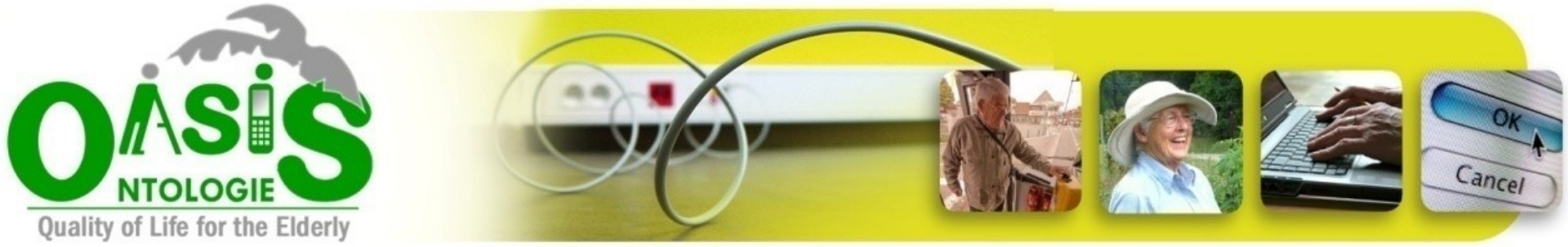

OASIS 1st International Conference

Florence, Italy – 4-5 November, 2009

Ontologies and Reasoning for Ambient Assisted Living

by

Immanuel Normann,
Frank Dylla, Joana Hois, Oliver Kutz, Mehul Bhatt

Universität Bremen

Wolfgang Putz,
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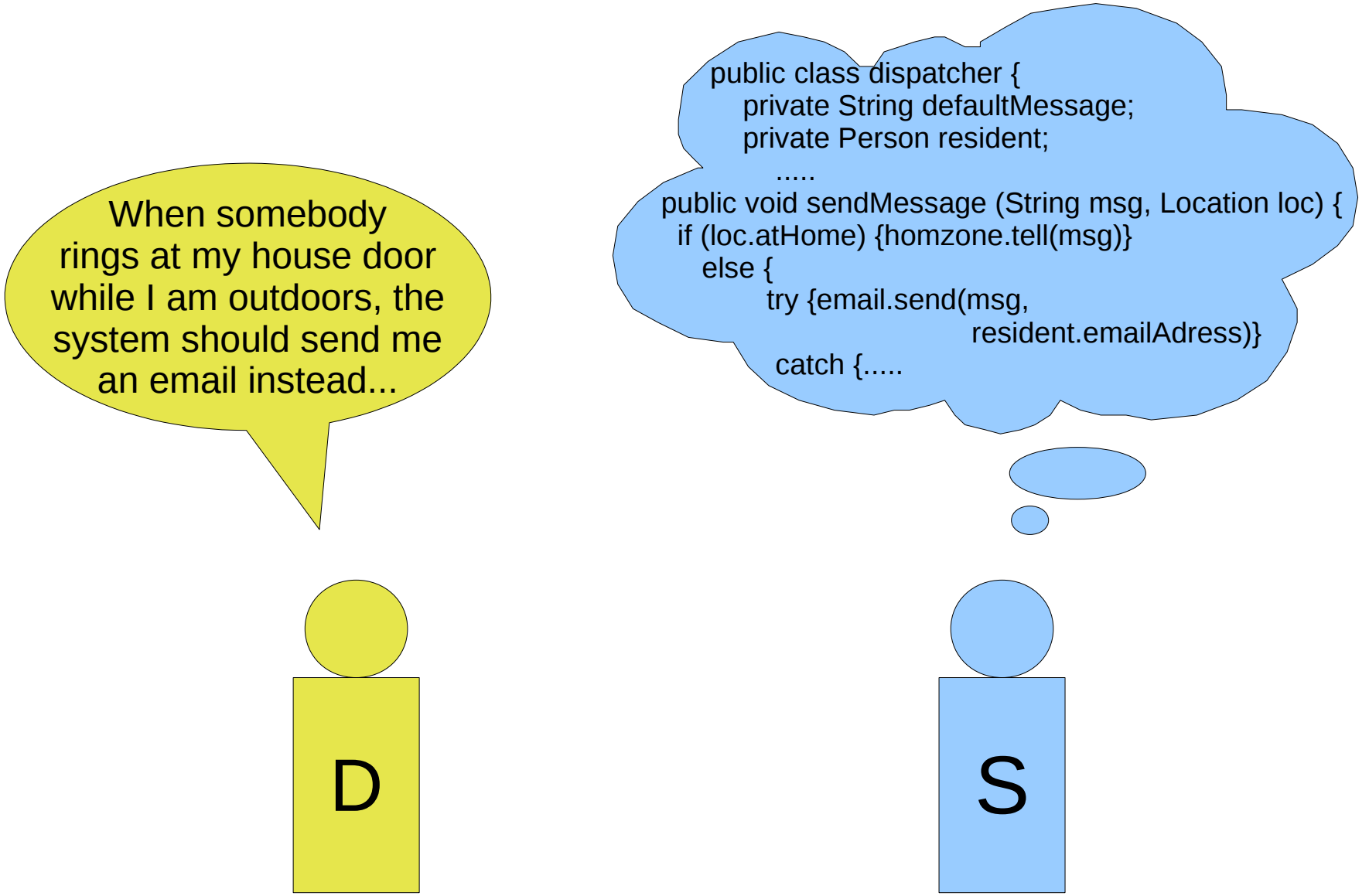
Software Development as Communication Challenge



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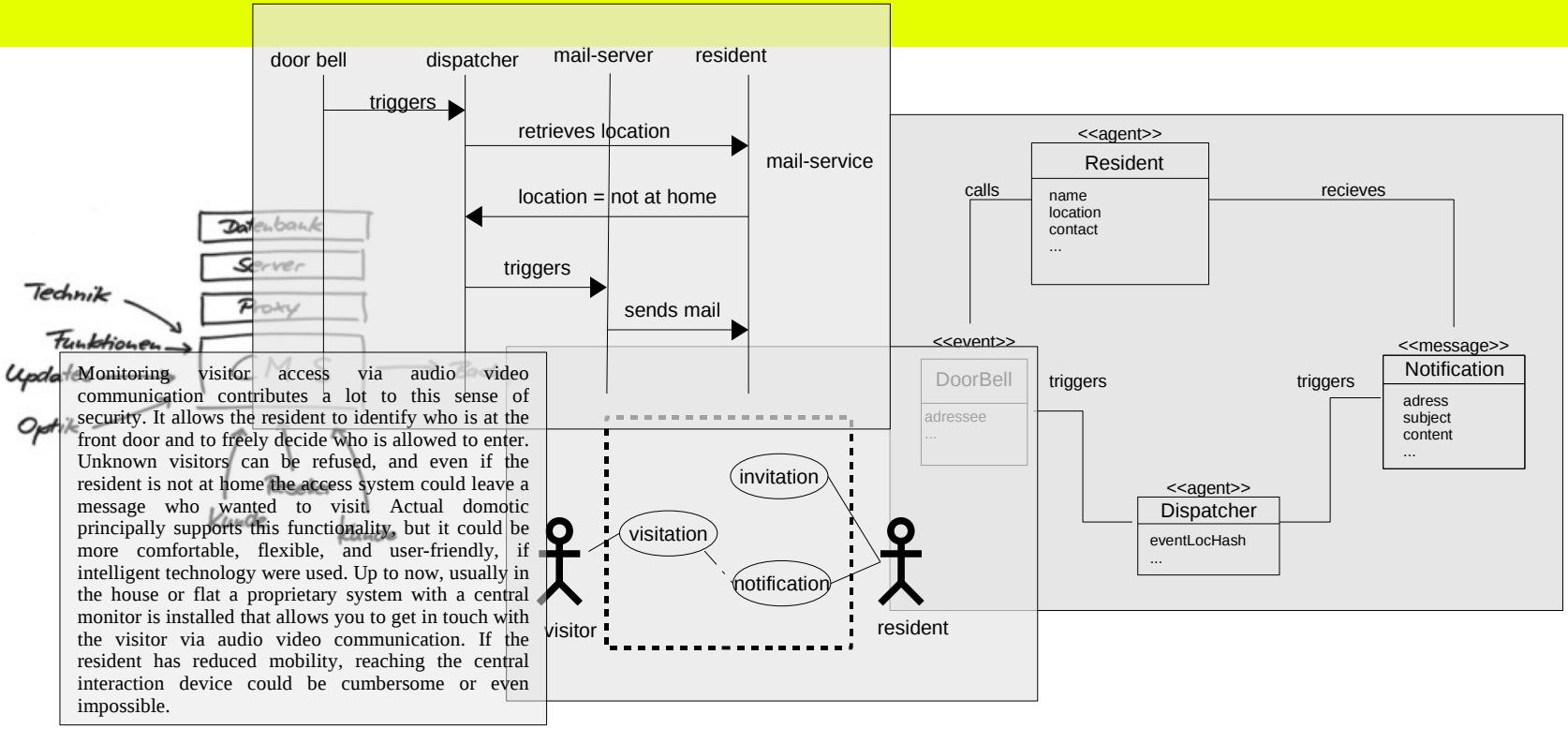

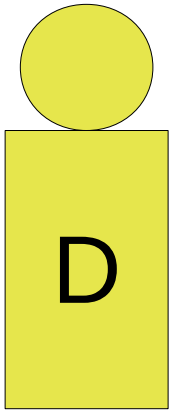

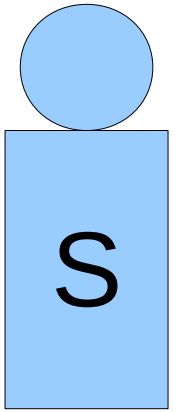

Gain of Ontological Approach

1. Ontology languages are comprehensible

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2. Ontologies represent models as explicitly as needed

