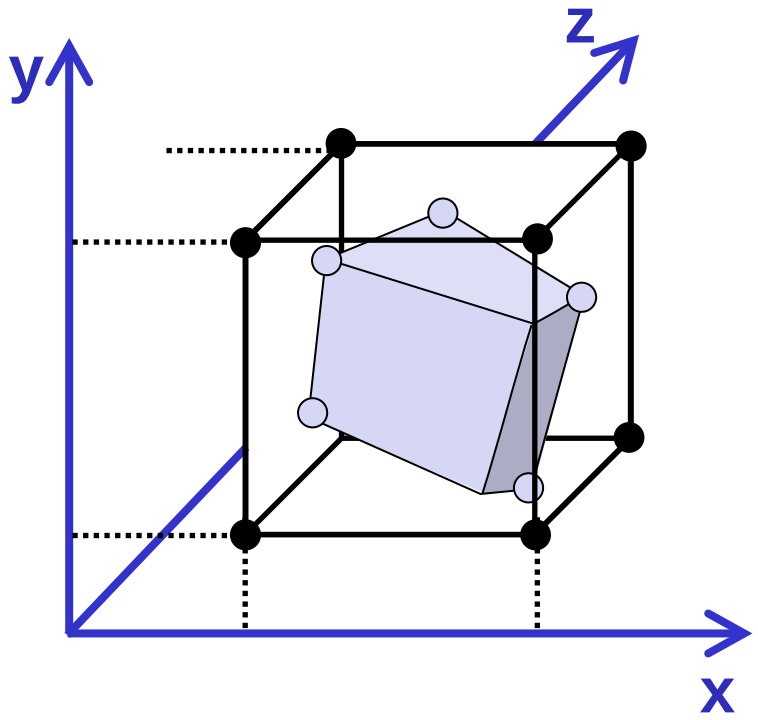
- **StructuredSpaceObjects that**
  - **would include the item in time and space if it had an interior.**
  - **intersects the item at every face or edge.**
- **Usually rectangles (2 dim) or boxes (3 dim).**

Bounding, Coordinate Frame Alignment

Intersects every edge of bounding rectangle







- Edges / faces of bounding shapes are usually
  - Straight/flat, and “parallel” to axes, axis planes.
- Enables compact representations (eg, as 2 points).

Overview

- Space Modeling
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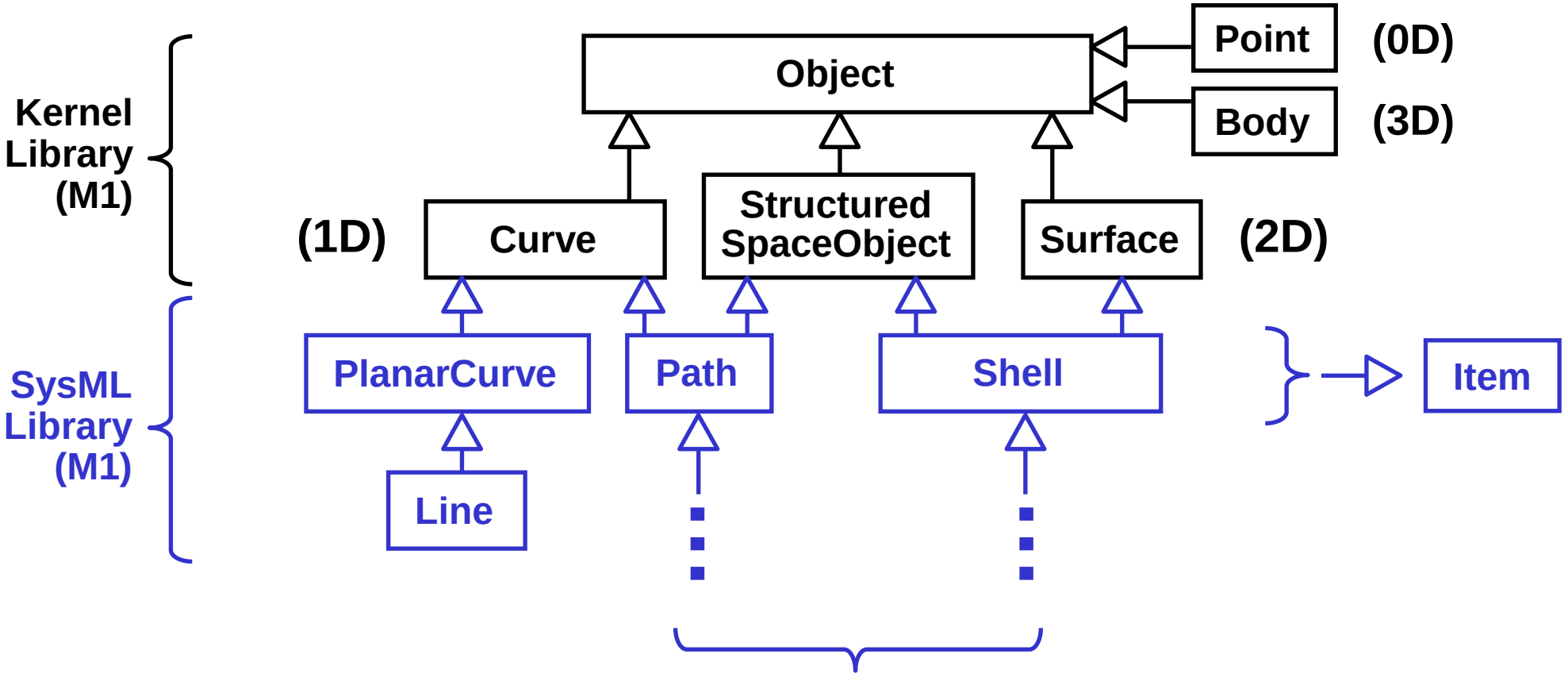
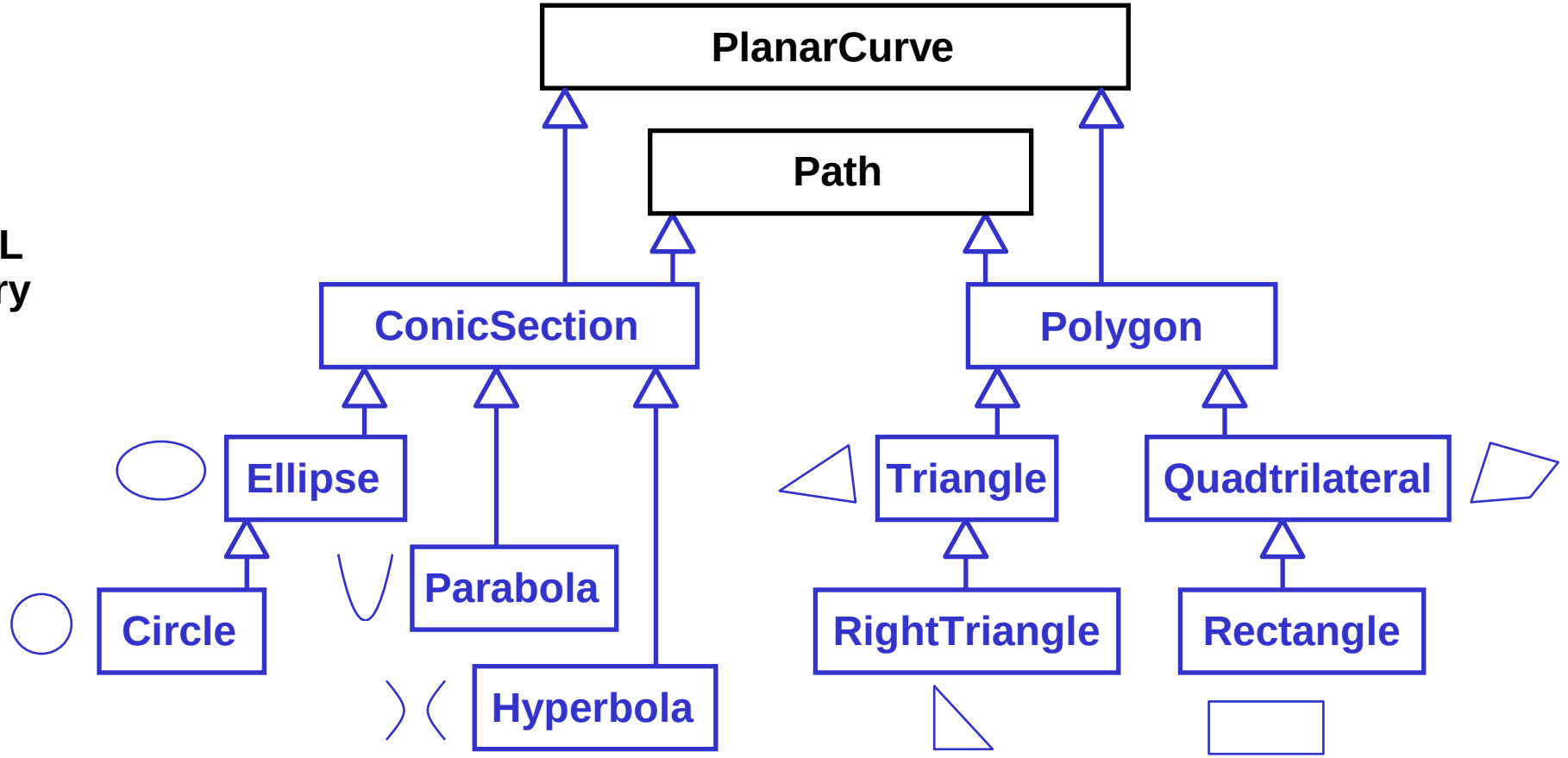
Shape Library, Top



