A Compositional Constructional Analysis of 'Hitting' Verb Argument Realization Patterns and Their Meanings

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‘Hitting’ verbs

- ‘Hitting’ verbs:
  - *E.g.: hit, slap, kick, punch, pat, tap, whack,* etc.
  - semantically similar
  - exhibit a wide range of similar argument realization patterns
  - different patterns describe different situations

Argument Realization Patterns

1. *She slapped/kicked/punched the box off the table*
   - actor causes motion of another entity

2. *She slapped her hand on / kicked her foot against the table*
   - actor moves body part, contacts another entity

3. *She slapped him on the back / across the face.*
   - actor affects person via contact at specific body location

Road Map

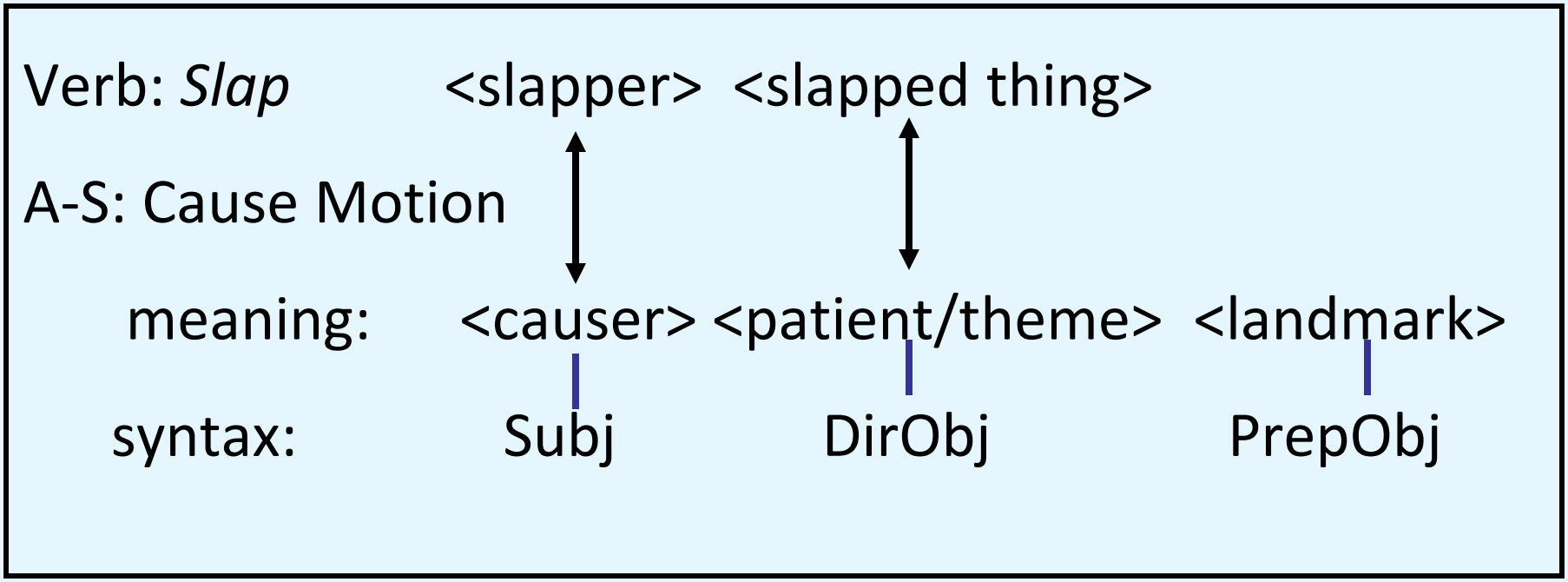
- Argument Structure Constructions

  (Goldberg 1995, 2006)
- Embodied Construction Grammar (ECG)

  (Feldman, Dodge, and Bryant, 2010)
- Analysis :
  - Meaning
  - Verb and A-S Constructions
  - Sentence examples