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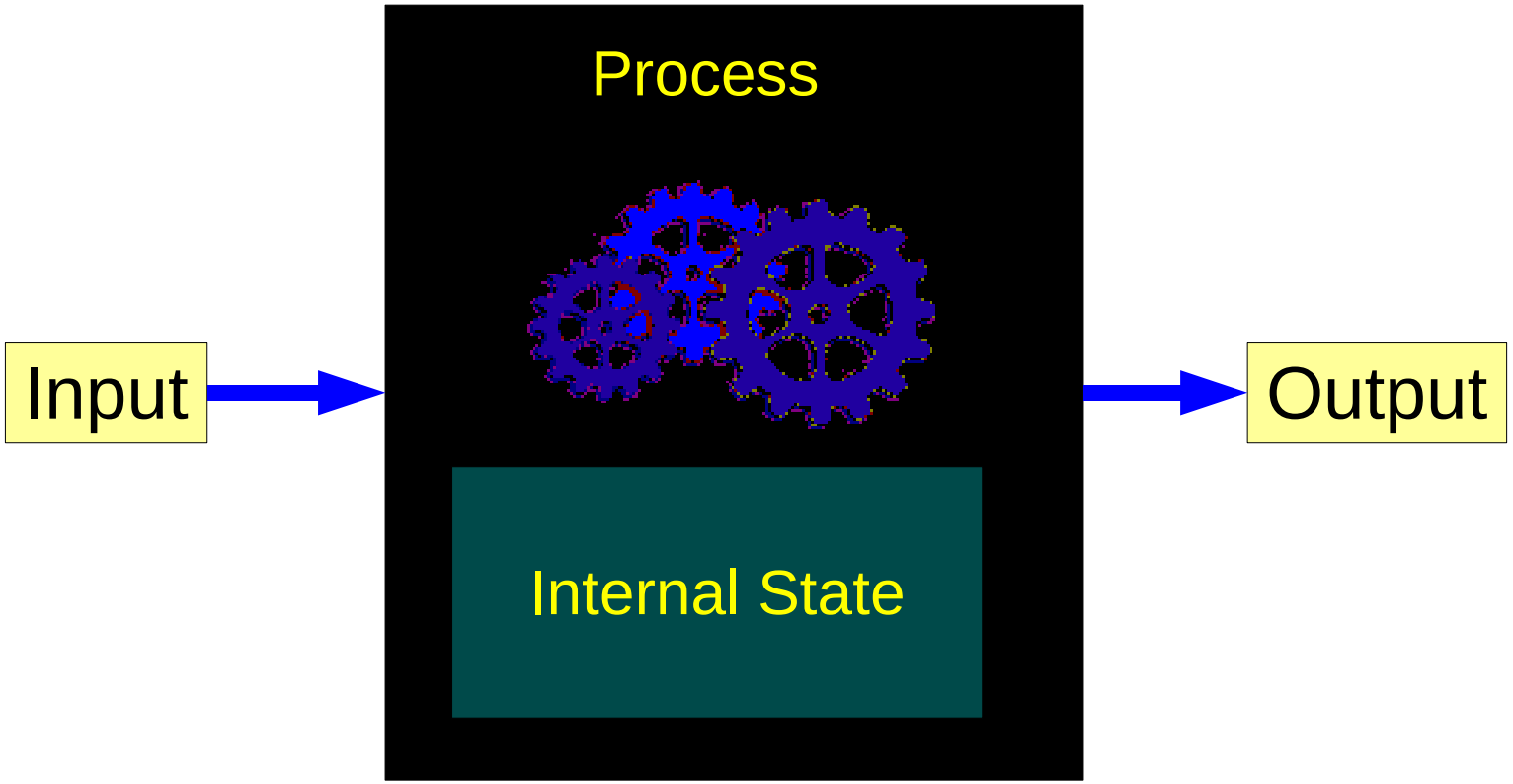
1. Ontology languages are comprehensible
2. Ontologies represent models as explicit as needed
3. Ontologies can be used as a substantial part of the executable code!

Overview

- Software interaction
- Basic evaluation loop in an ontological program
- Case study for Ambient Assisted Living
- Reasoning support for main stream programming languages
- Outlook

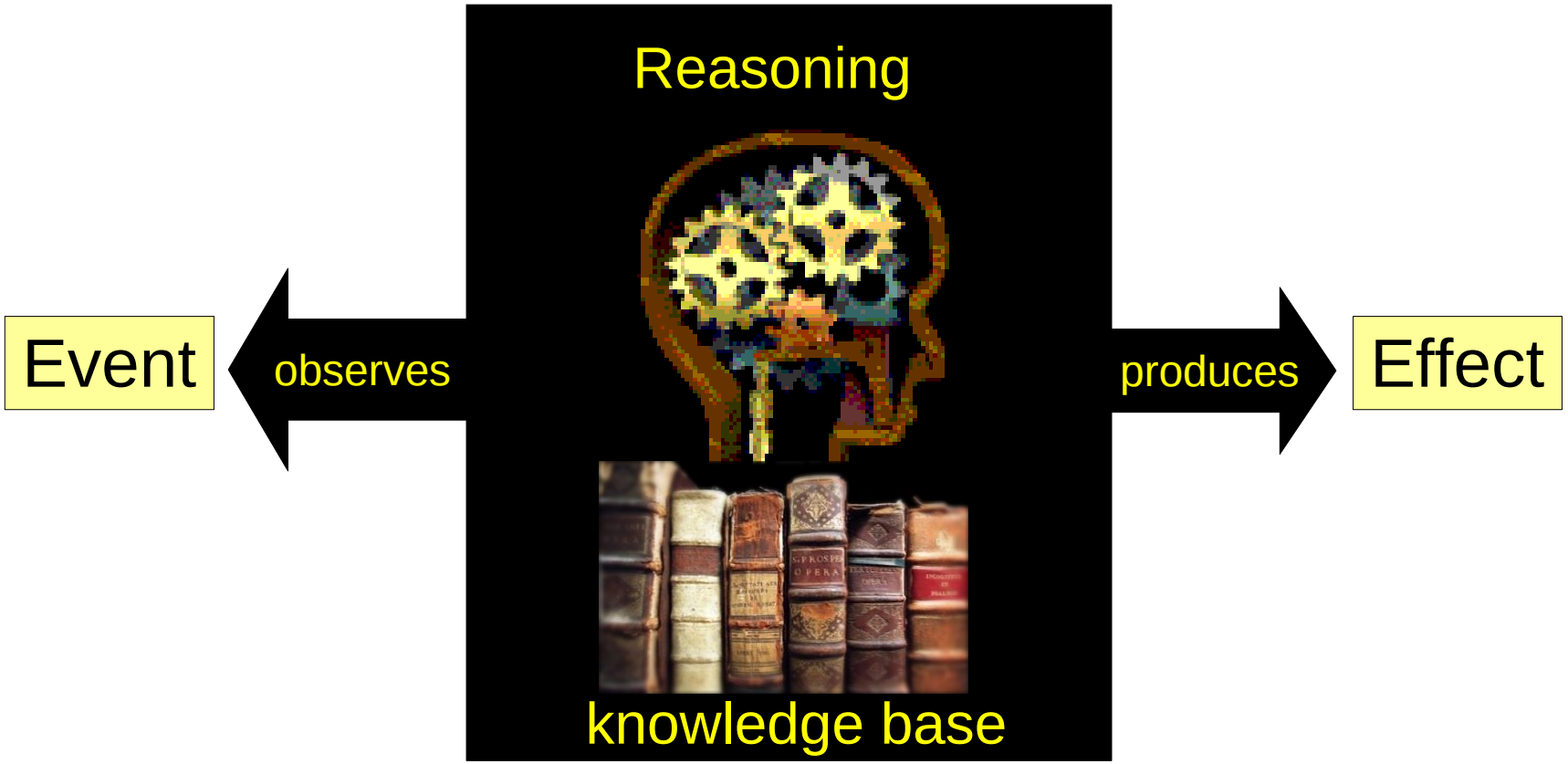
Interaction of Software

imperative perspective



Interaction of Software

ontological perspective



Interaction of Software

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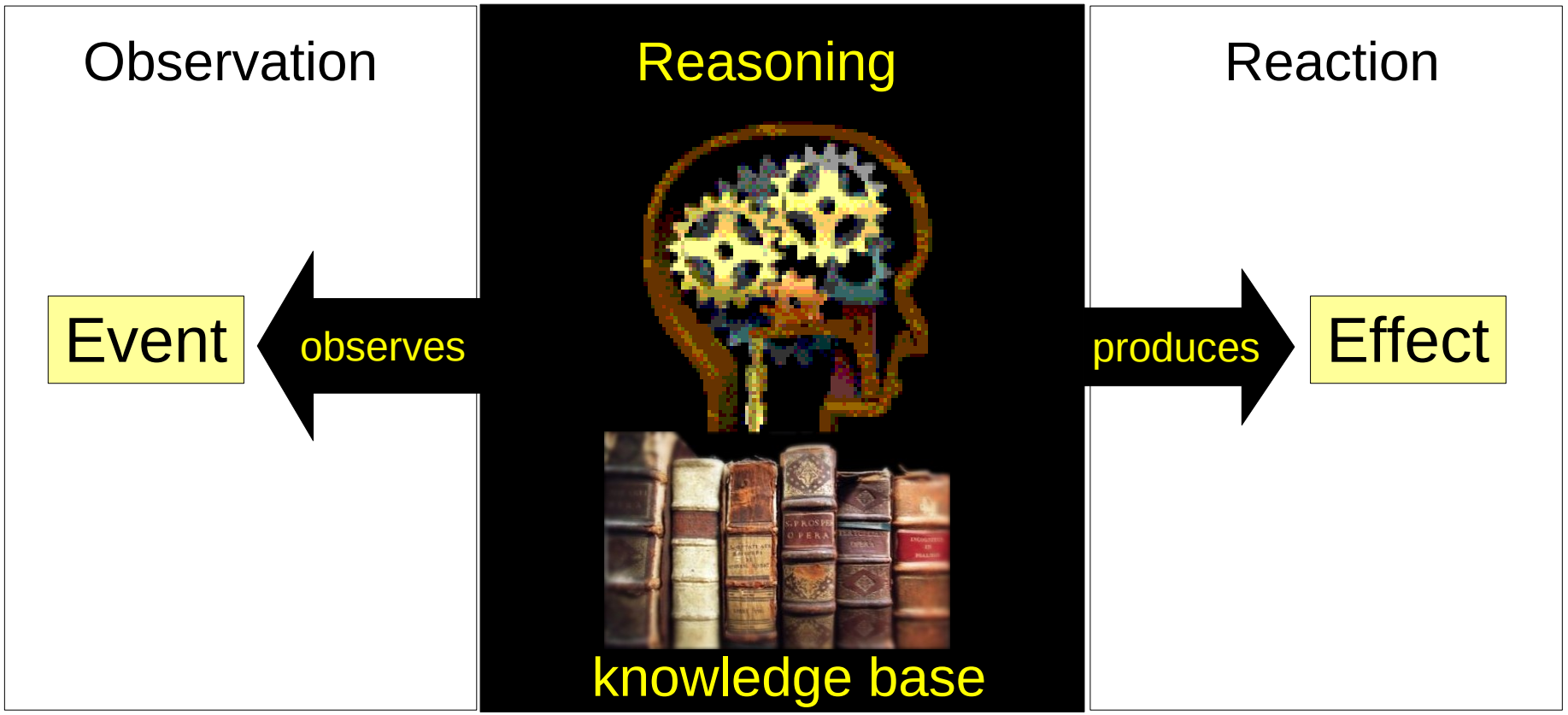

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Office

Ontology

rule:
If a person is in the office
then the light is switched on

rule:
If a person is in the office then the light is switched on

rule:

If a person is in the office then the light is switched on

sensor

rule:
If a person is in the office then the light is switched on

new fact:
A person is in the office

sensor

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derived fact:
light is switched on

rule:
**If a person is in the office
then the light is switched on**

new fact:
A person is in the office

actuator

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A Case Study Ontology

The *Entrance Hall* scenario in one sentence:

when a visitor rings the door bell, the resident should be notified on a communication channel adequate for his/her current location.