- Most of the library is “structured” (topological).
  - Divided in to 1 and 2 dimensional items.

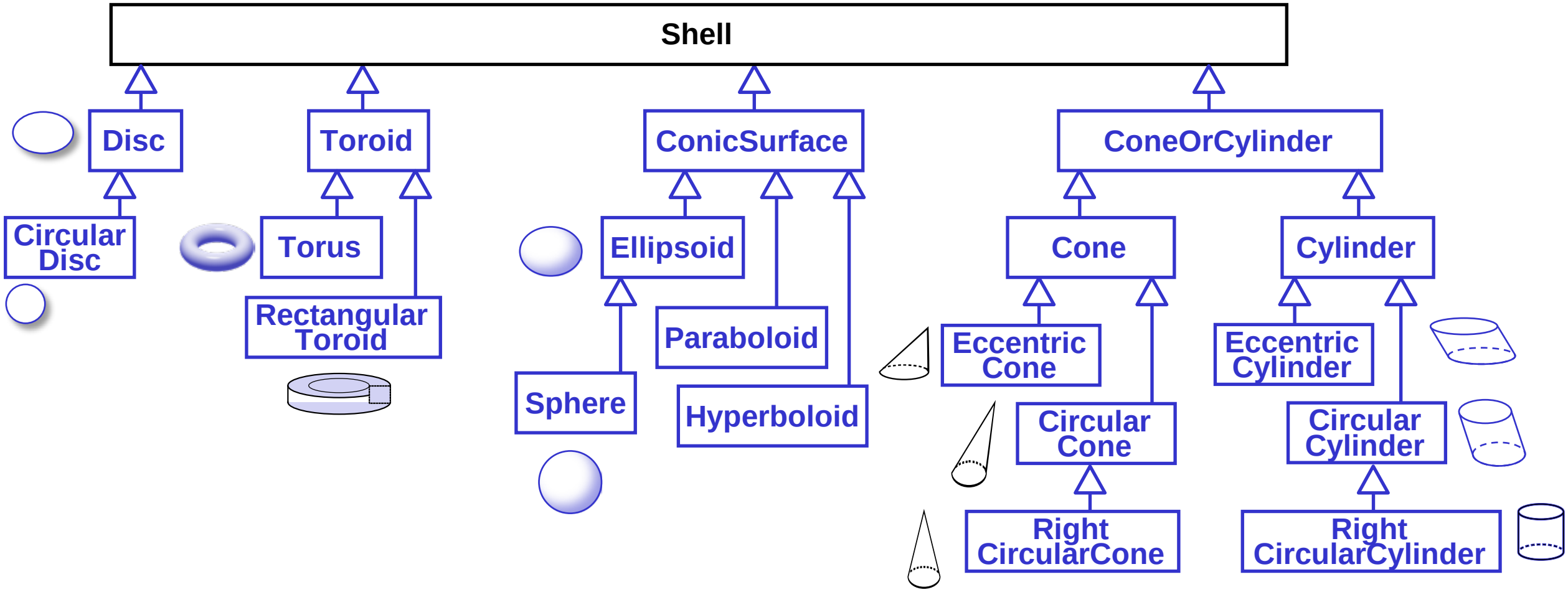
Shape Library, Paths

SysML Library (M1)