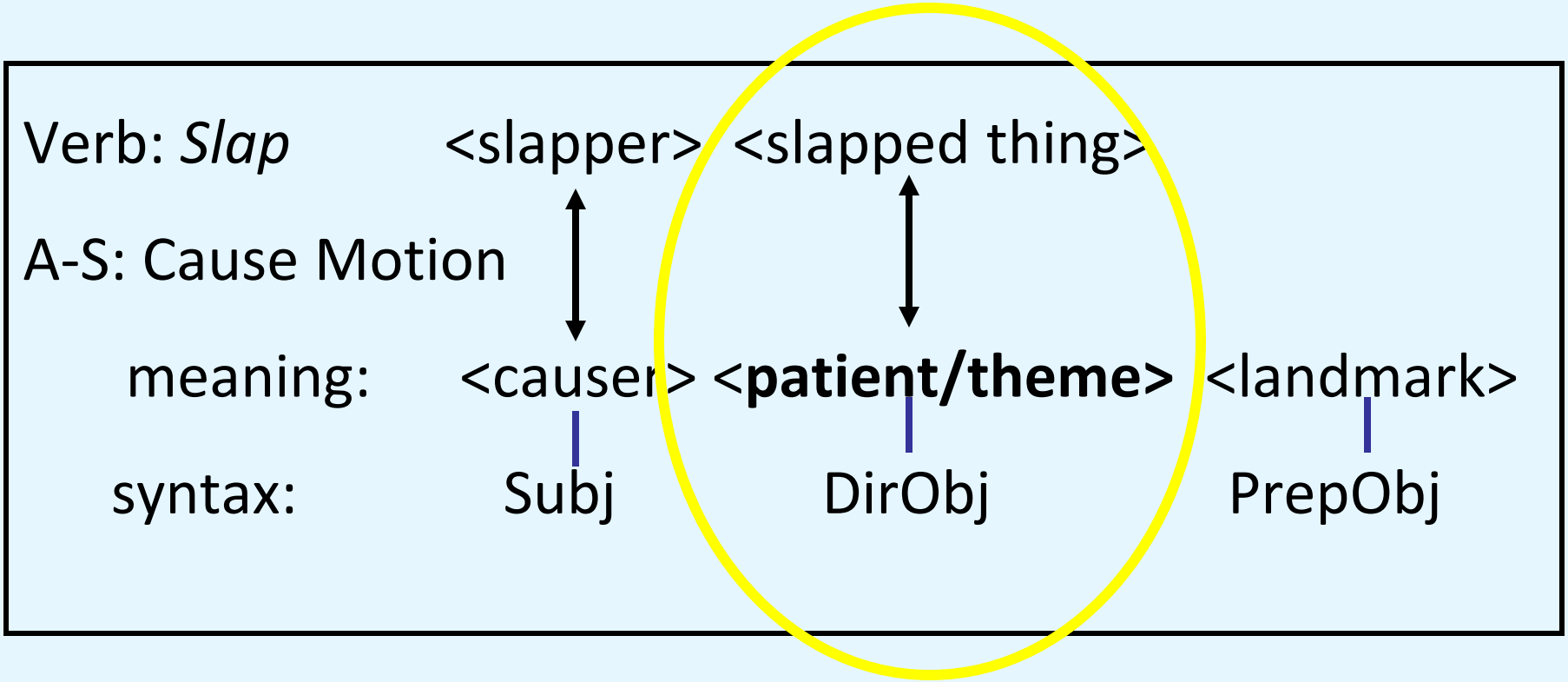
Argument Structure Constructions

She slapped the block into the box



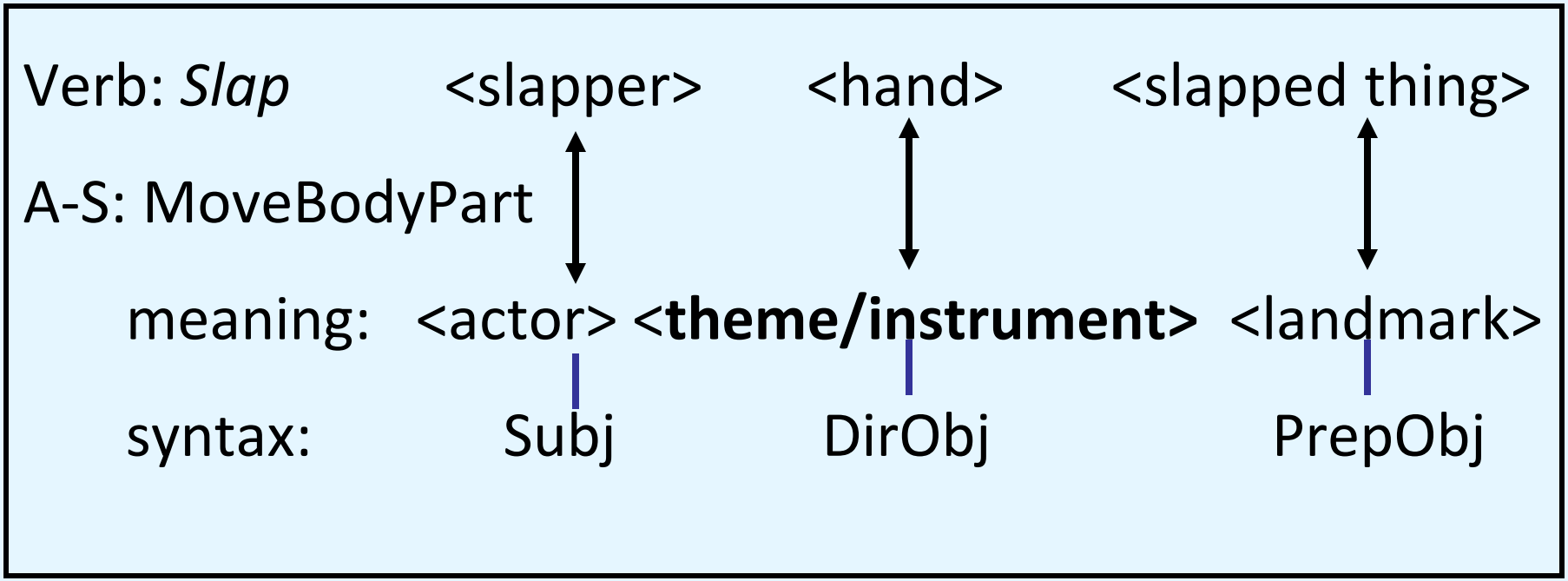
Argument Structure Constructions

She slapped the block into the box



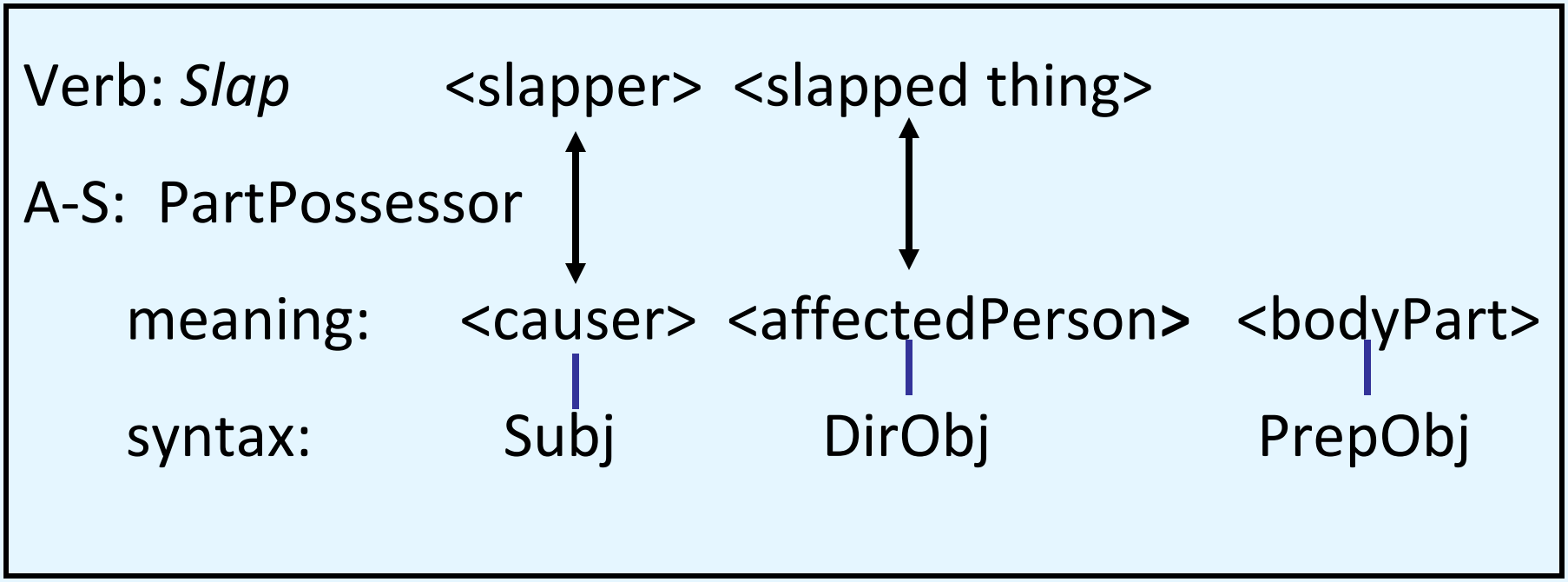
Argument Structure Constructions

She slapped her hand on the block



Argument Structure Constructions

She slapped him on the arm



Argument Structure Constructions

Need to identify and represent:

- Semantic commonalities that motivate different patterns of integration of verb, A-S construction, and nominal meanings
- Complex meanings that arise from this integration
- Relevant constraints that enable us to distinguish between different patterns

Embodied Construction Grammar

Construction grammar in which embodied semantics are central

Simulation semantics -- understanding a description of an event involves activation of the same/similar neural structure as is active for other experiences of that event

Language Understanding Model

- Analysis:
  - Determination of which constructions in a grammar “best-fit” a given utterance
  - Unification of instantiated constructions produces semantic specification (Semspec)
- Simulation:
  - Enactment of the situation specified in the Semspec.
  - May allow understander to draw further inferences.

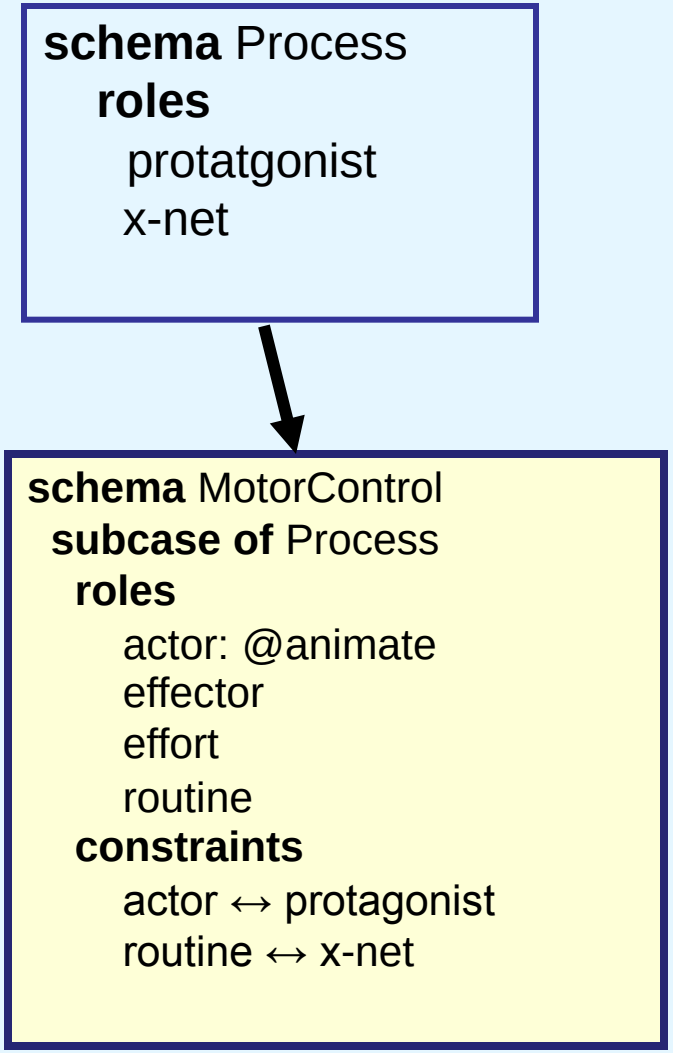
Embodied Construction Grammar

- ECG formalism enables precise, consistent representations of constructions and meanings
- Supports computational implementations:
  - ECG Workbench -- view, write and test grammars
  - Constructional Analyzer (Bryant 2008) – analyzes sentence examples, produces semantic specifications