A Case Study Ontology

- The resident is in the living room

A Case Study Ontology

- The resident is in the living room
- inside(living_room).
- note: we do not represent the resident in the fact, since ...

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- The TV can be seen from the sofa and the chair and speaker can be heard in the bath.

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- A device D covers an area A if A is a subpart of an area B which is also covered by D.

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- A device D covers an area A if A is a subpart of an area B which is also covered by D.
- covers(D,A) if partOf(A,B) and covers(D,B).

A Case Study Ontology

- Video connection is undesirable in intimate spaces.
- A video connection V is admissible if it covers the area A where the resident is inside, but only if this area is not intimate.

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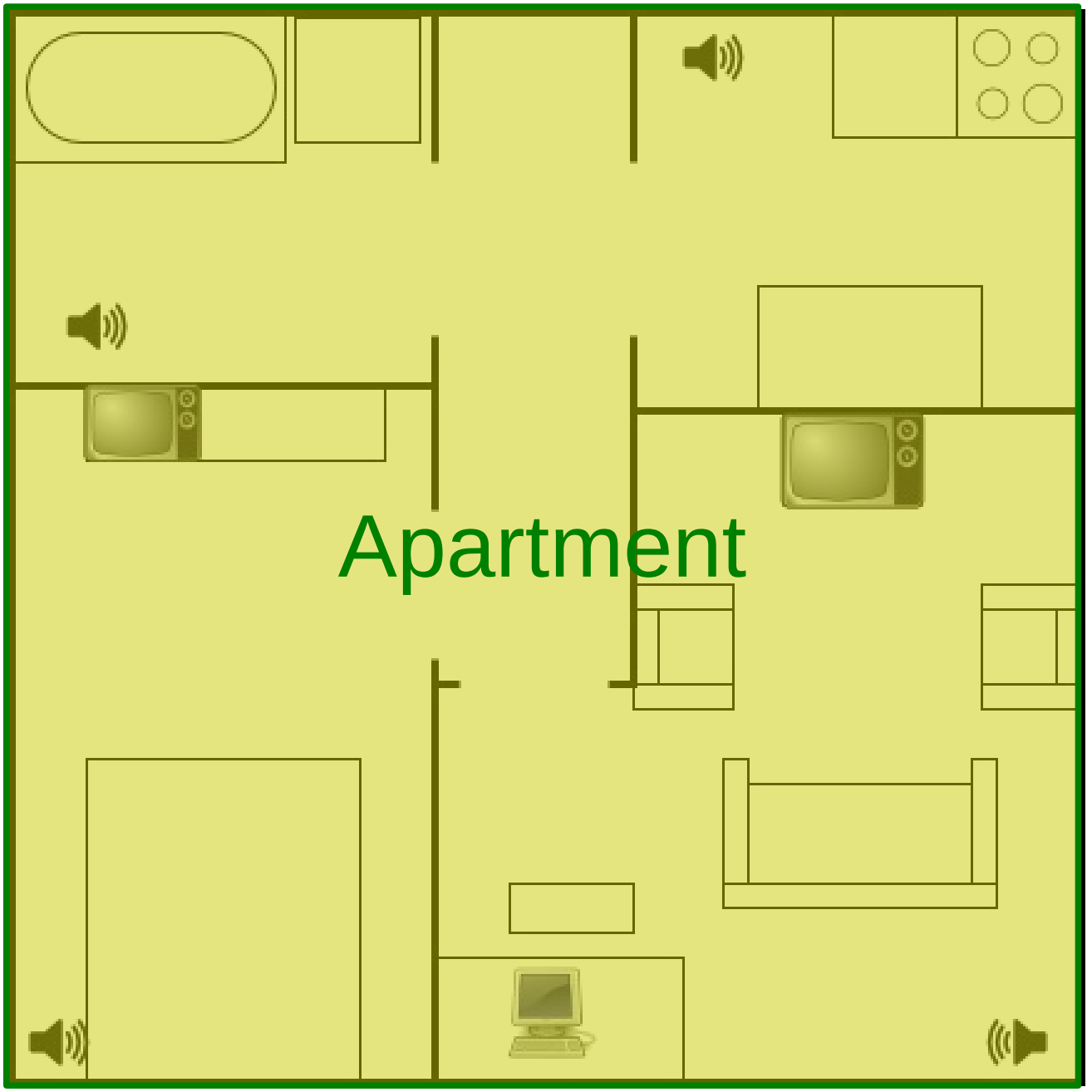
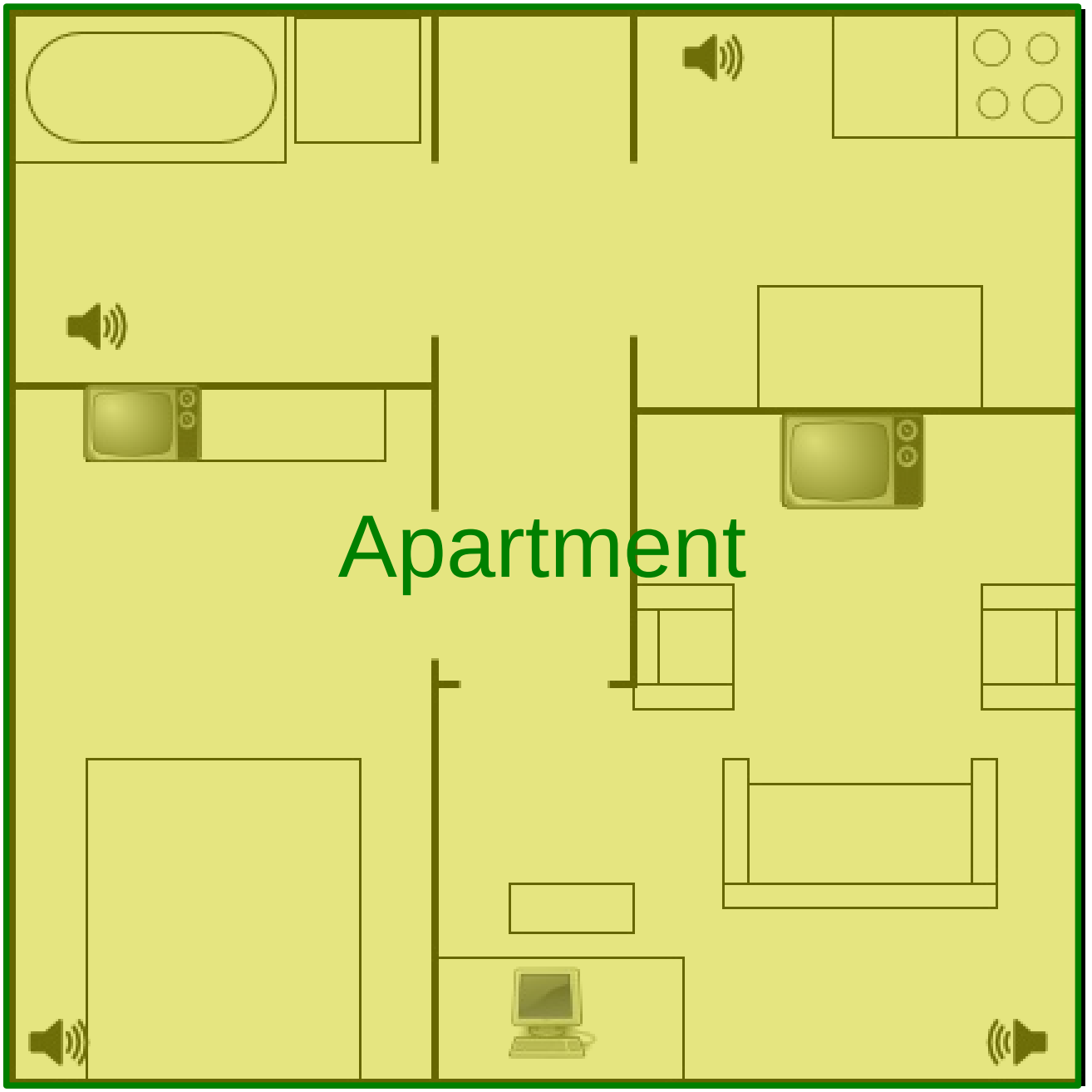
- admissible(V) if videoDevice(V) and
  - covers(V,A) and inside(A) and not(intimate(A)).
- facts:
- intimate(A) if sleeping_room(A) or bath(A) or ...
- videoDevice(V) if television(A) or computer(A) or ...
- partOf(chair,livinging_room), ...
- partOf(bed,sleeping_room), ...
- partOf(sleeping_room,apartment),...