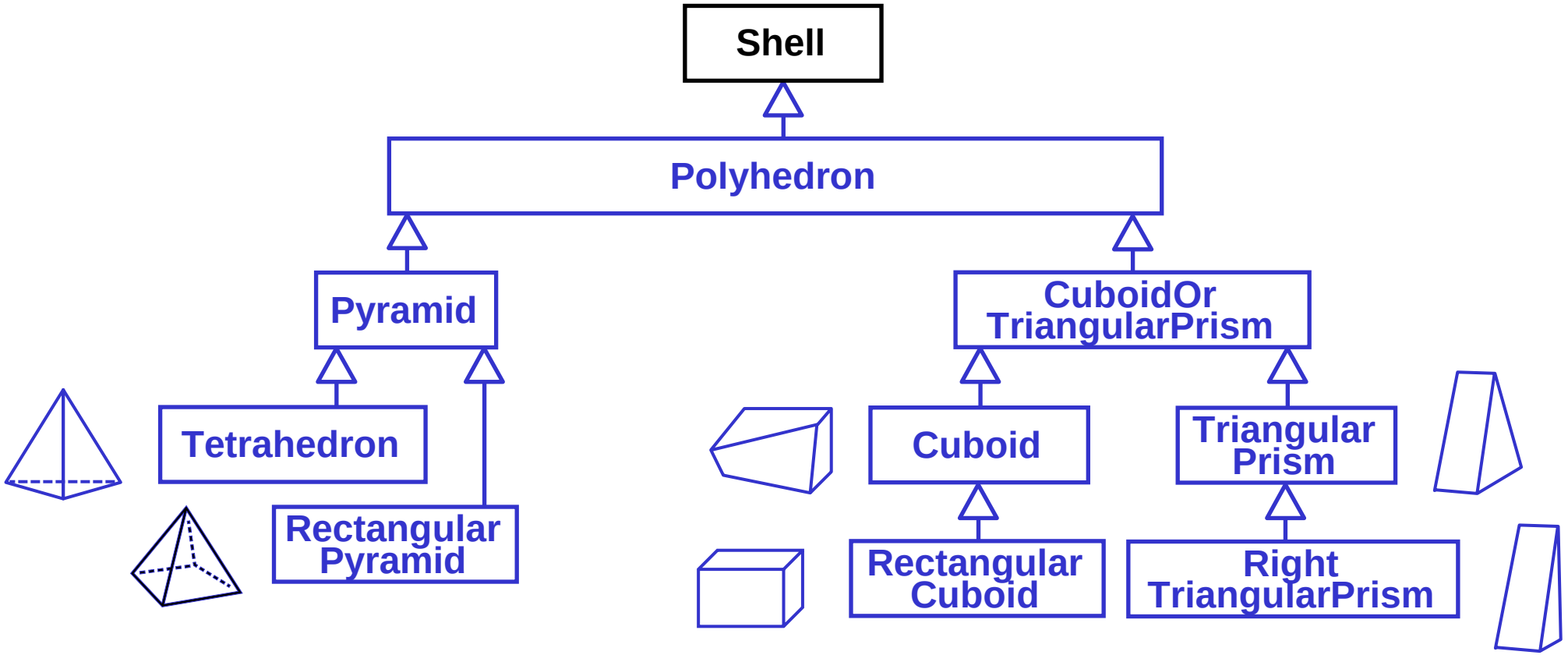
§ **Conic sections and polygons, all planar.**

Shape Library, Shells 1



§ Discs, toroids, conic surfaces, cones, cylinders

Shape Library, Shells 2

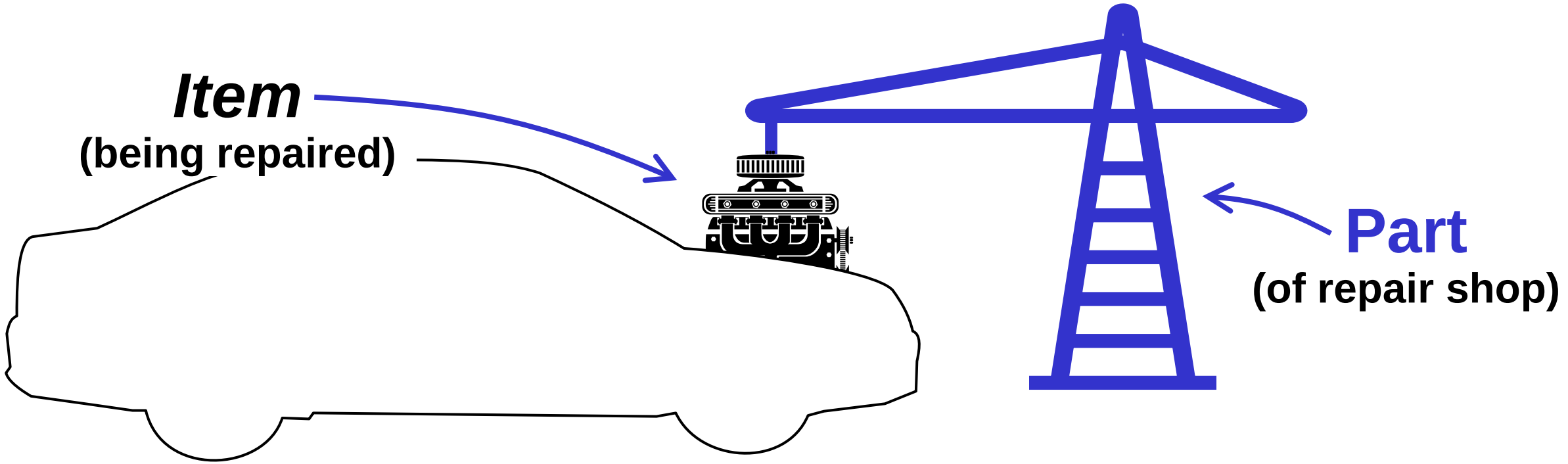


- Pyramids, cuboids, and triangular prisms

Overview

- Space Modeling
  - Review (ad/22-03-12)
  - Spatial “meets”
  - Surrounding
  - Bounding shapes
  - Shape library
- **Items and Parts**
- Summary