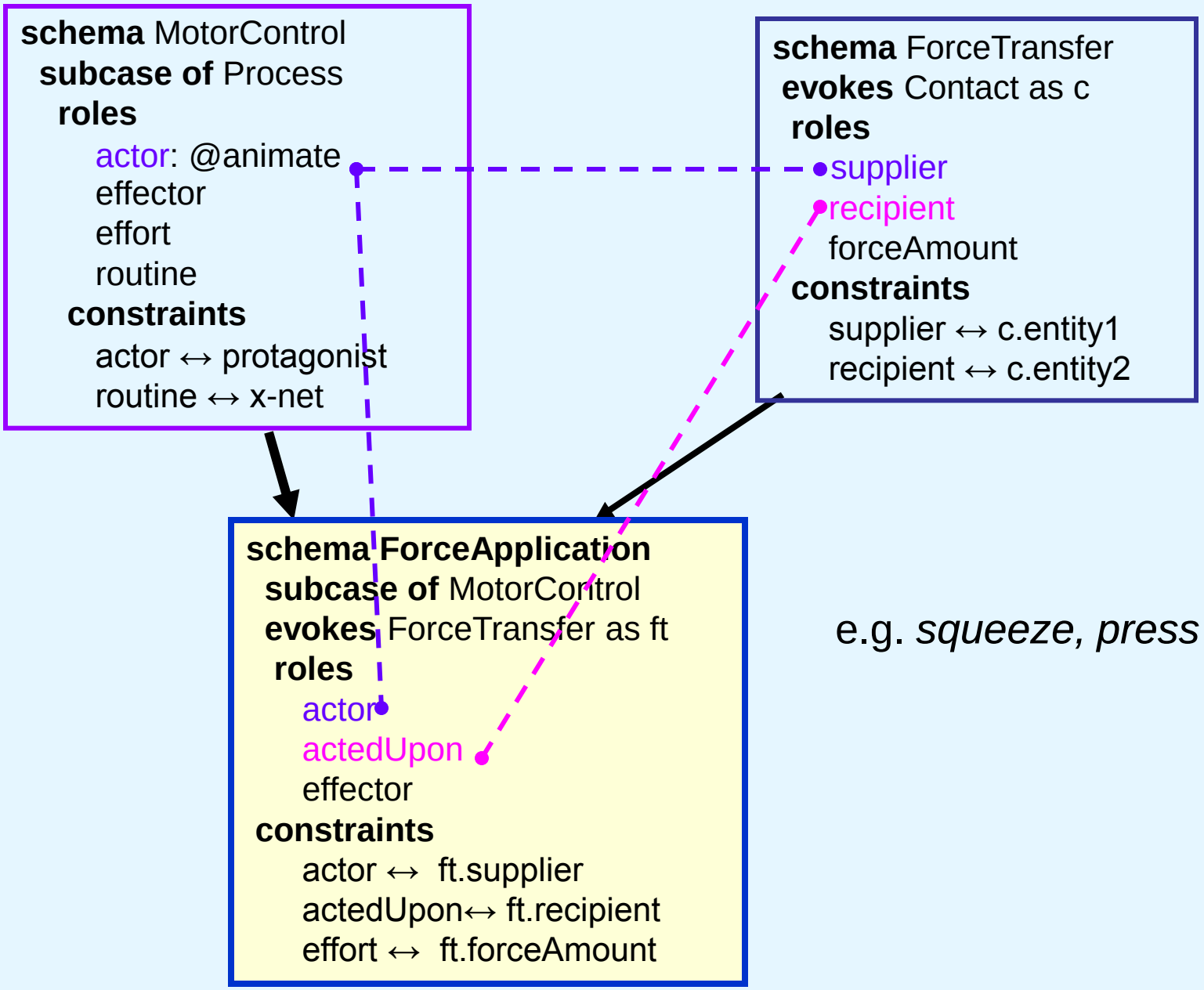
Meaning

- Represented using schemas
- Consistent with simulation semantics
- Meanings of verb and A-S constructions are represented using some of the same or related schemas