Ontology
&
Reasoning



Knowledge base

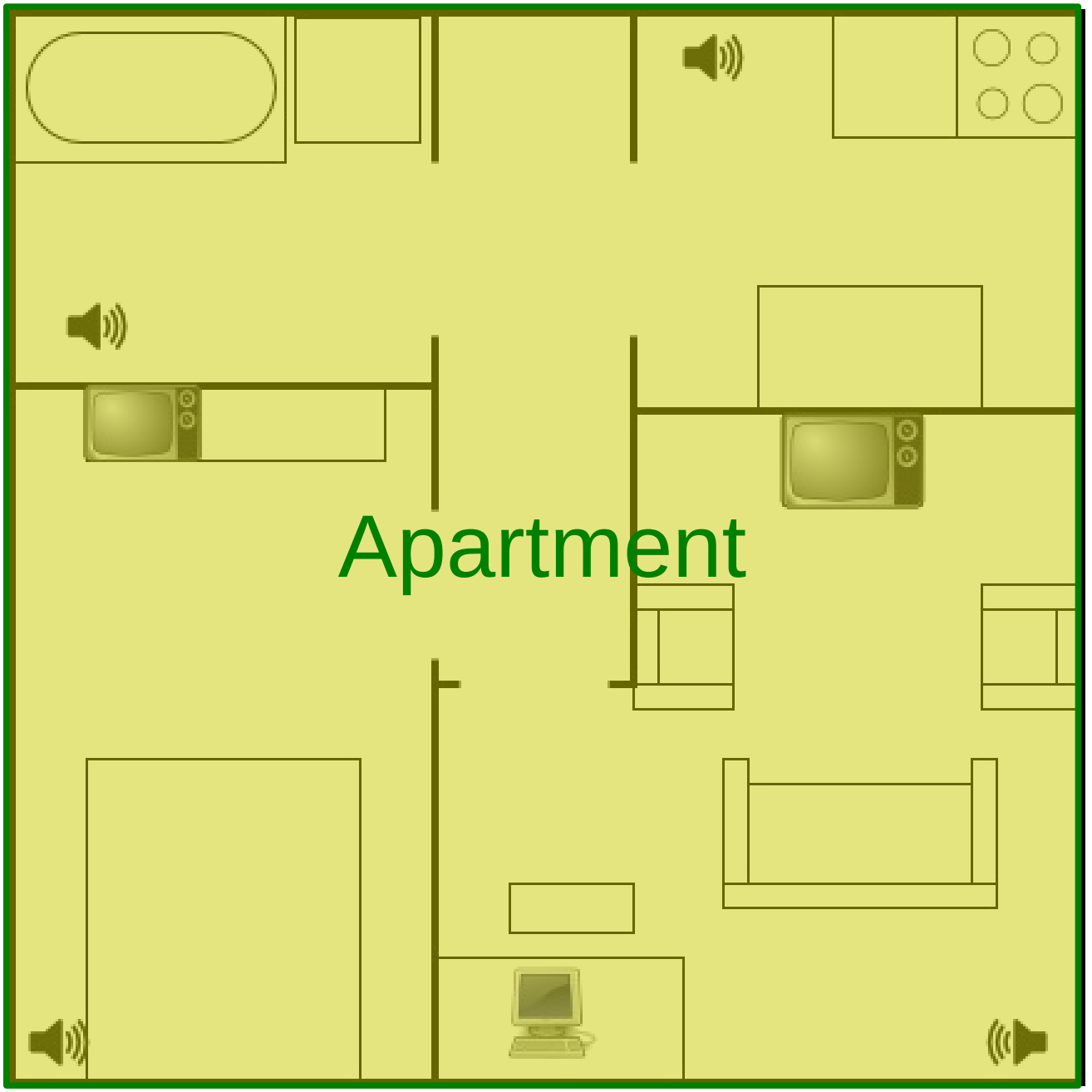
rules:

When the bell rings open comunication channel.
In intimate areas prefer audio over video connection.
...

static facts:

The sofa is part of the sitting area in the living room
The living room is part of the apartment ...

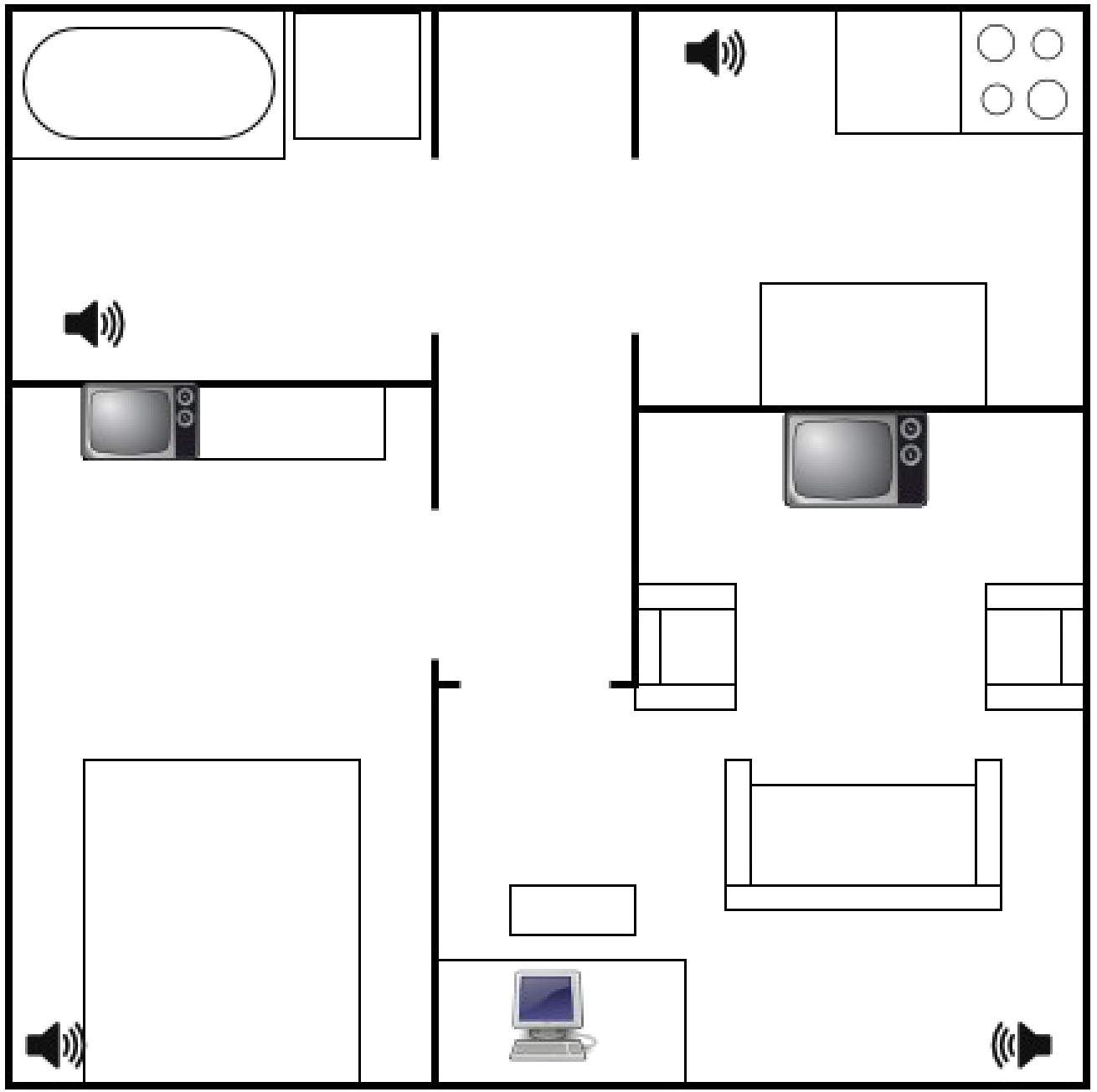
dynamic facts:




```
admissible(D)  if
      videoDevice(D) and
      covers(D,A) and
      inside(A) and
      not(intimate(A)).

admissible(D)  if
      audioDevice(D) and
      covers(D,A) and
      inside(A).
...
partOf(sofa1,sitting_area).
partOf(sitting_area,living_room)
partOf(living_room,apartment)
...
```

dynamic facts:



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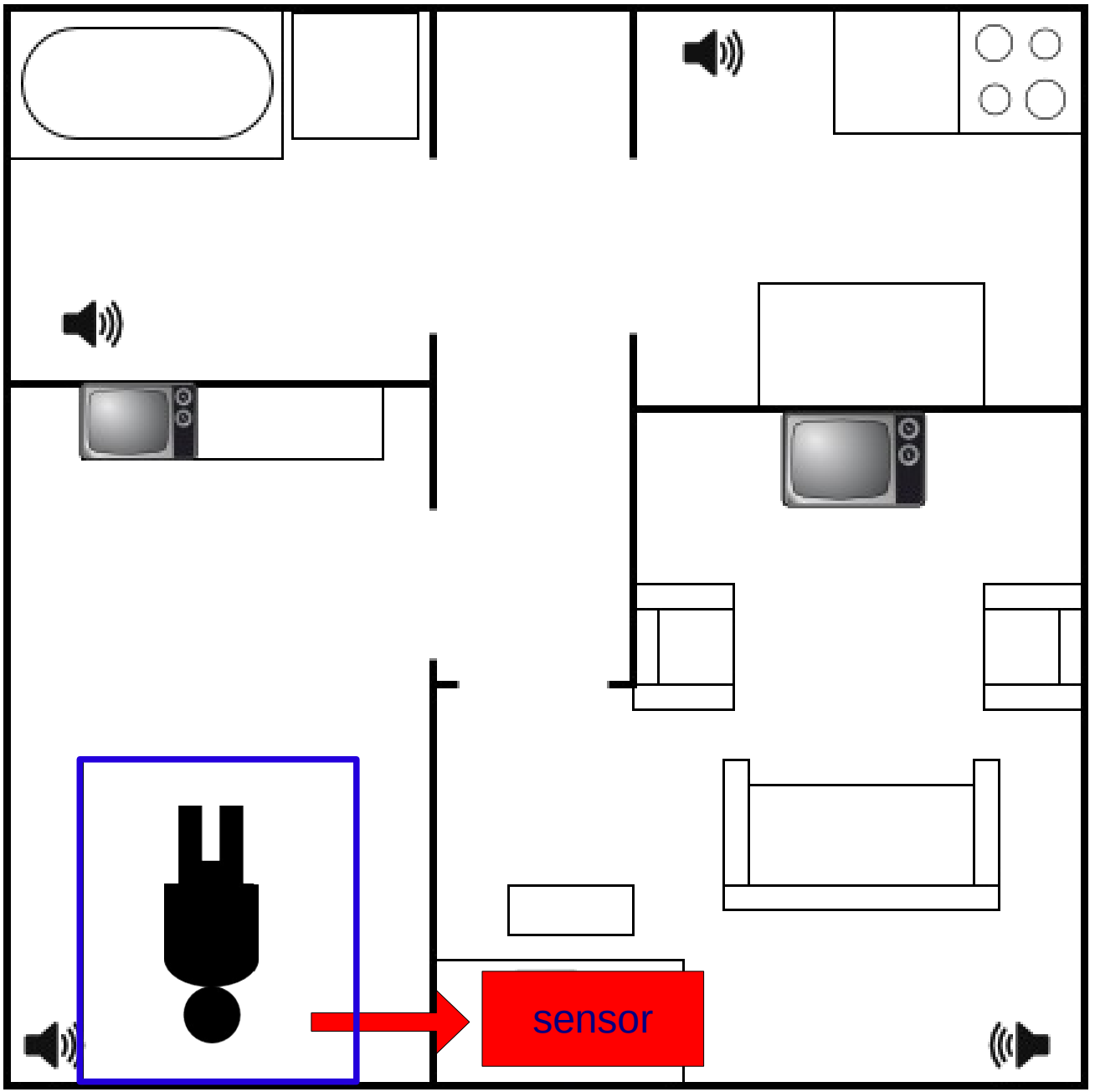