Items and Parts

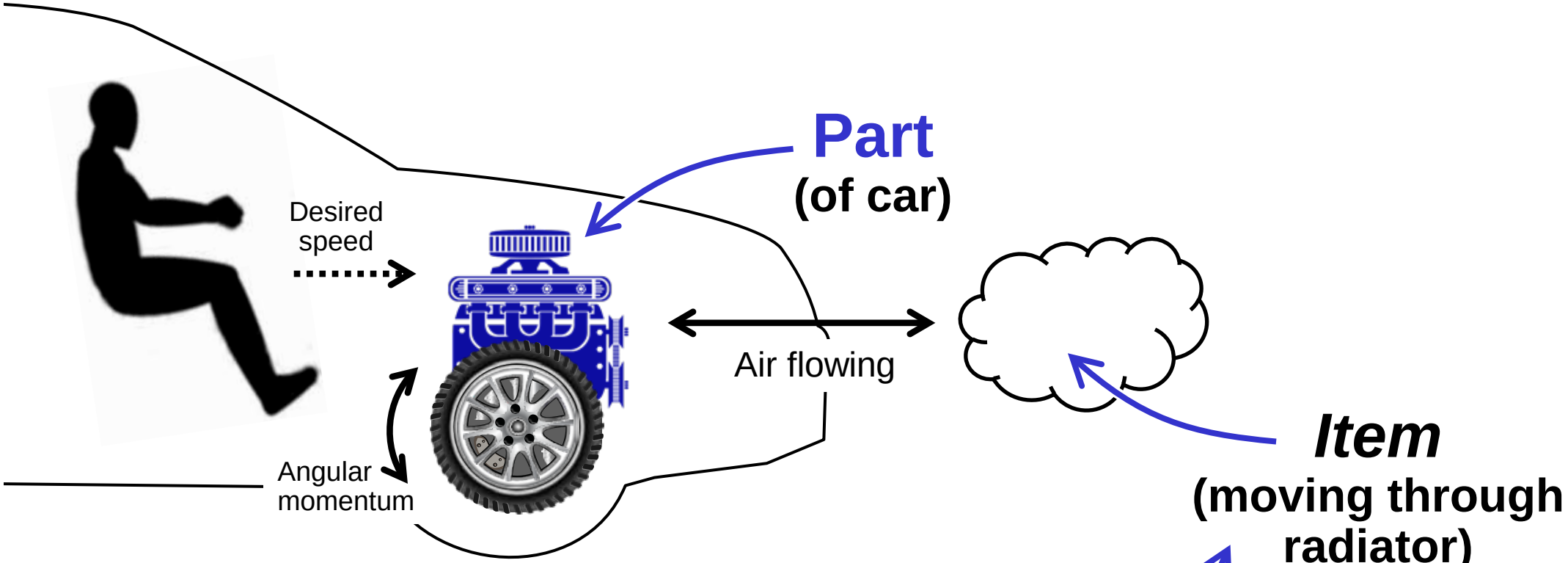


Acted on,
not **components of a system,**
passive

Act on other things,
(components of) a system,
active

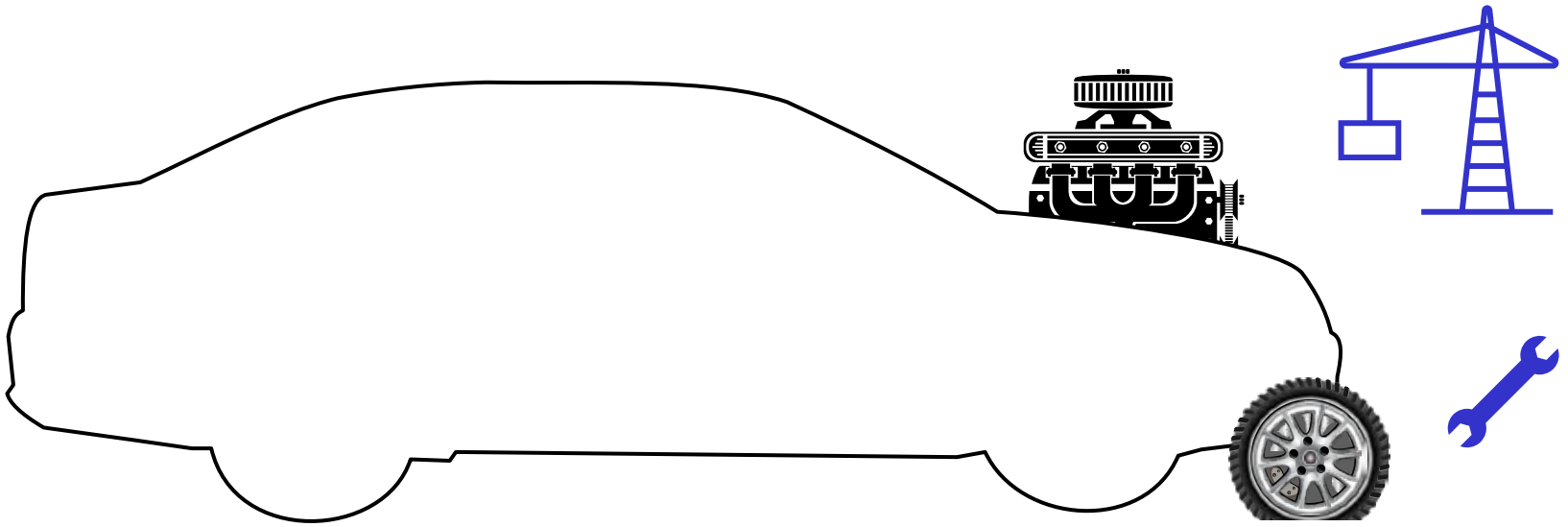
- **In a repair shop**
  - ***engine is an item*****, crane is a part**

Item à Part



- In running car
  - Engine is a part
- Item/part depends on usage.