Motor Control Schema

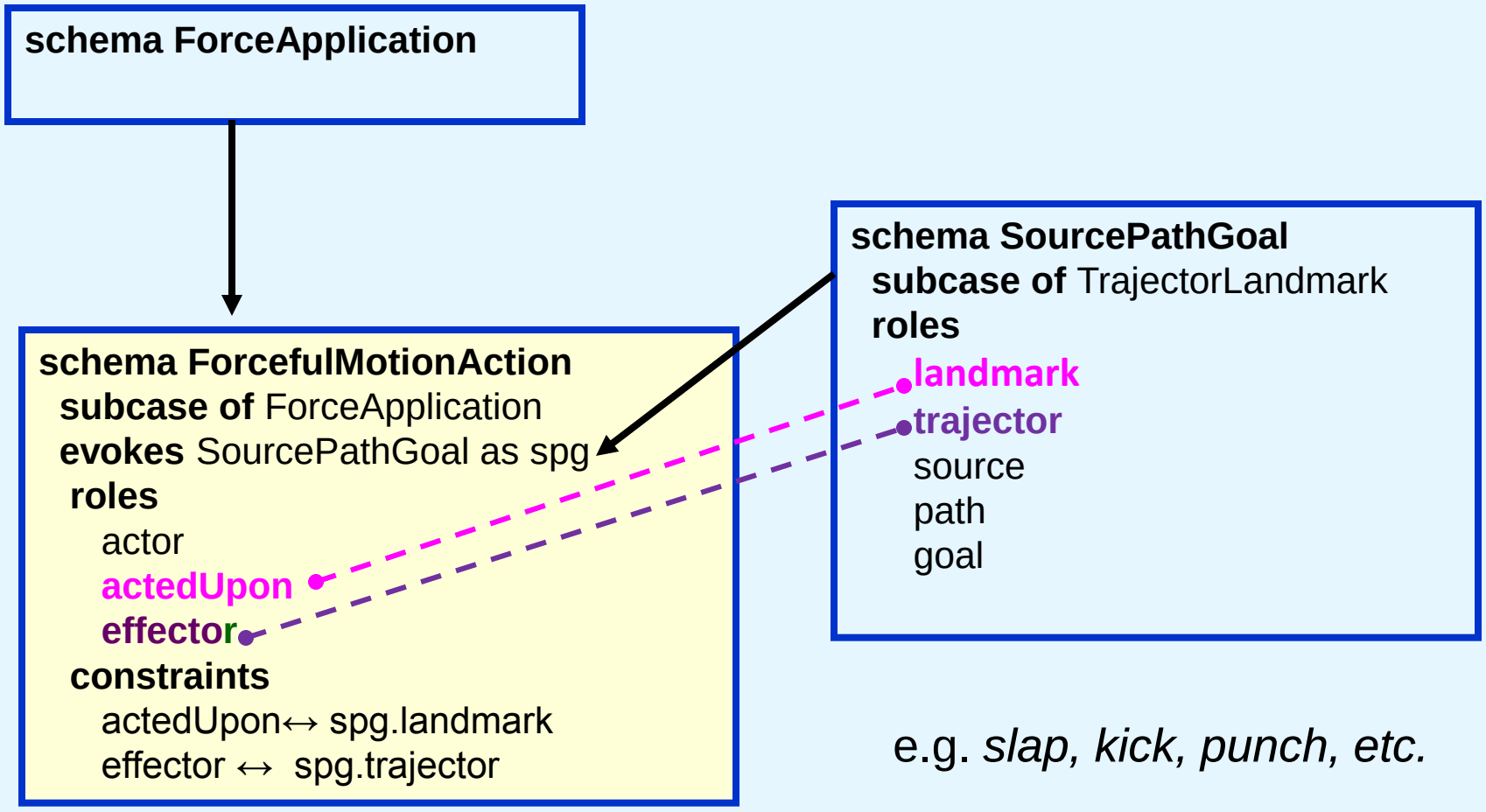


Force Application



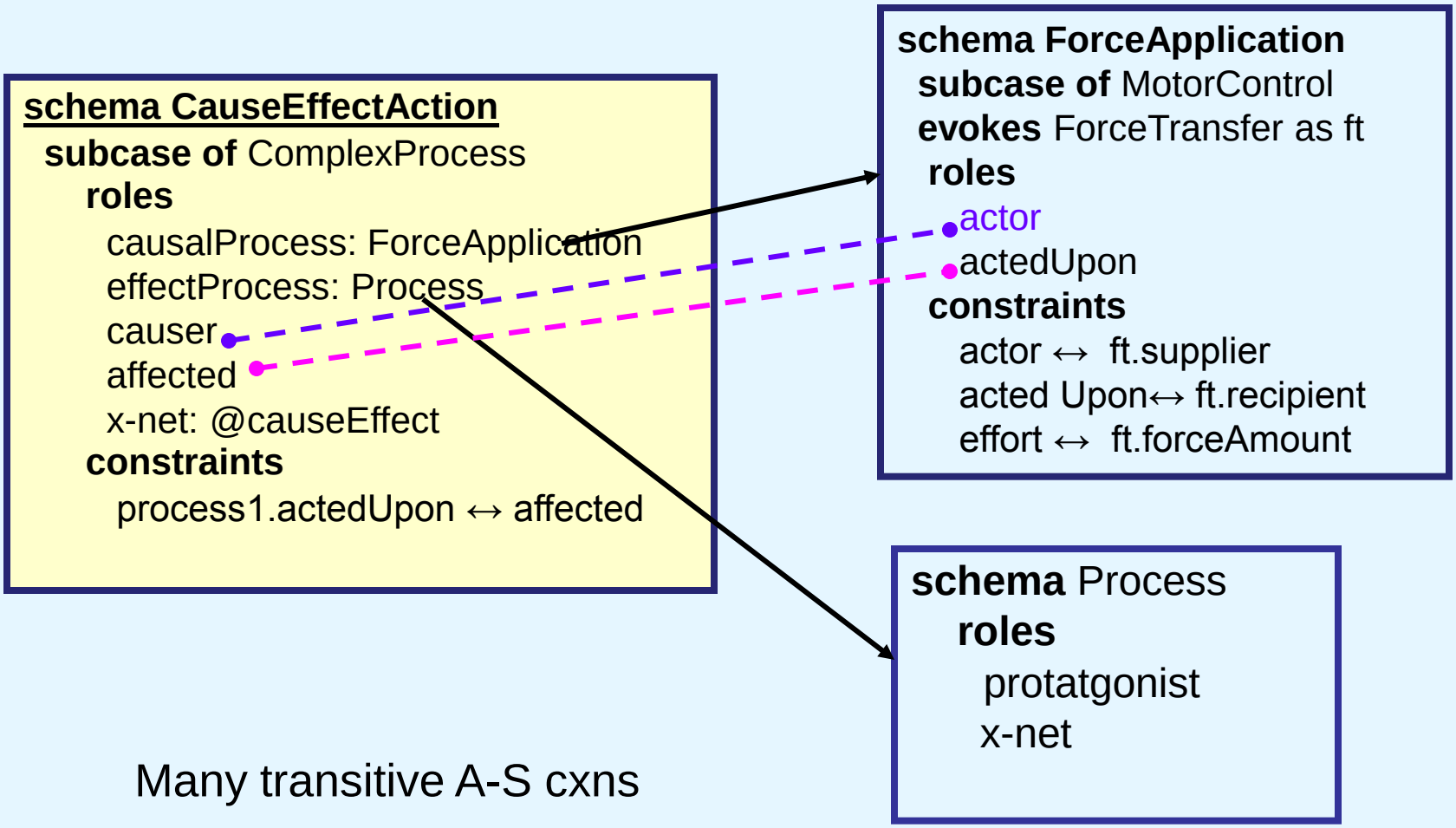
e.g. *squeeze, press*

ForcefulMotionAction



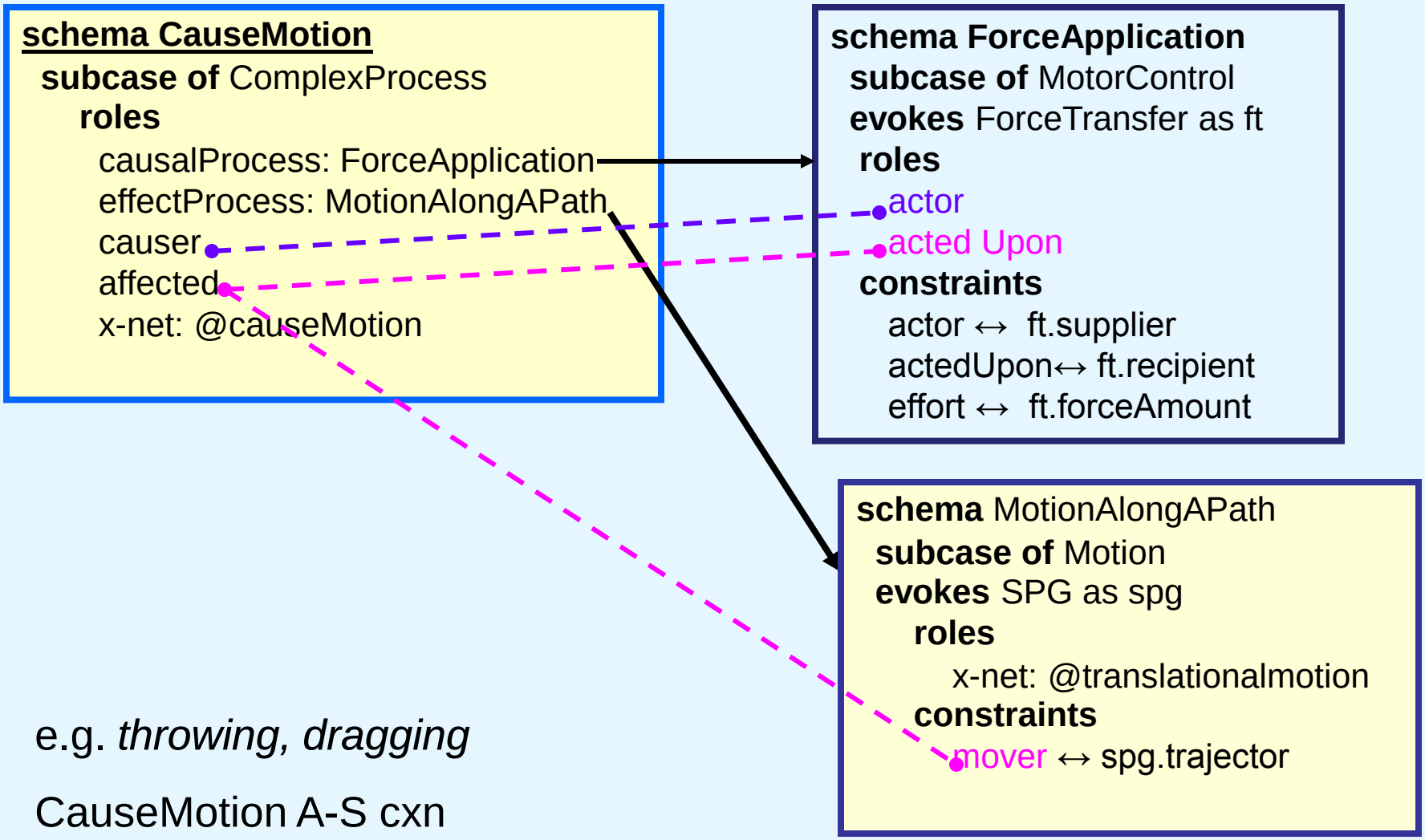
e.g. *slap, kick, punch, etc.*

CauseEffectAction



Many transitive A-S cxns

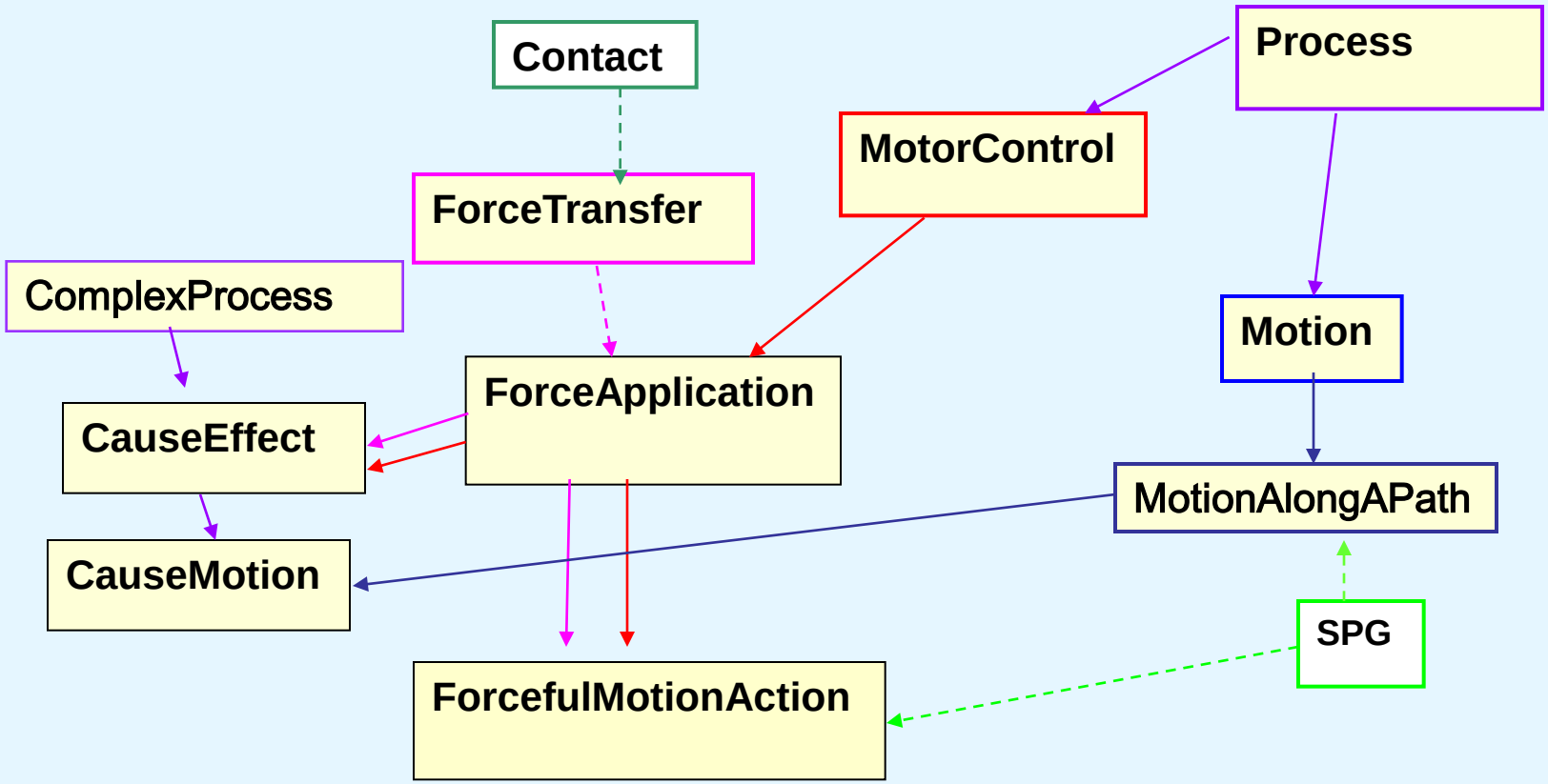
Cause Motion



e.g. *throwing, dragging*

CauseMotion A-S cxn

Process schema lattice (portion)



Constructions

A given sentence instantiates many constructions

For *She slapped the block into the box:*

- Lexical constructions: *She, slapped, the, block, into, box*
- PastTense cxn
- Phrasal cxns: *the block, into the box*
- Argument Structure Cxn: CauseEffect
- Clause cxn: Declarative

Verb Constructions

construction SlapPast
  subcase of Slap, PastTense
  form: WordForm
    constraints
      self.f.orth ← "slapped"
  meaning: ForcefulMotionAction
    constraints
      effector ← @hand
      self.m.x-net ← @slap

schema ForcefulMotionAction
  subcase of ForceApplication
    roles
      actor: @animate
      actedUpon
      effector
      x-net: @forcefulMotionAction

Other similar verbs:

kick effector = foot
punch: effector = fist
tap: force amount = low
whack: force amount = high