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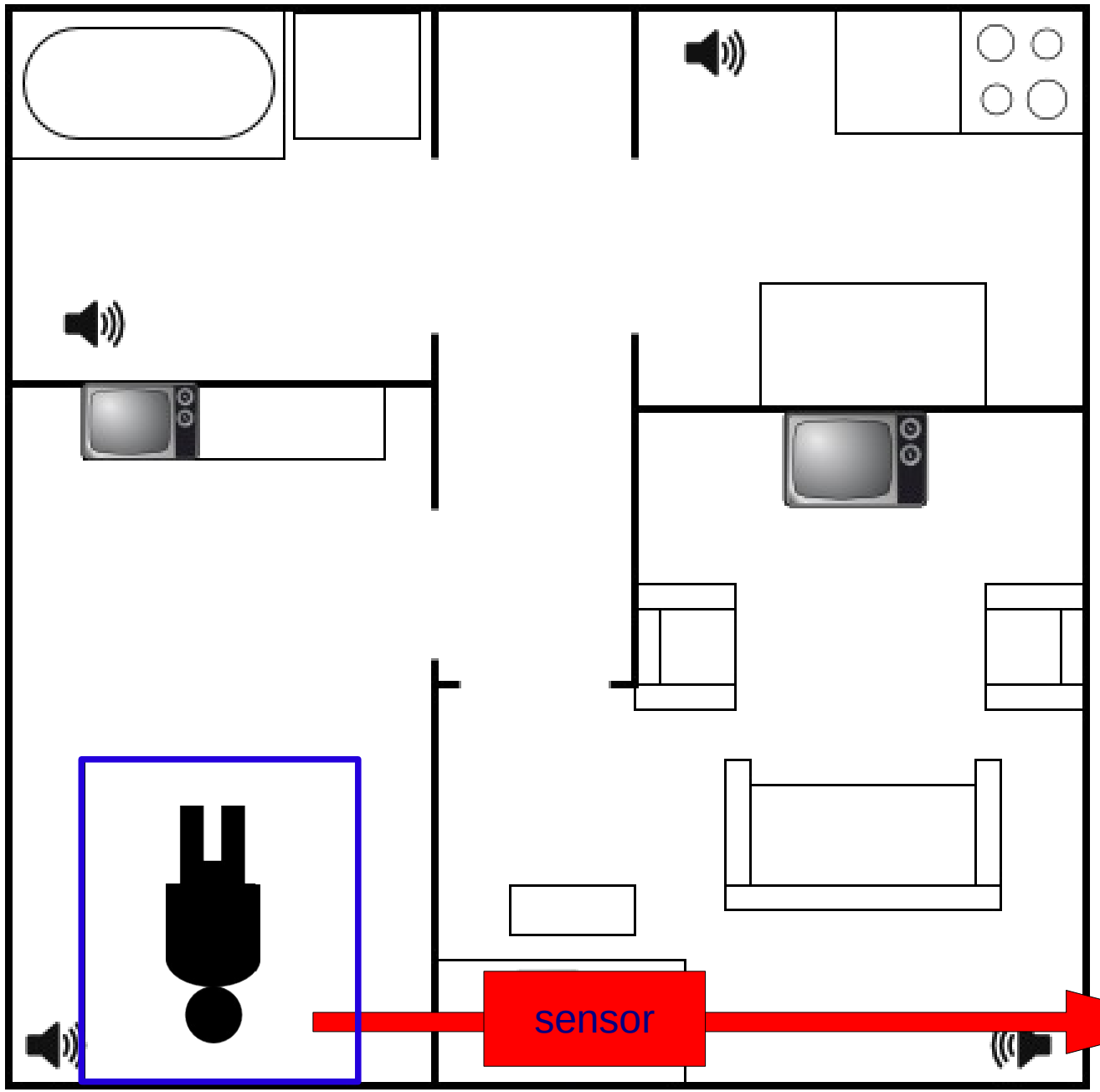


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partOf(living_room,apartment)
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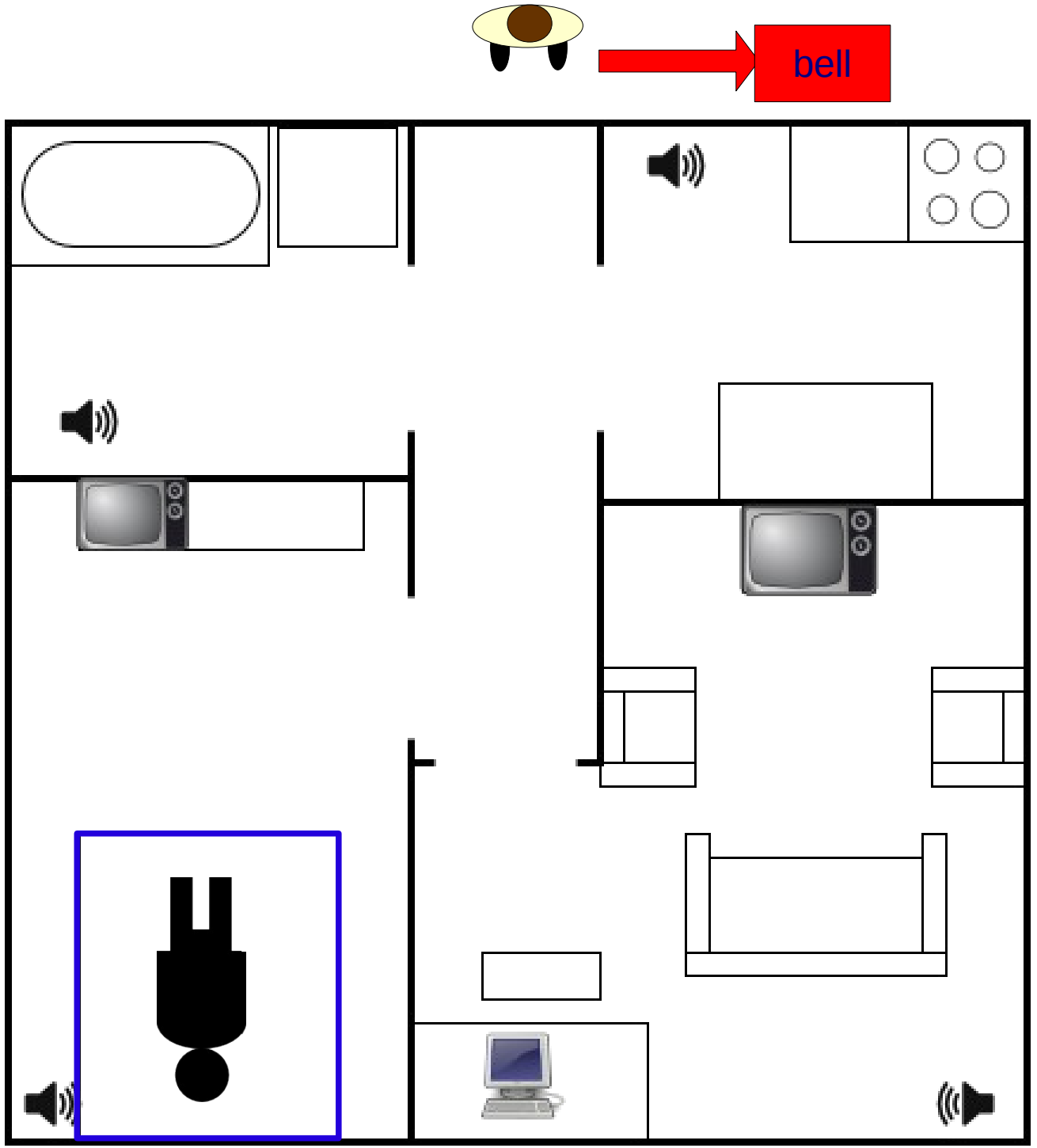
dynamic facts:

inside(bed)