Part à *Item*



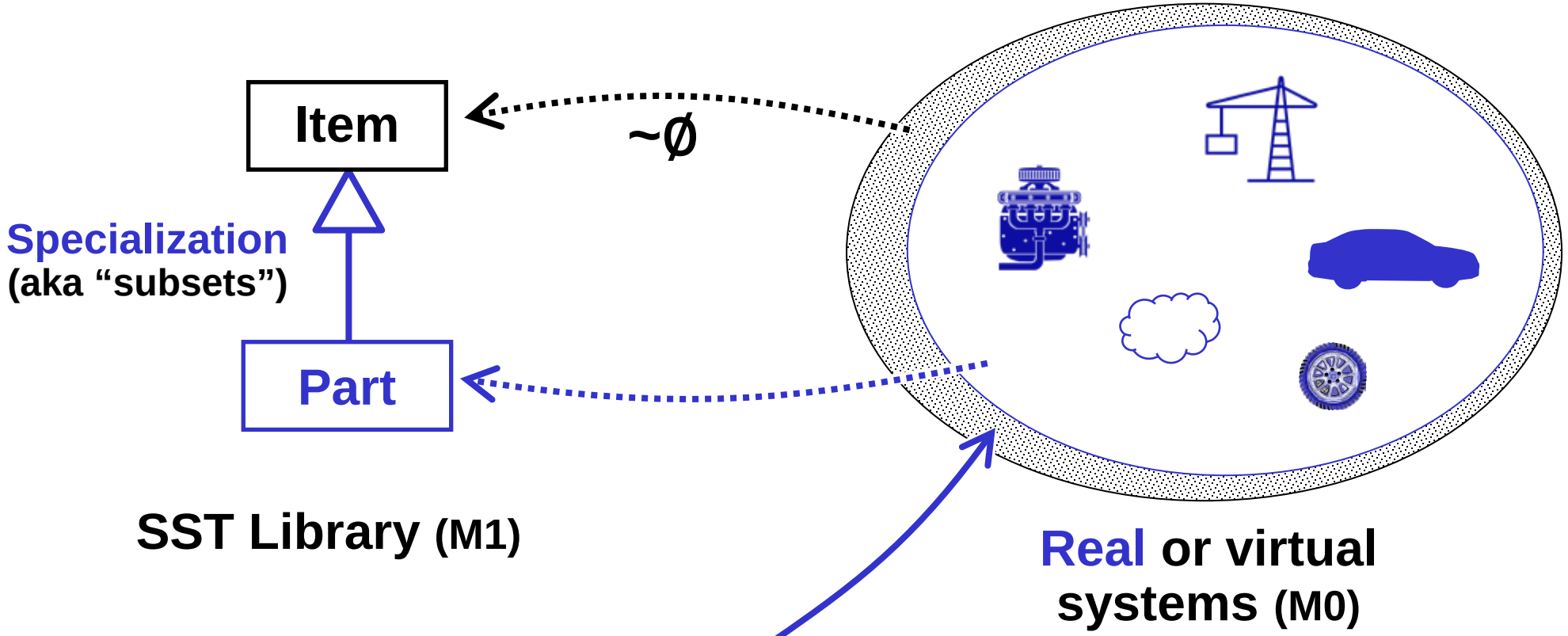
Item, Part ??

- Back in the repair shop
  - They're *items again*.
- Everything's a part
  - but sometimes they're *treated like items*.

Needs
abstra

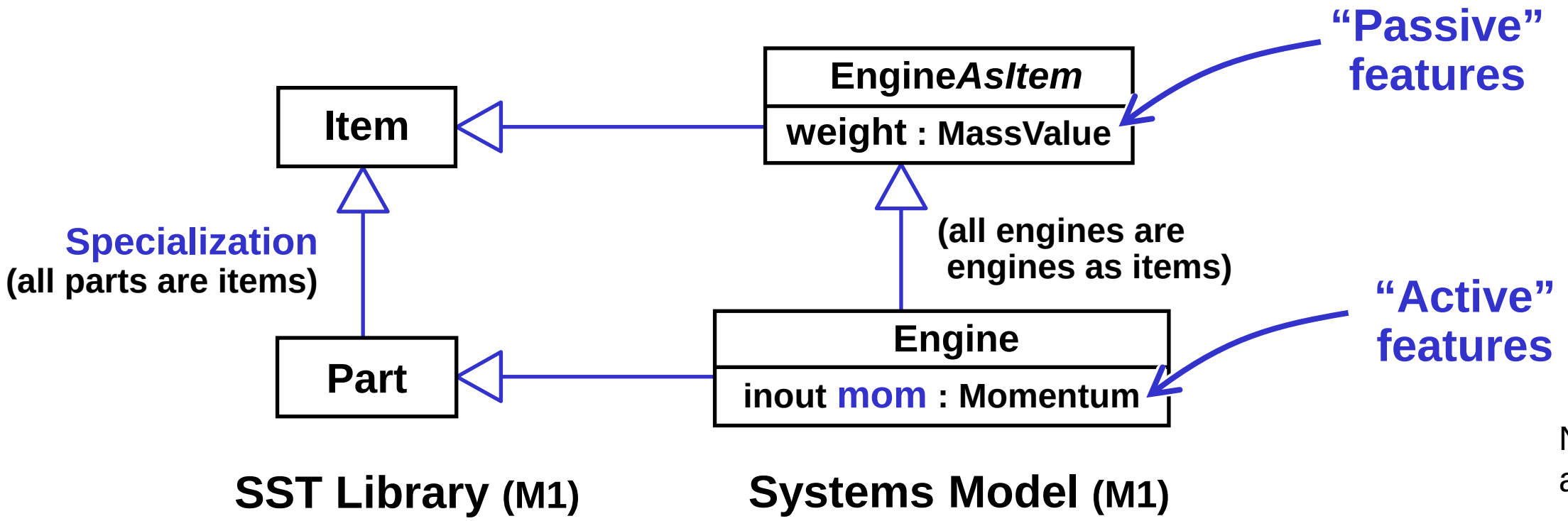
abstra

Every Item is a Part (sometime)



- (Almost) *no items* that aren’t parts.
  - Everything plays an active role sometime
- (Most) *items* are parts.