Ontology

animate sub of entity
    animal sub of animate
    person sub of animate

bodyPart sub of entity
    foot sub of bodyPart
    arm sub of bodyPart
    leg sub of bodyPart

CauseMotion A-S cxn

construction ActiveTransCauseMotion2
subcase of ArgumentStructure
constructional
constituents
v : Verb // inherited
np: NP
pp: Path-PP
form
constraints
v.f before np.f
np.f before pp.f
meaning: CauseMotion
evokes EventDescriptor as ed
evokes ForcefulMotionAction as fma
constraints
v.m <--> self.m.causalProcess
self.m.affected <--> np.m
self.m.causer <--> ed.profiledParticipant
self.m.effectProcess.spg <--> pp.m

schema CauseMotion
subcase of ComplexProcess
roles
causalProcess: ForceApplication
effectProcess: MotionAlongAPath
causer
affected
x-net: @causeMotion

Cause Motion A-S construction

e.g. *She slapped the block into the box*

CAUSE MOTION 2

Constituents: Verb, NP, PP

Form: Verb > NP > PP

A-S cxn meaning: **CauseMotion**

Verb meaning: **ForcefulMotionAction**

Meaning constraints:

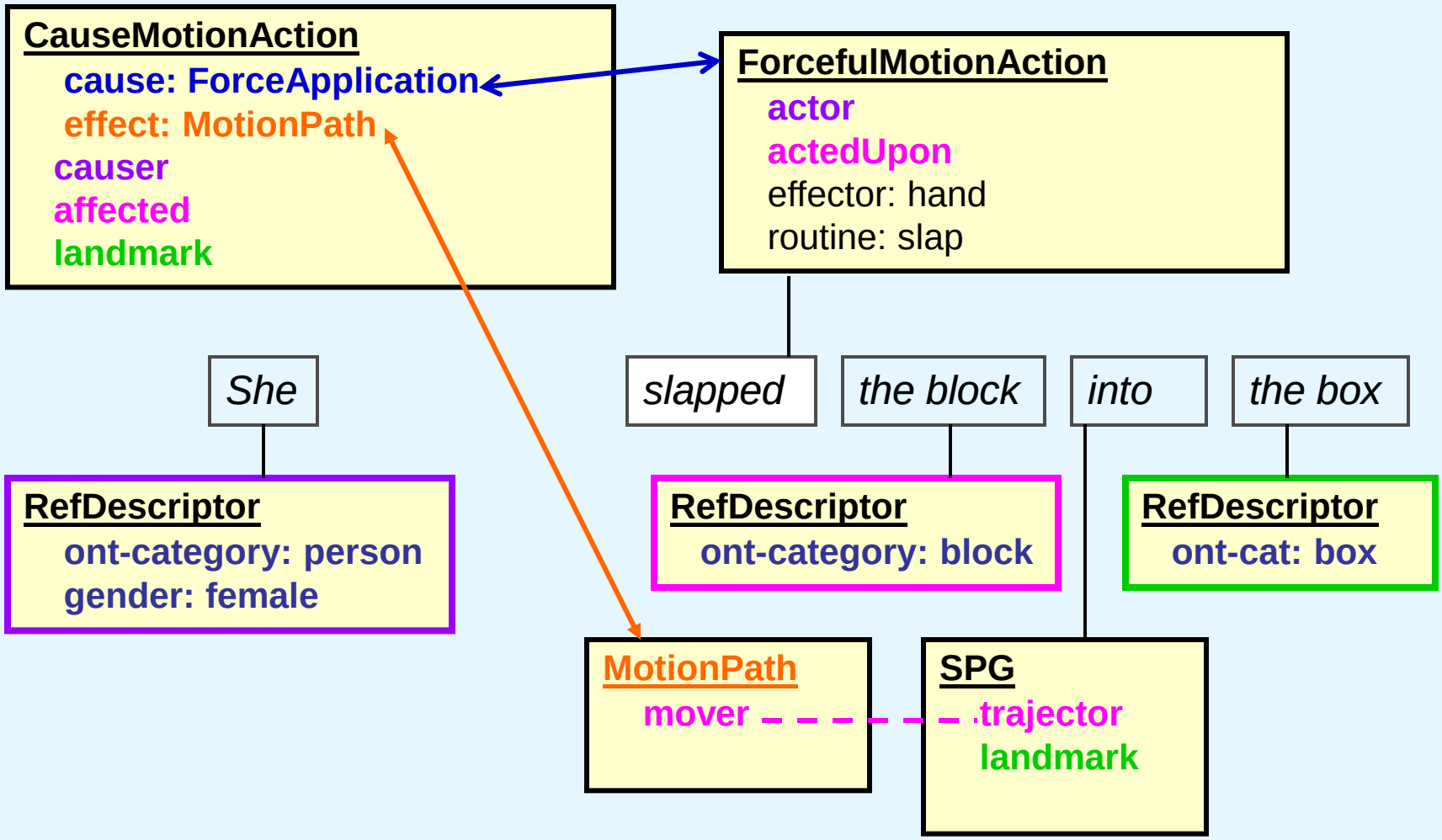
verb meaning = CauseMotion.causalProcess

profParticipant = causer <–> **actor**

NP meaning = affected <–> **actedUpon** <–> **mover** <–> **trajector**

PP.np meaning = **landmark**

She slapped the block into the box



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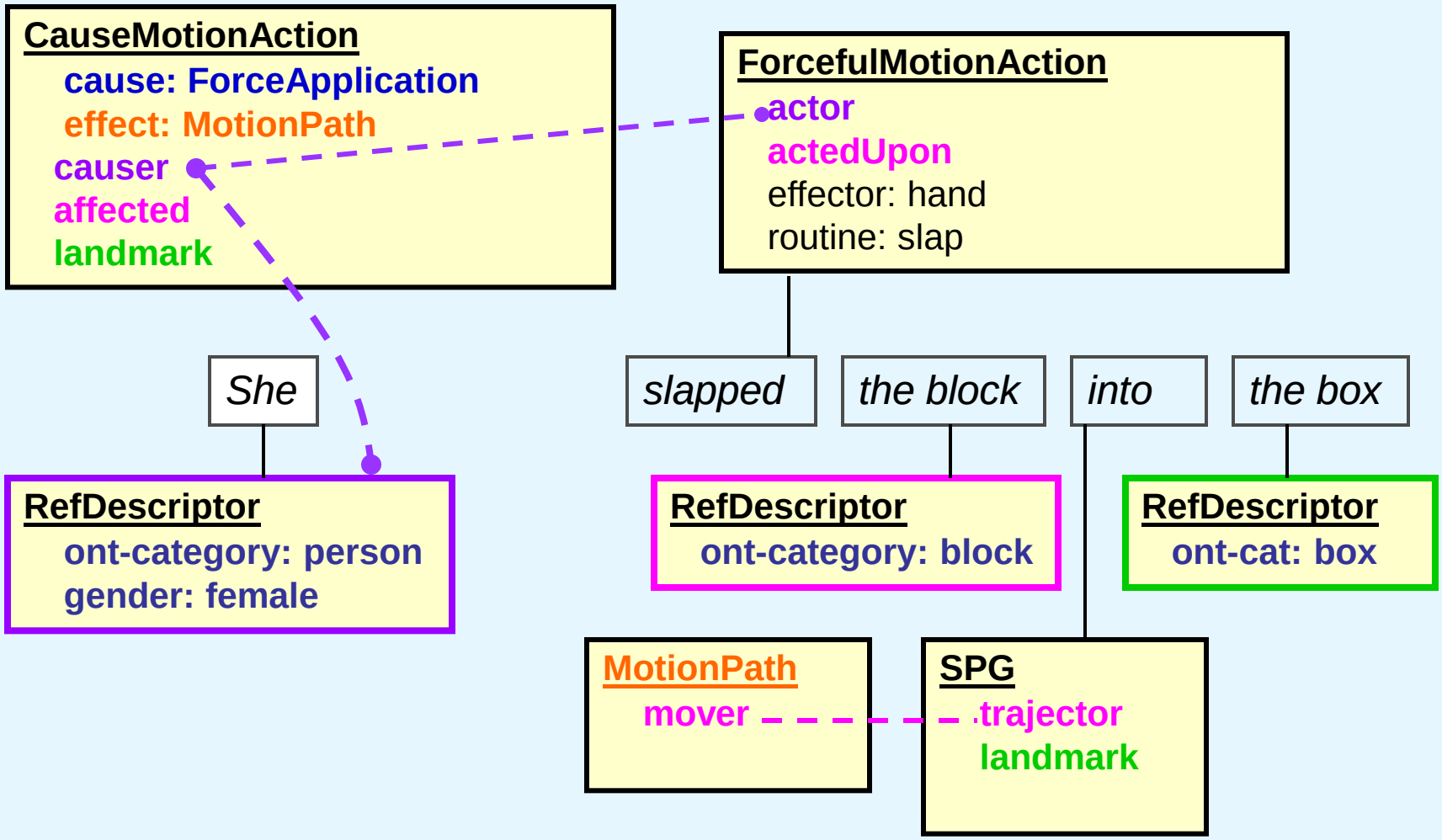