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partOf(sitting_area,living_room)
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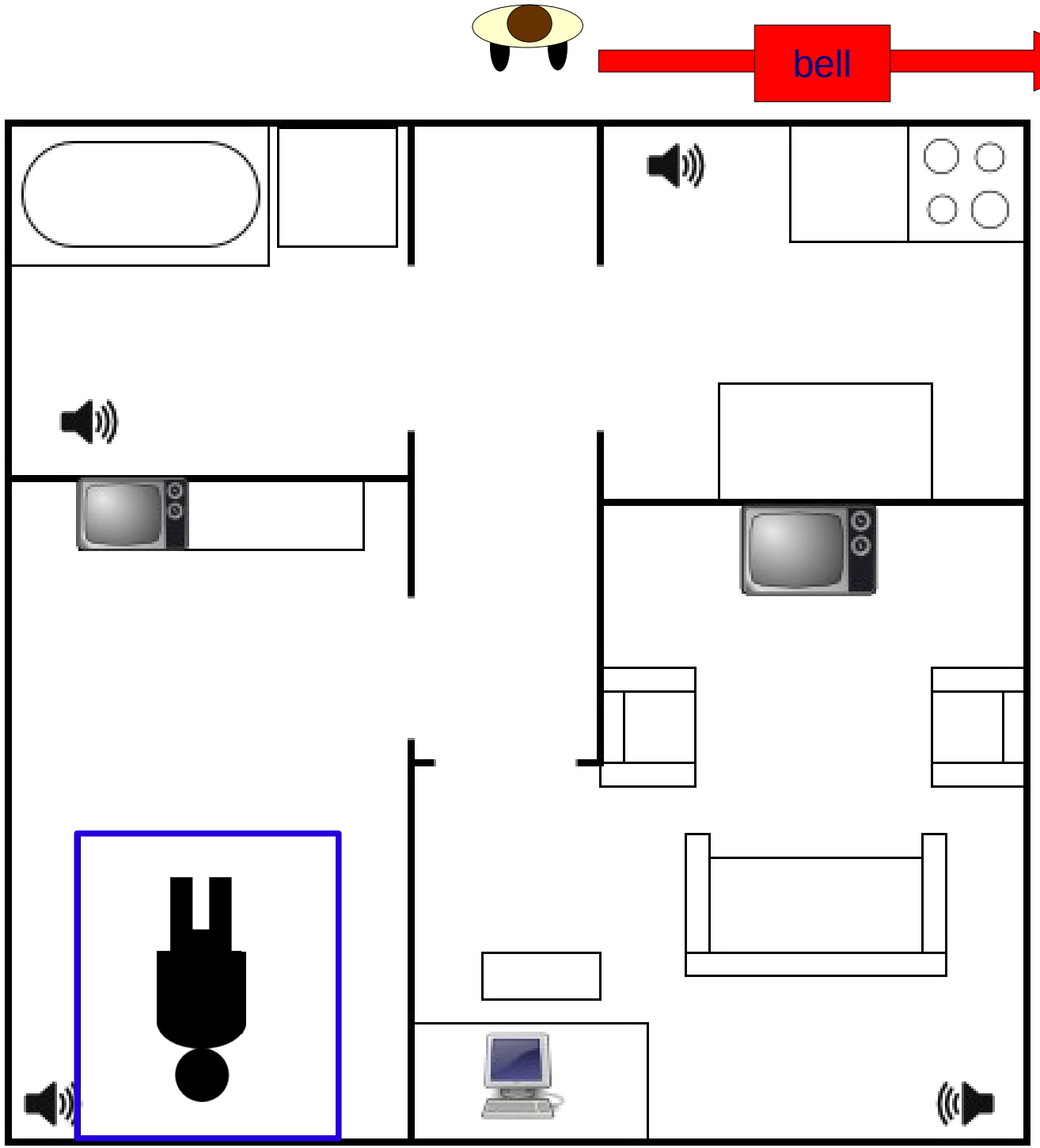


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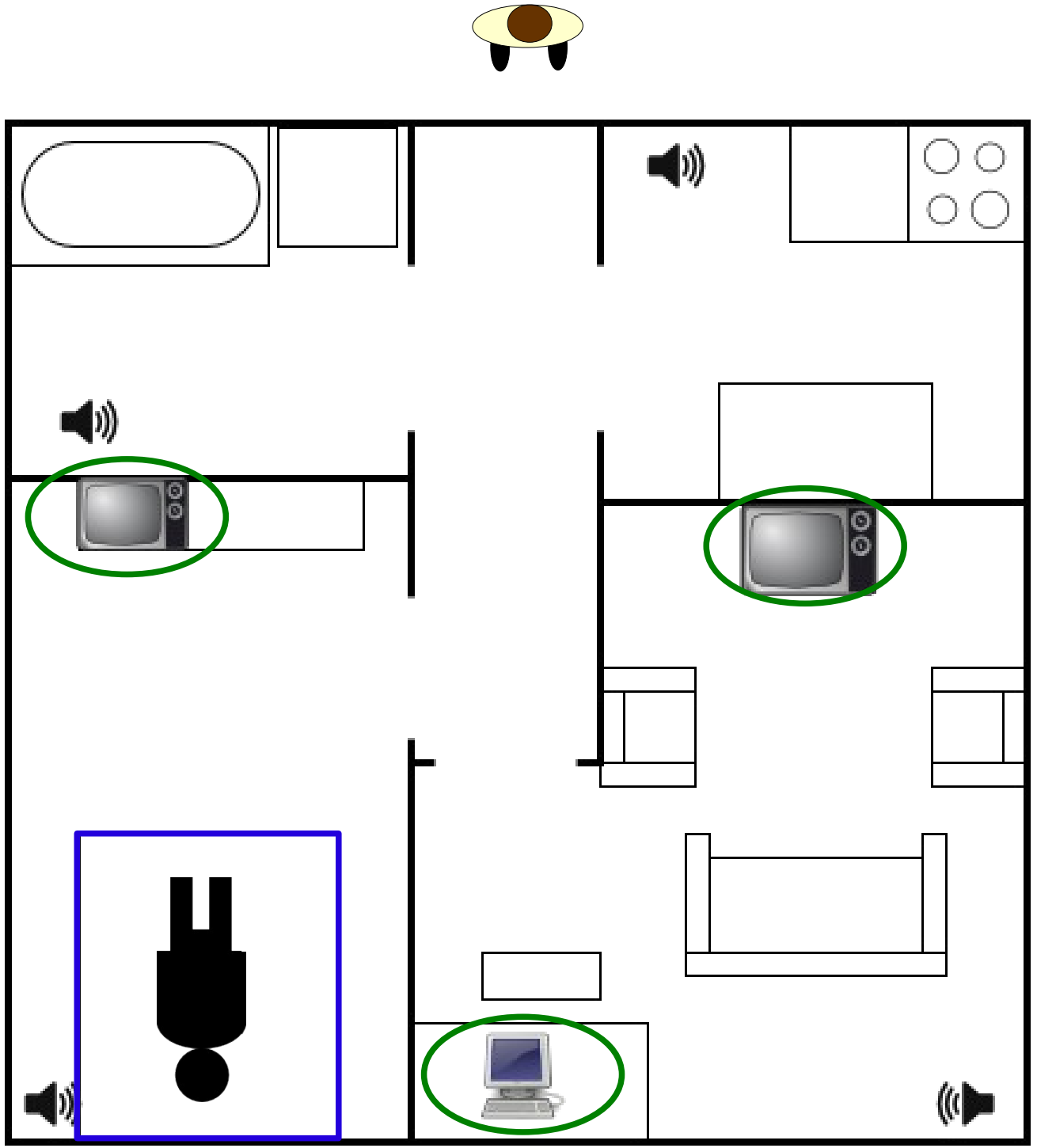

admissible(V)?

admissible(V) if
videoDevice(V) and
covers(V,A) and
inside(A) and
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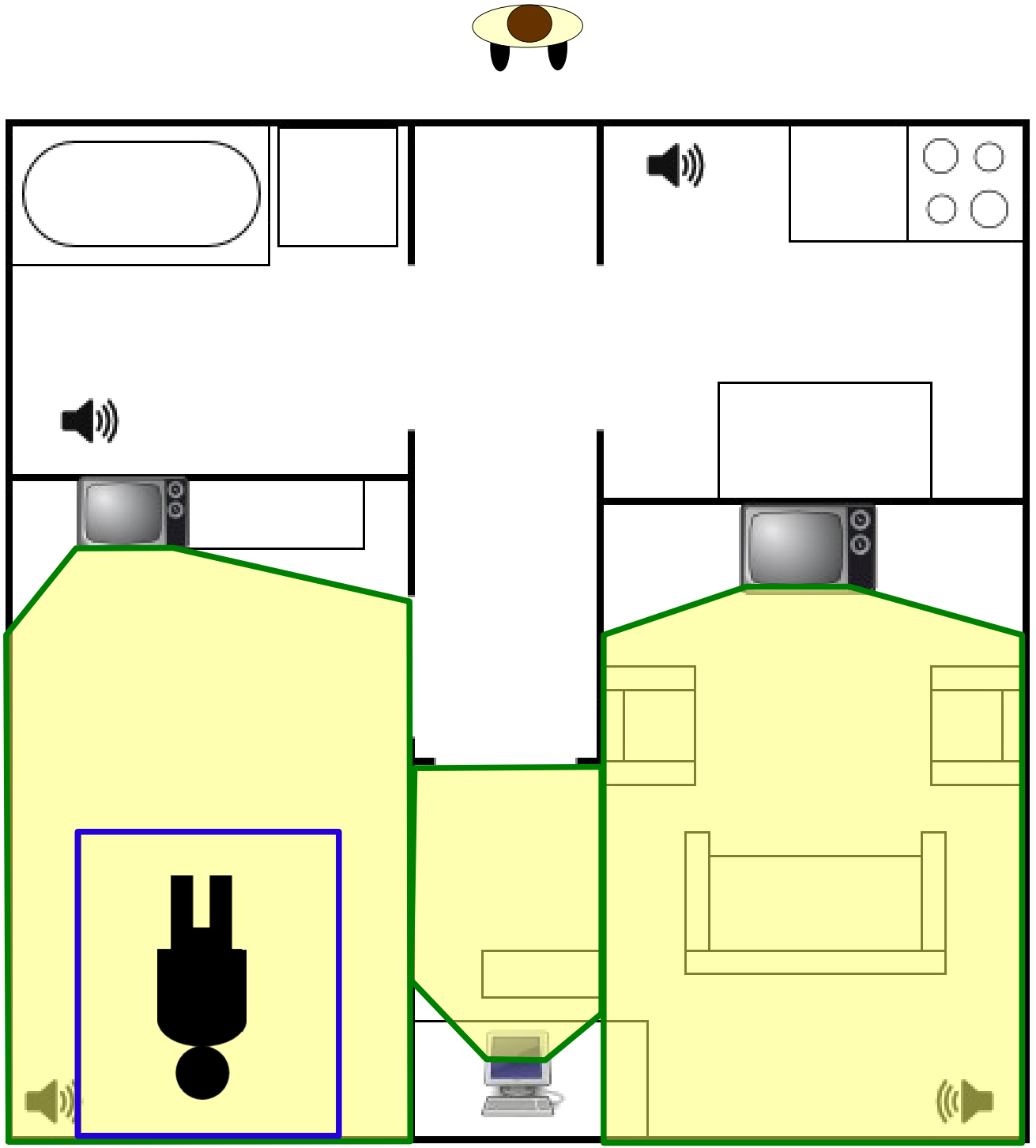
dynamic facts:

inside(bed)



admissible(V)?