Items ßà Parts, Modeling

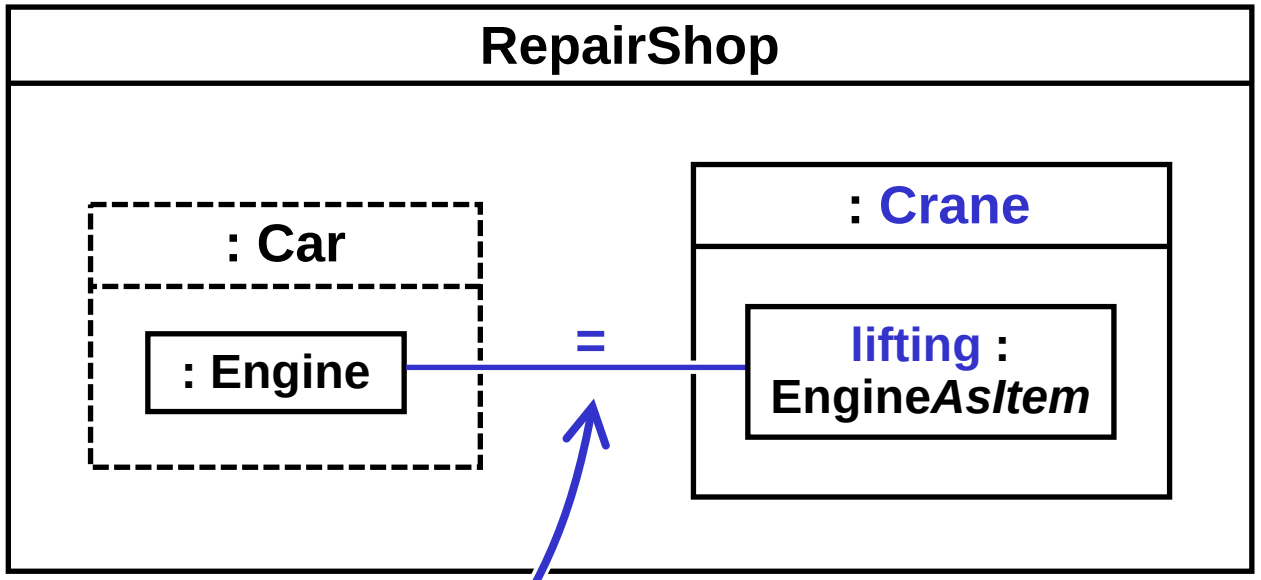


Needs su
abstract p

abstract p

§ **Separating "passive and active" aspects of objects.**
  - **Active kinds specialize passive …**
  - **… all active things *can be treated* as if they were passive.**

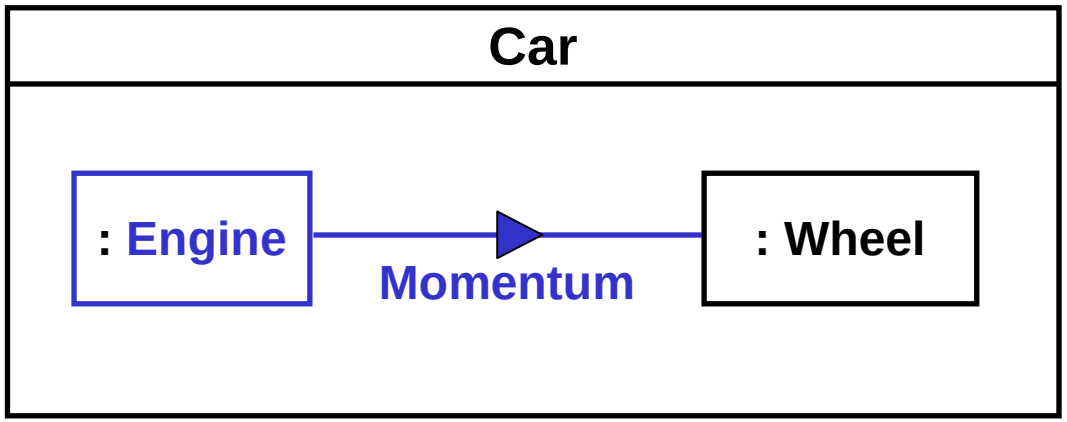
Treating Parts as *Items* (Sometimes)



Crane lifts
(an otherwise active)
engine from car

EngineAsItem
(passive)