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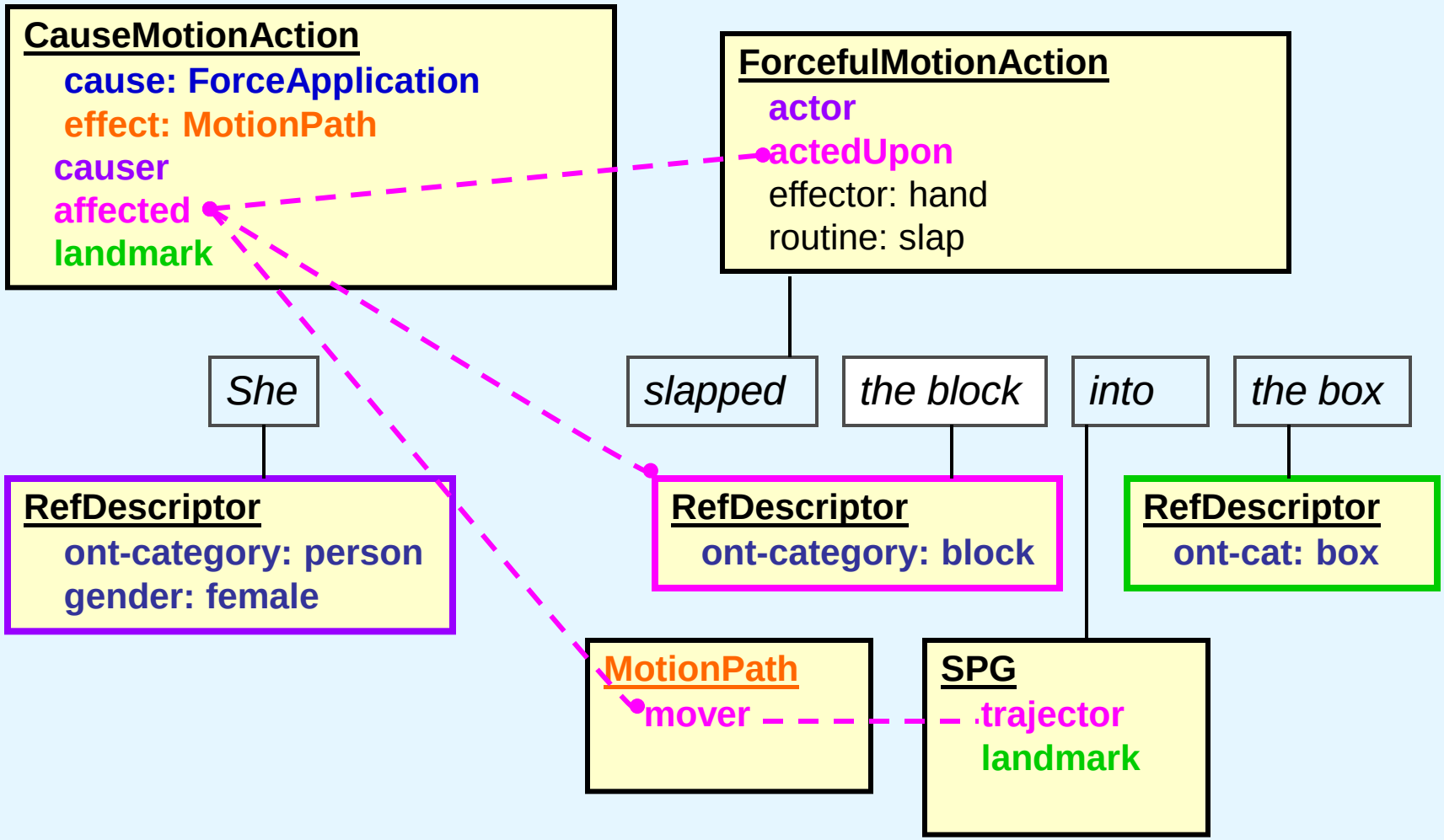

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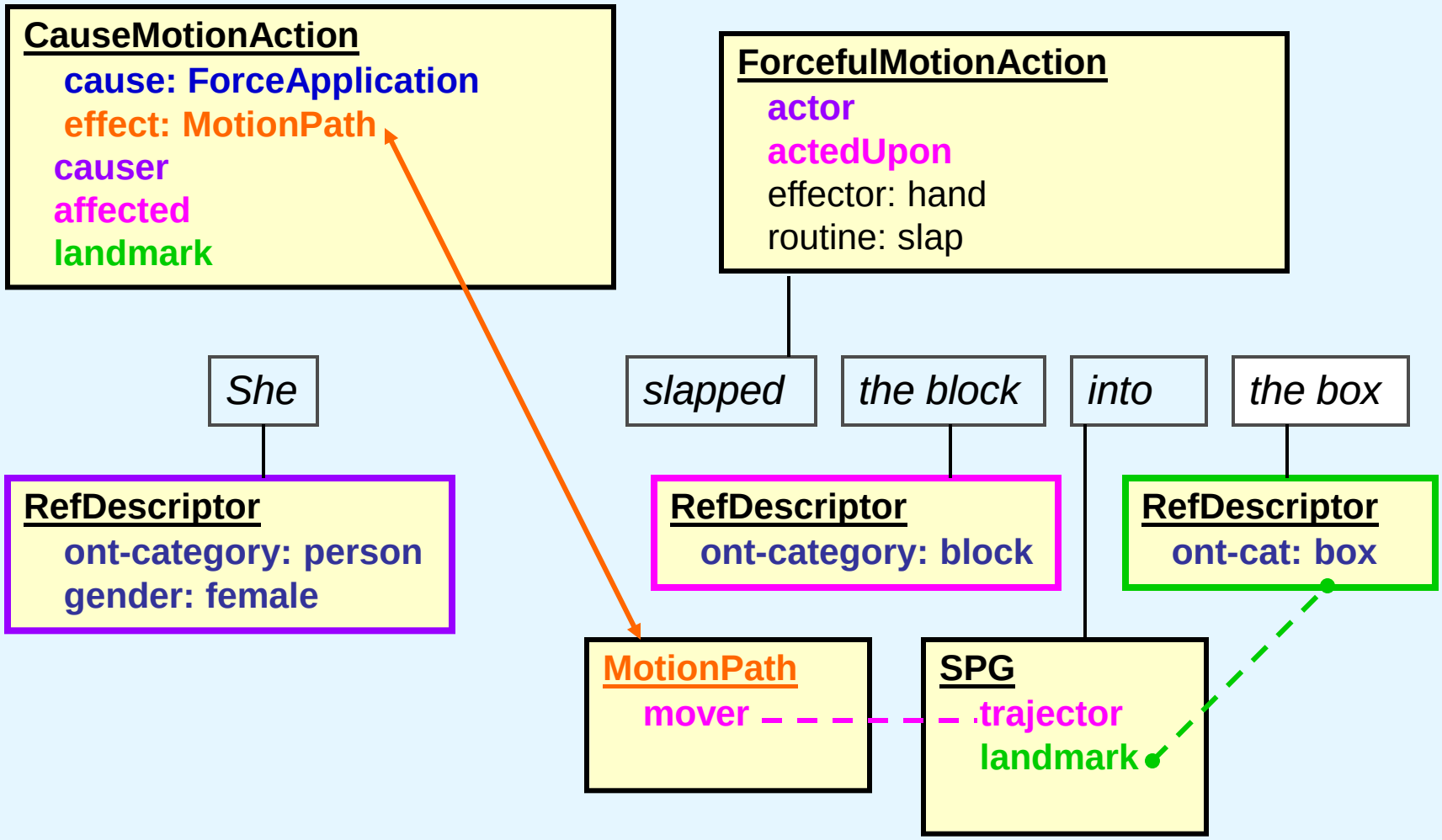