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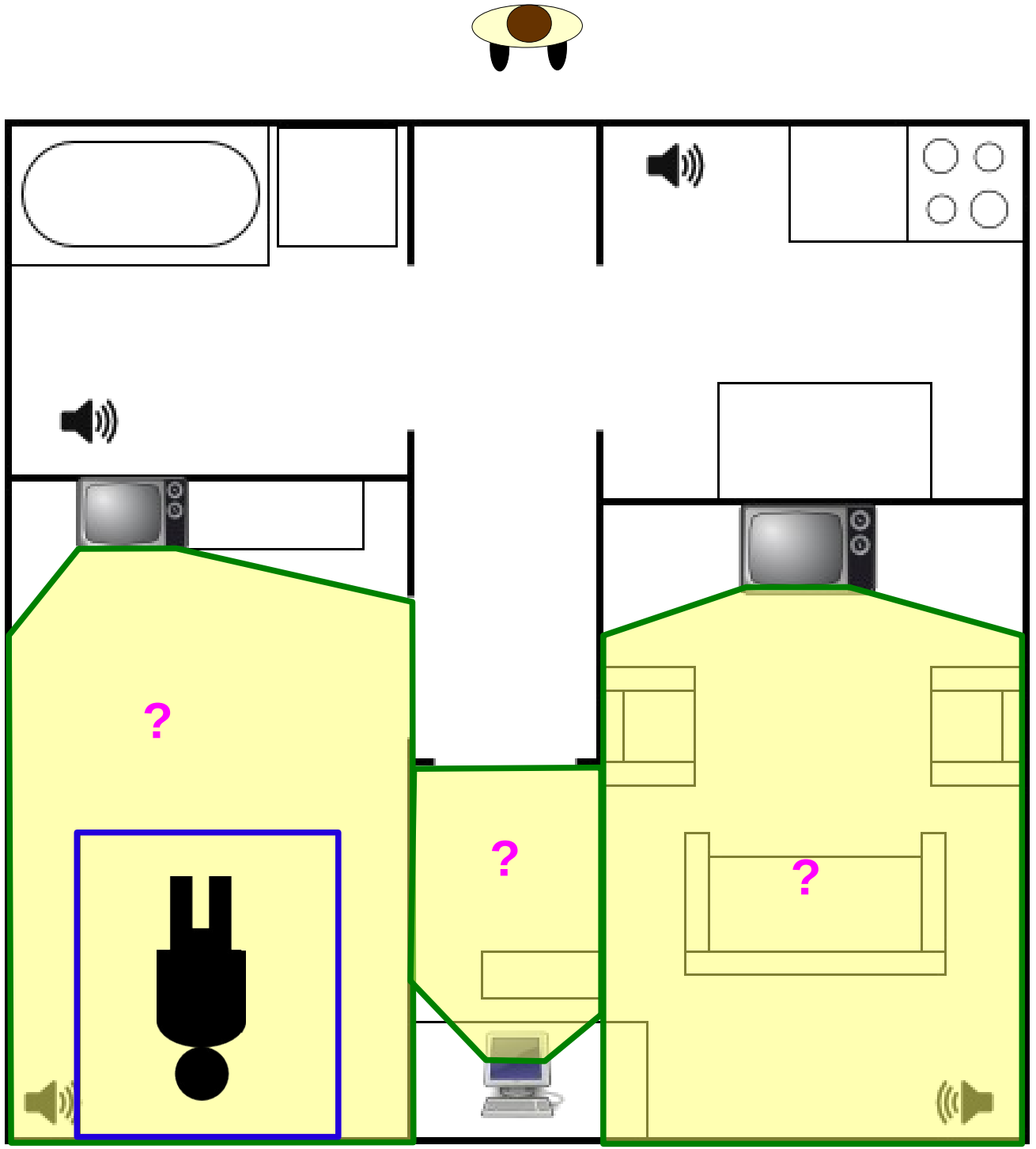


admissible(V)?

admissible(V) if
videoDevice(V) and
covers(V,A) and
inside(A) and
not(intimate(A)).

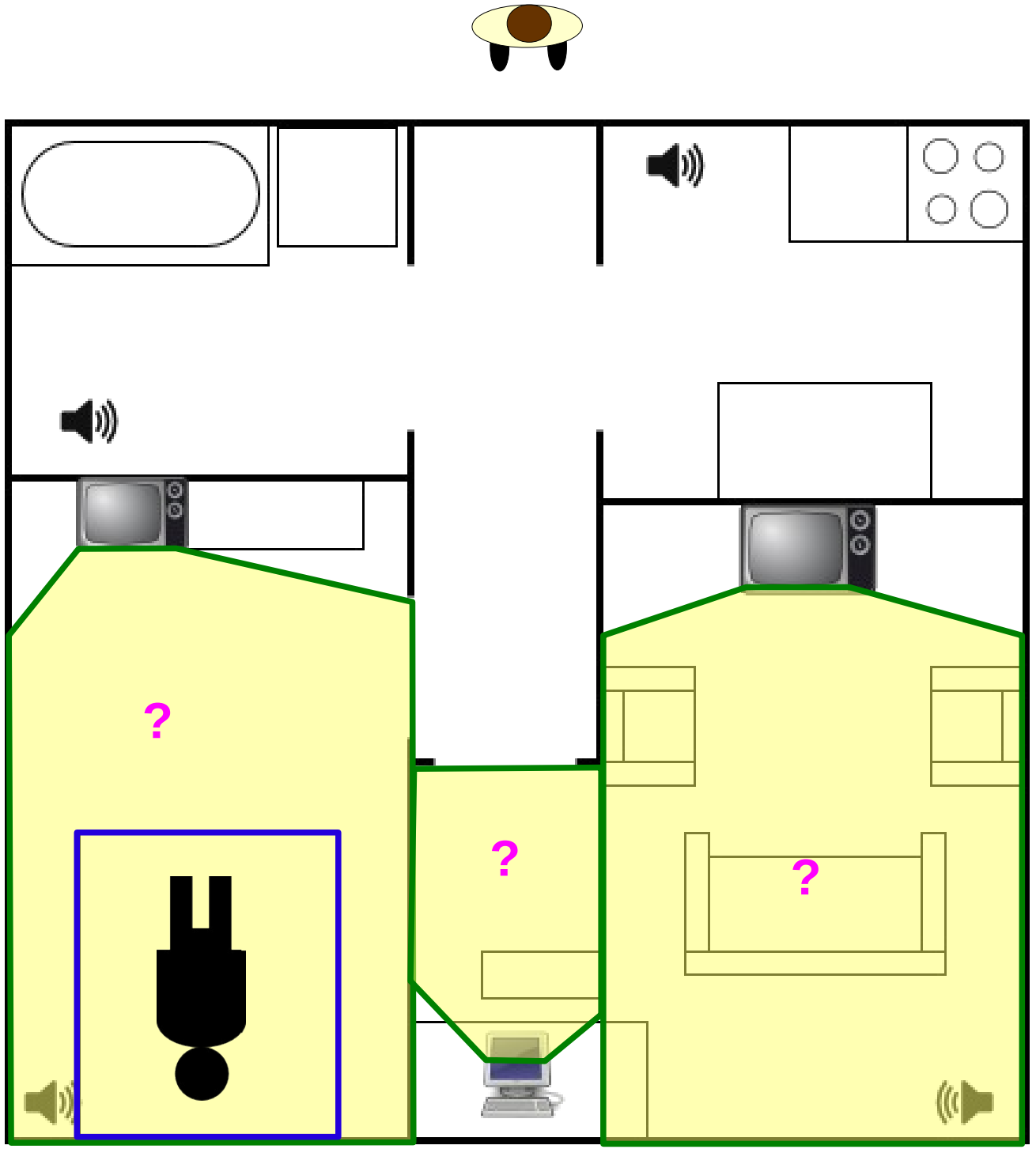
?

inside(A1) if
partOf(A2,A1) and
inside(A2).

partOf(bed,tv1_area).

dynamic facts:

inside(bed)



admissible(V)?

admissible(V) if
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inside(bed) if
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partOf(bed,tv1_area).

dynamic facts:

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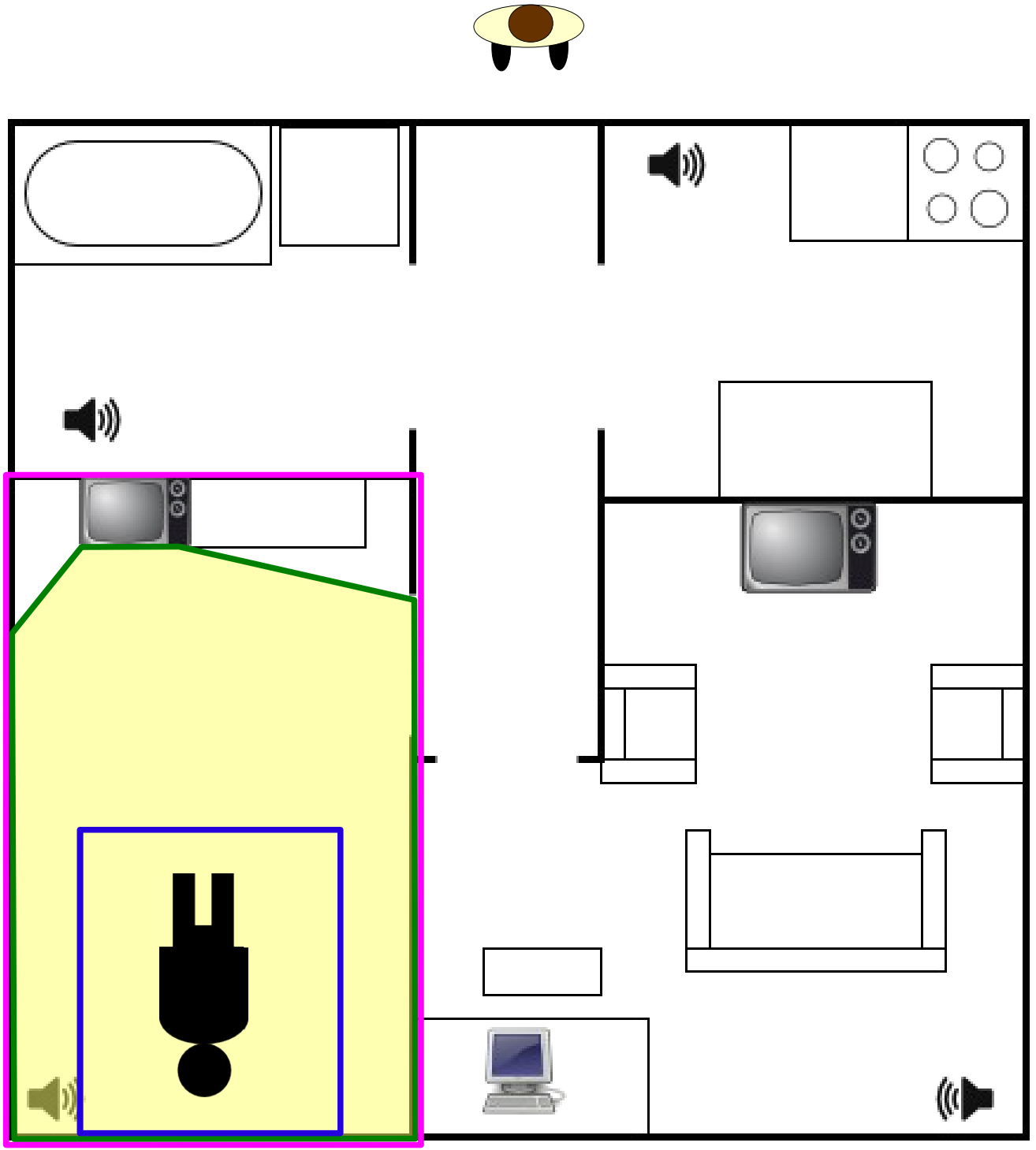


admissible(V)?

admissible(tv1) if
videoDevice(tv1) and
covers(tv1,tv1_area) and
inside(tv1_area) and
not(intimate(tv1_area)). ?