Crane treats
engine as passive

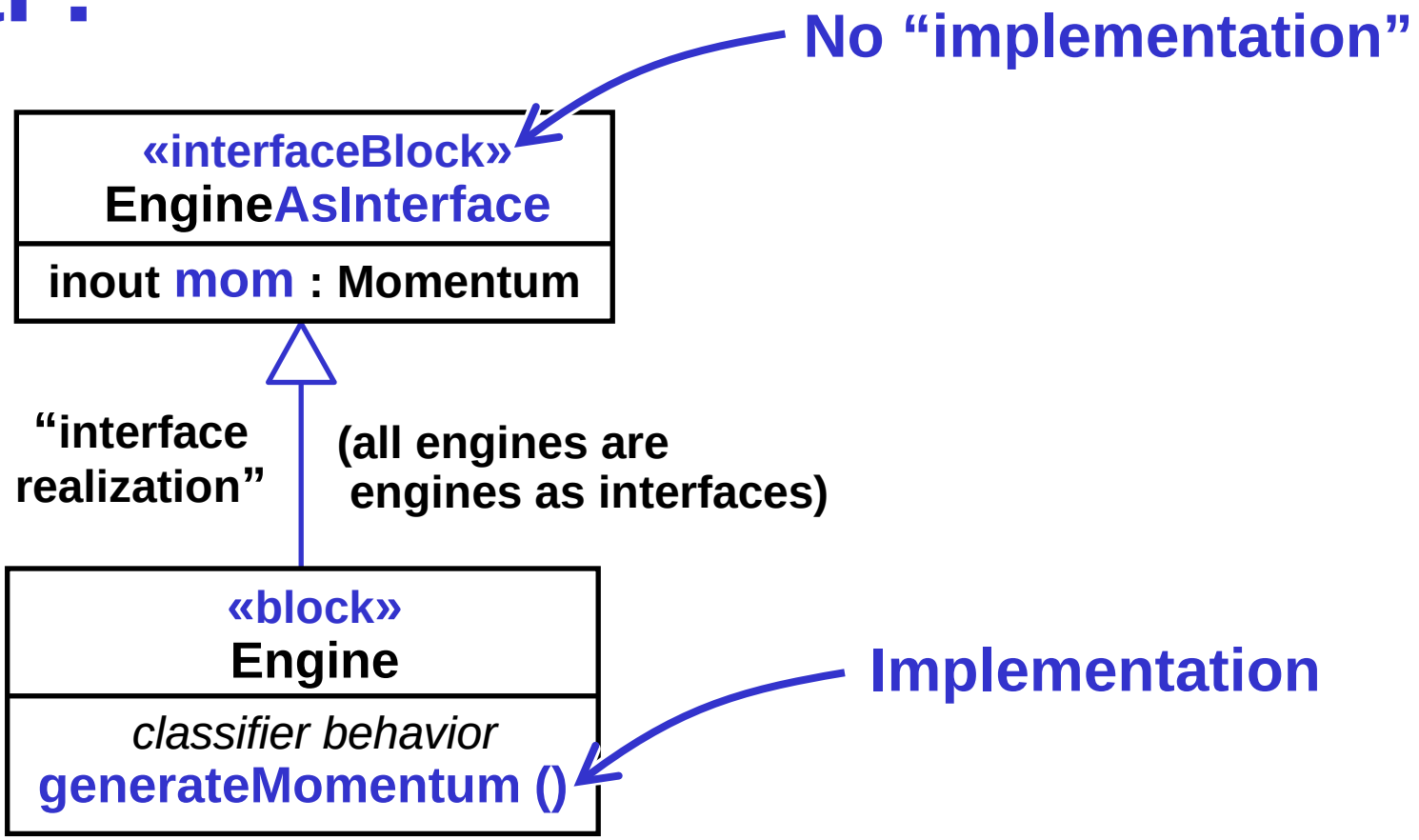


Engine
(active)

Car treats engine
as active

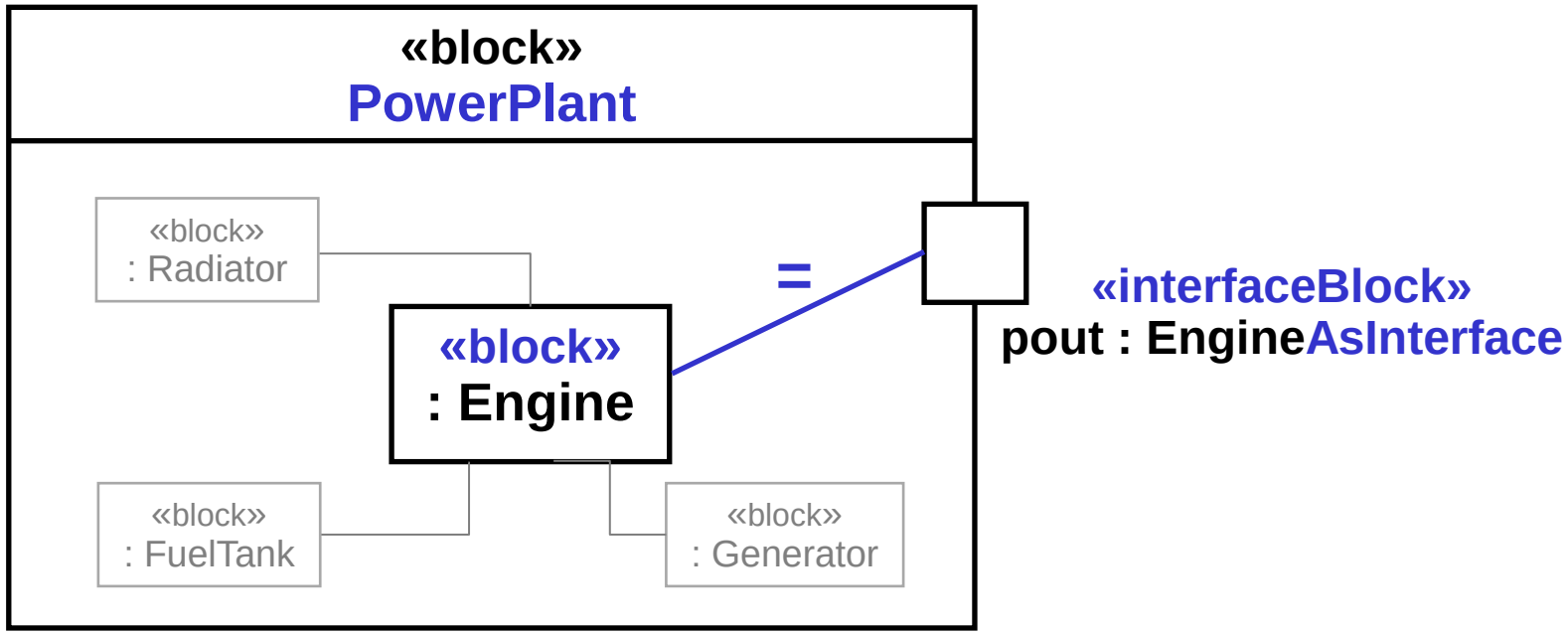
Sound Familiar?

SysML 1.x
Systems Model (M1)