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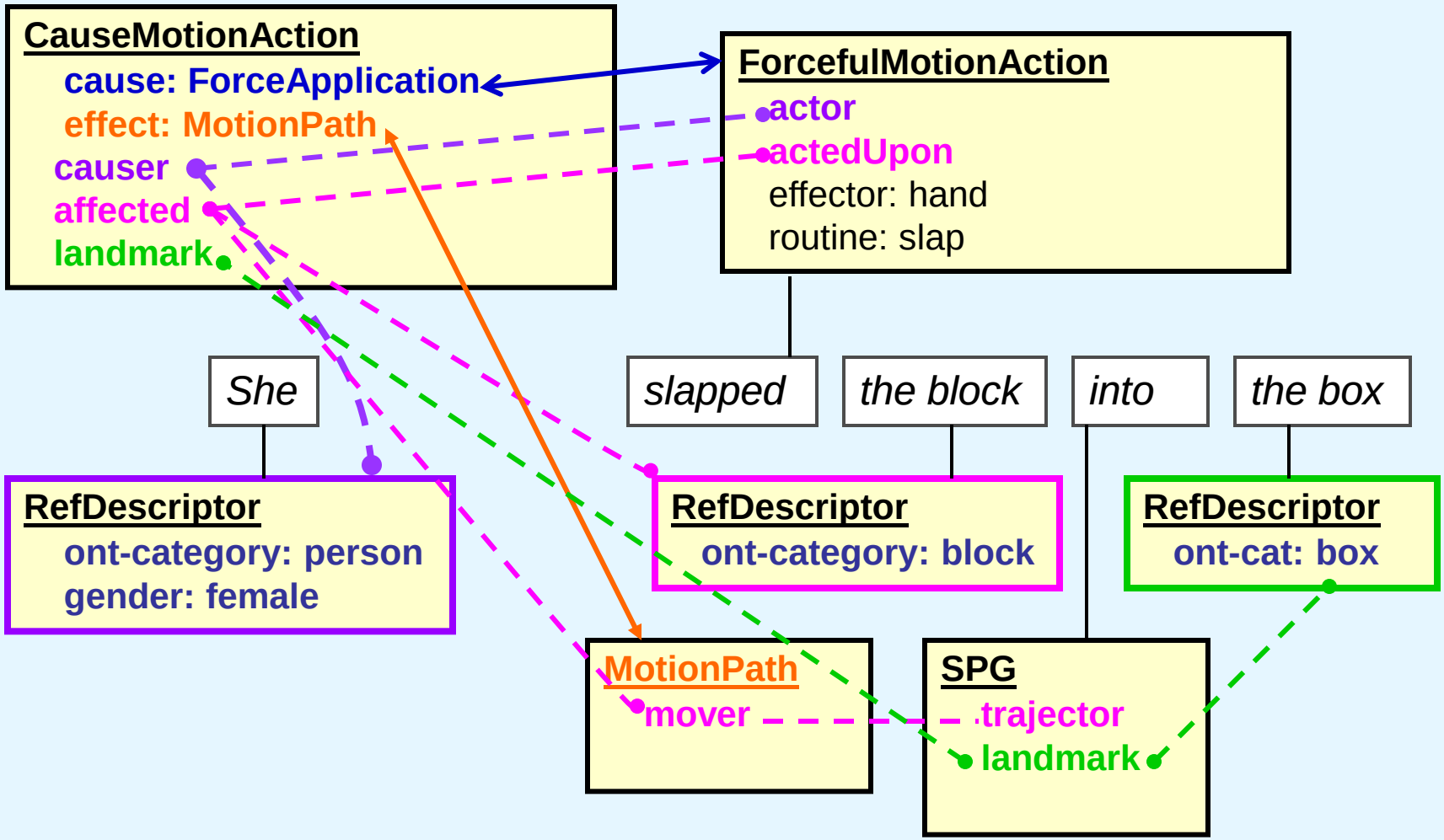


She slapped her hand on the block

EFFECTOR MOTION

Constituents: Verb, NP, PP

Form: Verb > NP > PP

A-S cxn meaning:

ForcefulMotionAction

Verb meaning:

ForcefulMotionAction

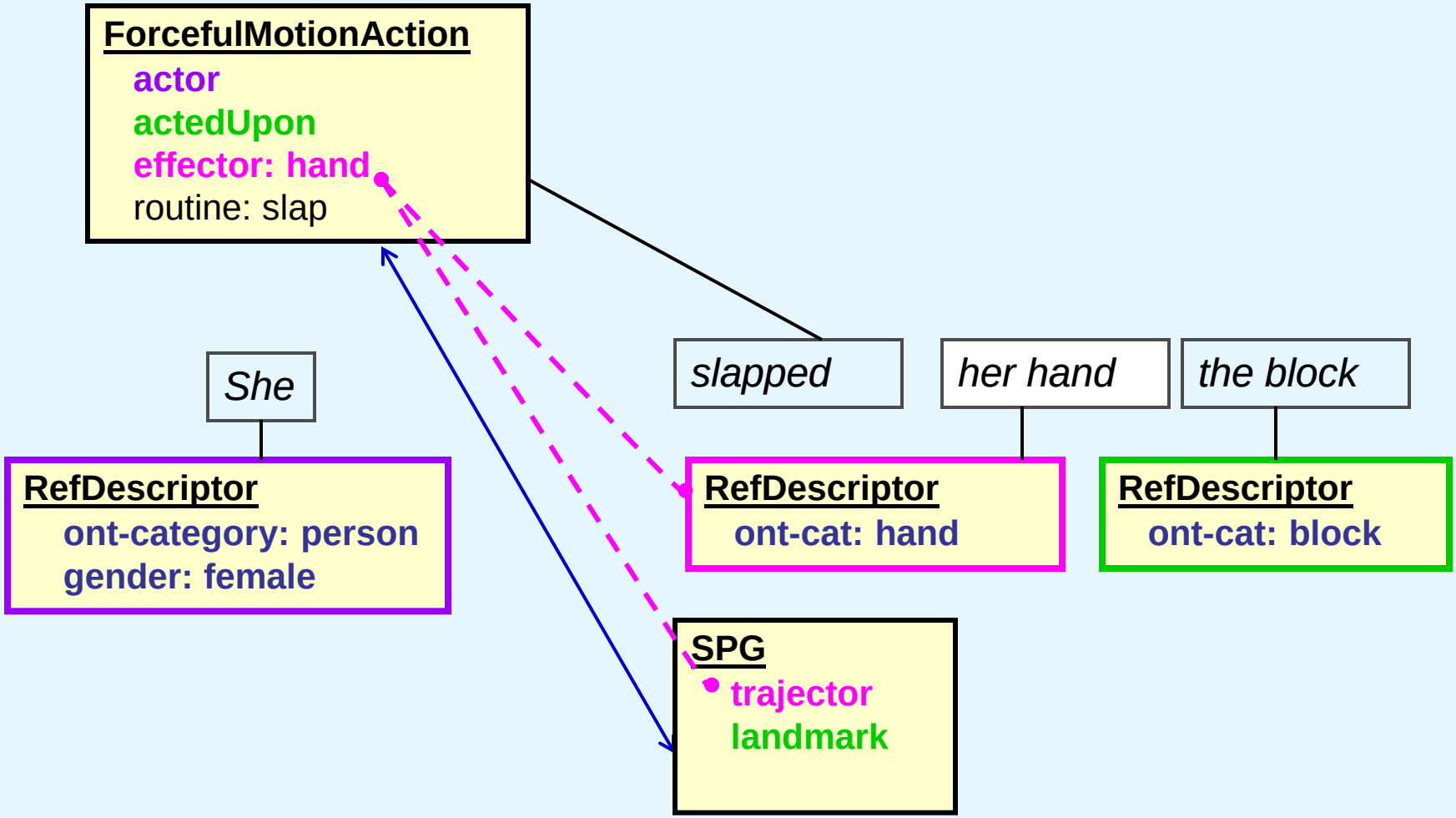
Meaning Constraints:

profParticipant = actor

NP meaning = effector <–> trajector

PP.np meaning = actedUpon <–> landmark

She slapped her hand on the block



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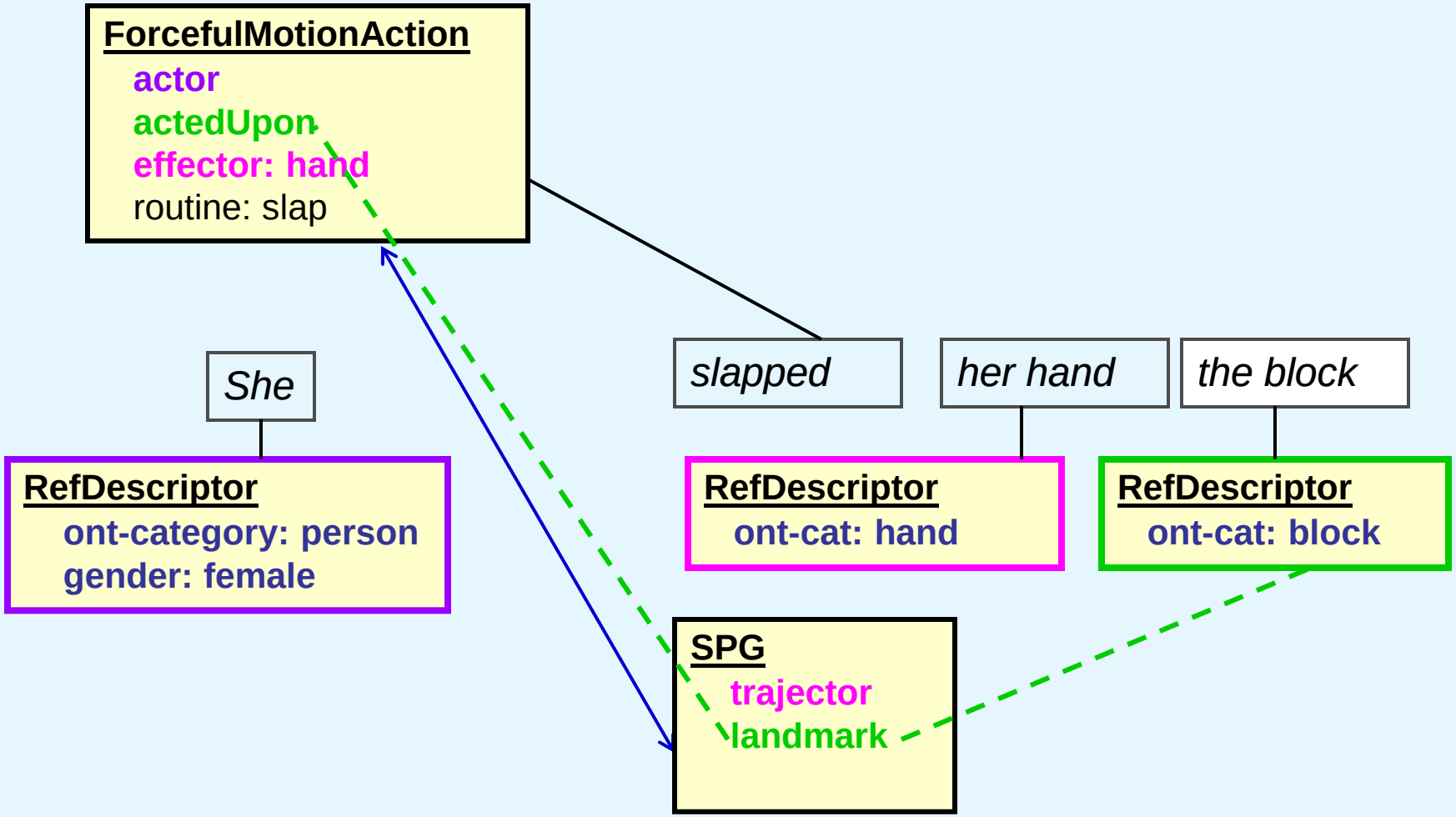