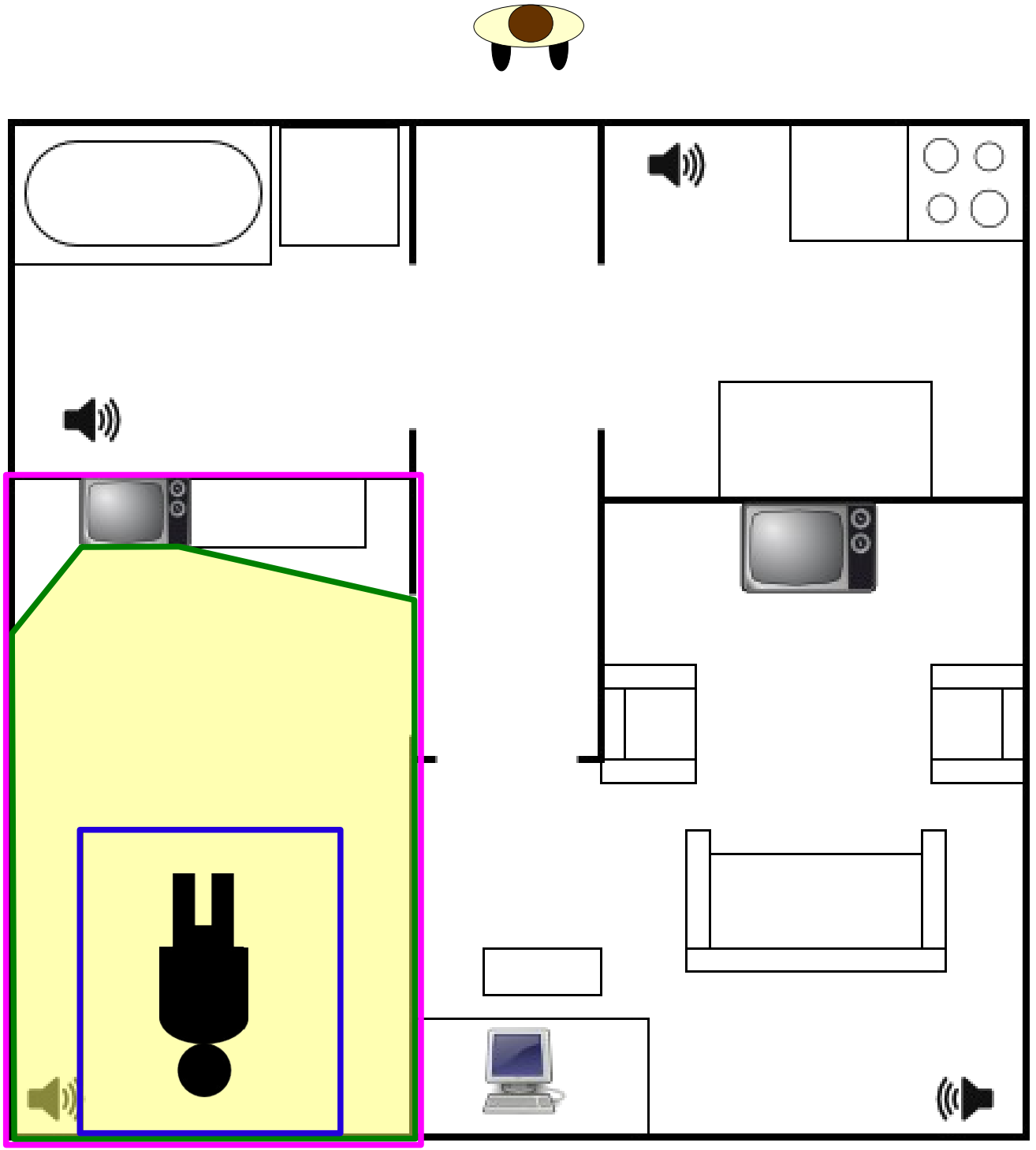
inside(bed) if
partOf(bed,tv1_area) and
inside(tv1_area).

partOf(bed,tv1_area).
partOf(tv1_area,sleeping_room).

intimate(A) if
partOf(A,sleeping_room).

dynamic facts:

inside(bed)



admissible(V)?

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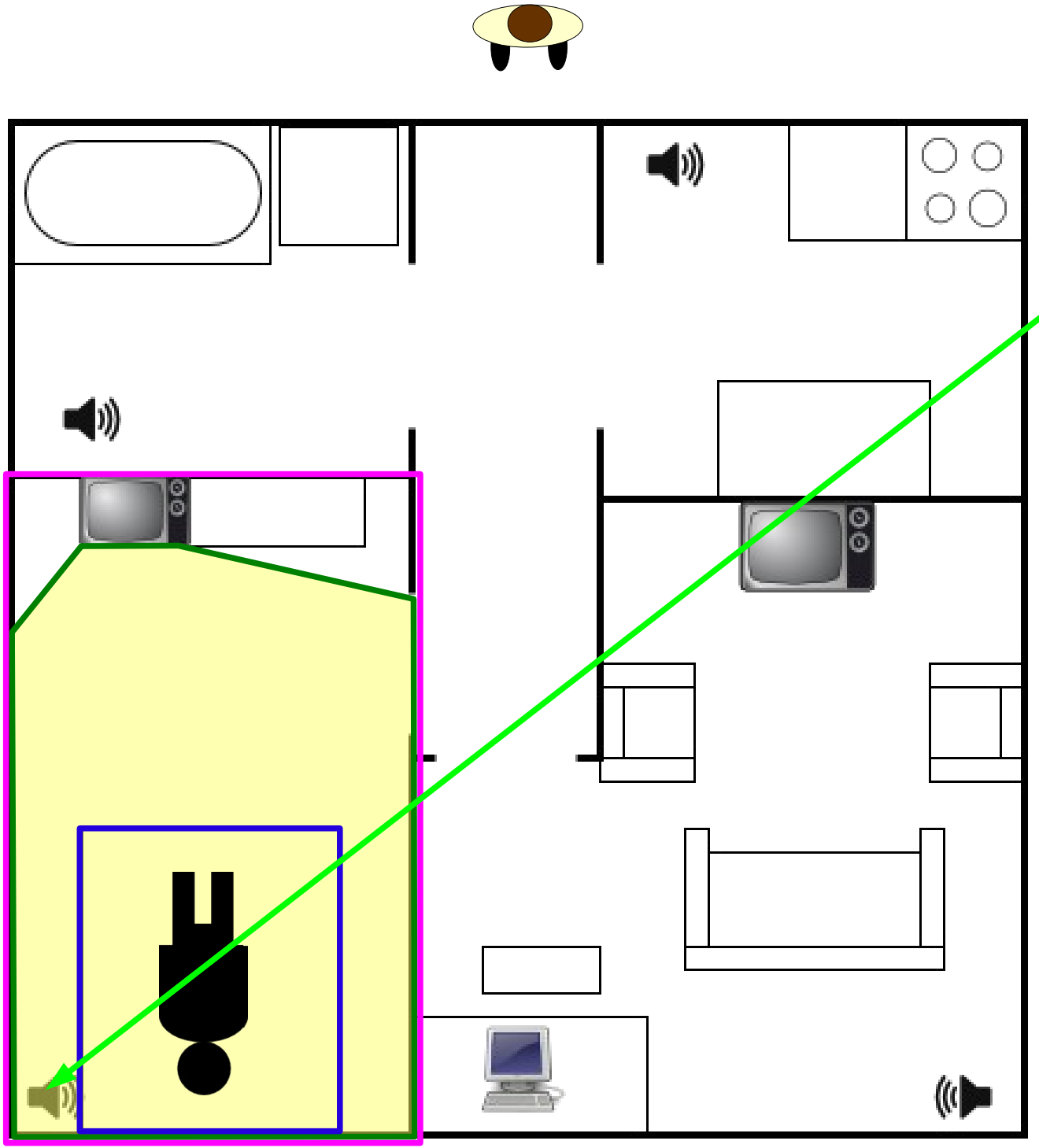
inside(bed)  if
        partOf(bed,tv1_area) and
        inside(tv1_area).

partOf(bed,tv1_area).
partOf(tv1_area,sleeping_room).

intimate(bed) if
        partOf(bed,sleeping_room).
```

dynamic facts:

inside(bed)



admissible(sp1)!

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dynamic facts:

inside(bed)

Typical Objections

- „These rules don't look like OWL!“
- „Why not just implement rules via if-then in Java?“
- „This was Prolog, but we want Java!“

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Rule Engines

http://www.manageability.org/blog/stuff/rule_engines/view

- List of ca. 30 rule engines and reasoners implemented in Java.
- Most prominent systems:
  - JESS, OpenRules, Jboss Drools, Pellet, Jena, ...

Rule engines have been extensively field-tested in business-logic by global players! e.g. IBM's ILOG business rule management system (http://www.ilog.com)

=> automated reasoning is not just an academic playground, but already facilitates sophisticated applications.

OASIS can take advantage from this experience!

Outlook

- Explore further OASIS domains with the ontological approach.
- Adoption of other OASIS ontologies.
- Transform the Prolog prototype to a Java implementation with integrated reasoner & rule engine.
- Practical experience with reasoning on modularized ontologies.
- Apply advanced modularisation techniques as well as more sophisticated (qualitative) spatial reasoning.