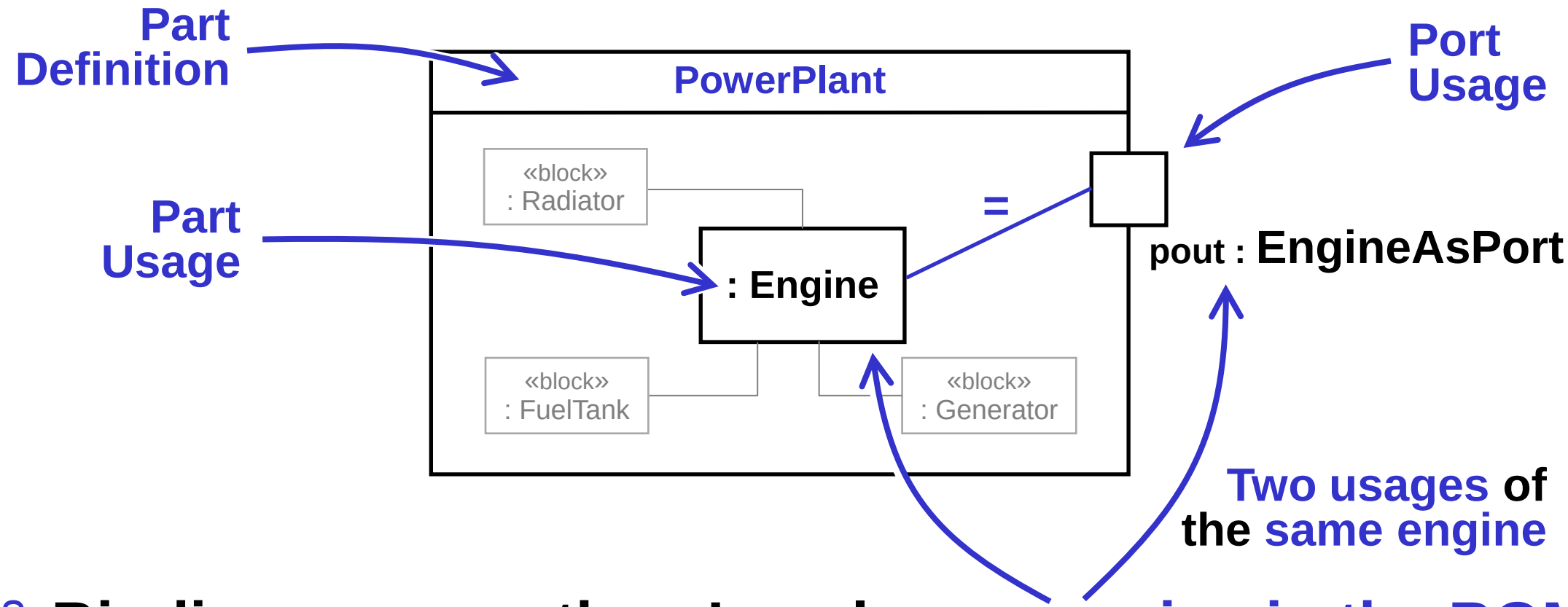
§ **Separating “implementation” aspects of objects.**
  – **Implementation blocks specialize interface blocks …**
  – **… all implementations can be treated as if they were interfaces.**

Treating Blocks as Interfaces (Sometimes)



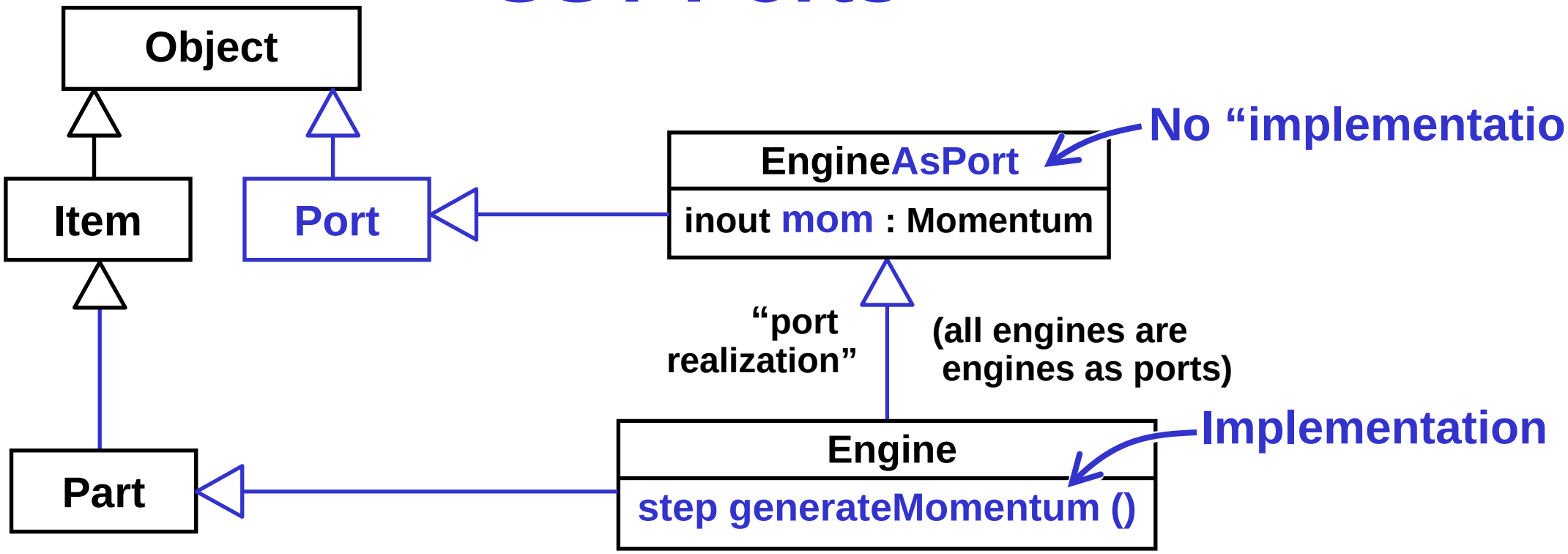
- **Single object (with implementation)**
  - **Treated as interface at port.**
  - **Port does not add to BOM.**

SST: Treating Parts as Ports (Sometimes)



- **Binding ensures there's only one engine in the BOM.**
  - **Part (an Engine) plays the role of port (an EngineAsPort)**

SST Ports


Object
Item
Port
Part
EngineAsPort
inout mom : Momentum
No “implementation”
“port realization”
(all engines are engines as ports)
Engine
step generateMomentum ()
Implementation
SST Library (M1)
Systems Model (M1)

Overview

- Space Modeling
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- **Summary**

Spatial relations, Part 2

- **JustOutsideOf / MatesWith**
  - **No space between (analogous to happens just before).**
- **Surrounds**
  - **Car drivers aren't in car material, material is around them.**
- **Inner boundaries, inner spaces (voids)**
  - **Closed portions of boundaries à Surrounded spaces**
- **Bounding shapes**
  - **Overlaps object somewhere on every "side" of shape.**
- **More shapes**
  - **in library**

Items and Parts (and Ports)

- **Items are almost always parts.**
  - **Because everything is active in some usages.**
- **Models separate them for usages to choose …**
  - **To "see" only item features or …**
  - **All features of parts, by specializing items.**
- **Same idea applies to ports**
  - **Ports separate out "exposed" features of parts.**
  - **Parts specialize ports.**
- **Items and ports are "role" types.**
  - **Parts play these roles.**