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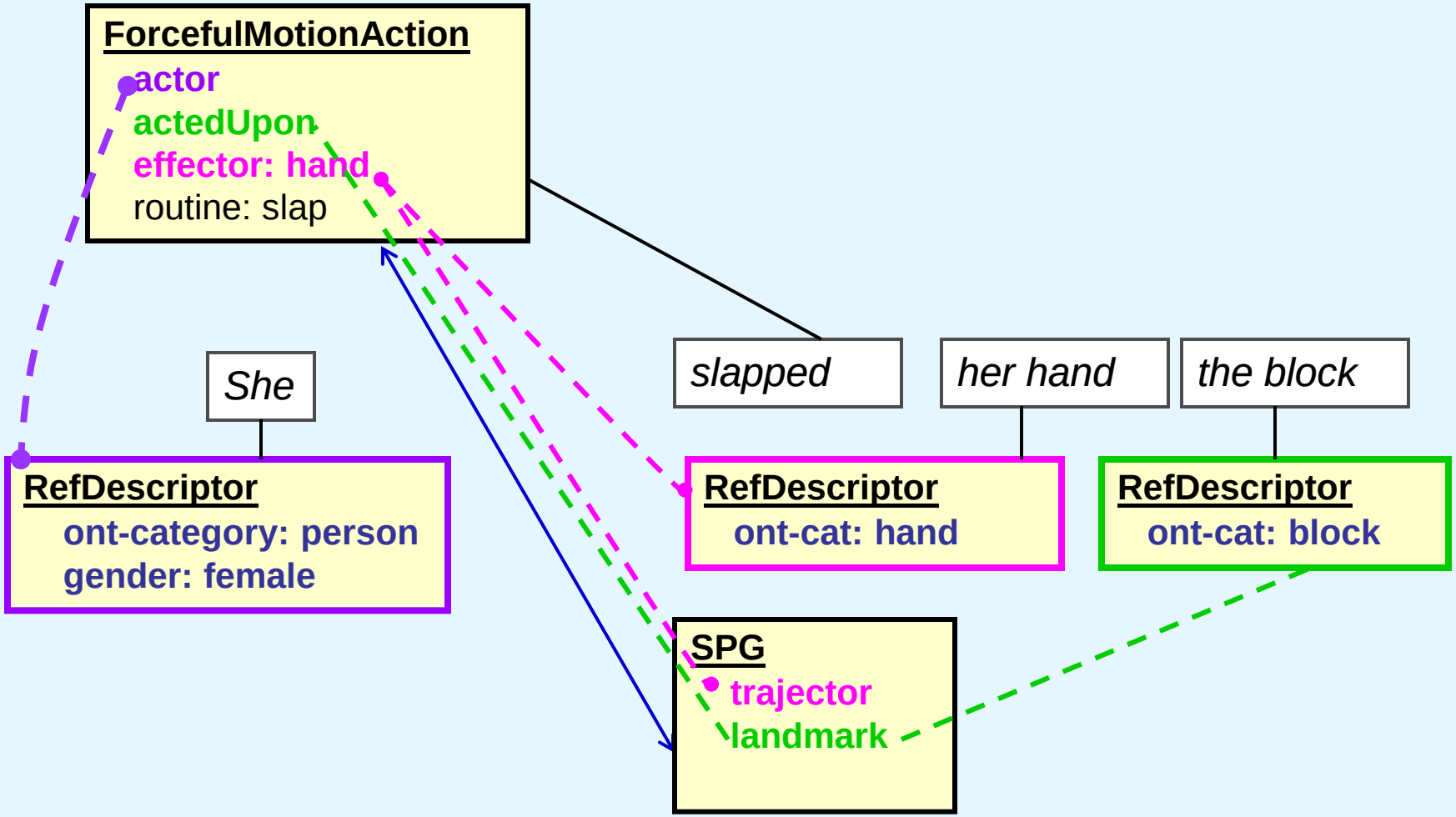


She slapped him on the hand

PART POSSESSOR

Constituents: Verb, NP, PP: BodyPartPP (*the*+BodyPart)

Form: Verb > NP > PP

A-S cxn meaning:

CauseEffect

evokes: Possession

Verb meaning:

ForcefulMotionAction

Meaning Constraints:

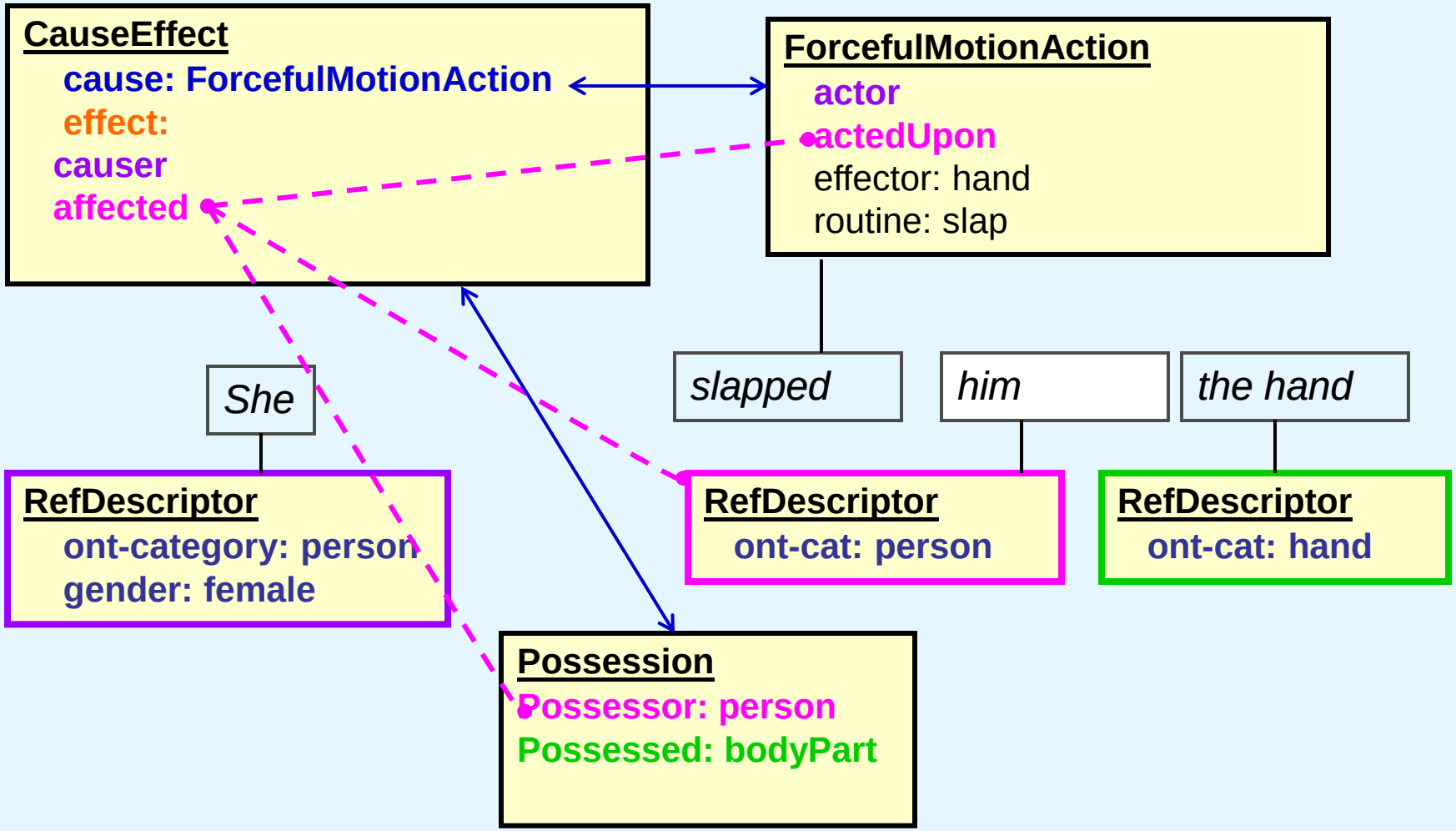
verb meaning = CauseEffect.causalProcess

profParticipant = causer <–> actor

NP meaning = affected <–> actedUpon <–> **p.posssessor** **(@person)**

PP.np meaning = <–> **p.possessed** **(@bodyPart)**

She slapped him on the hand



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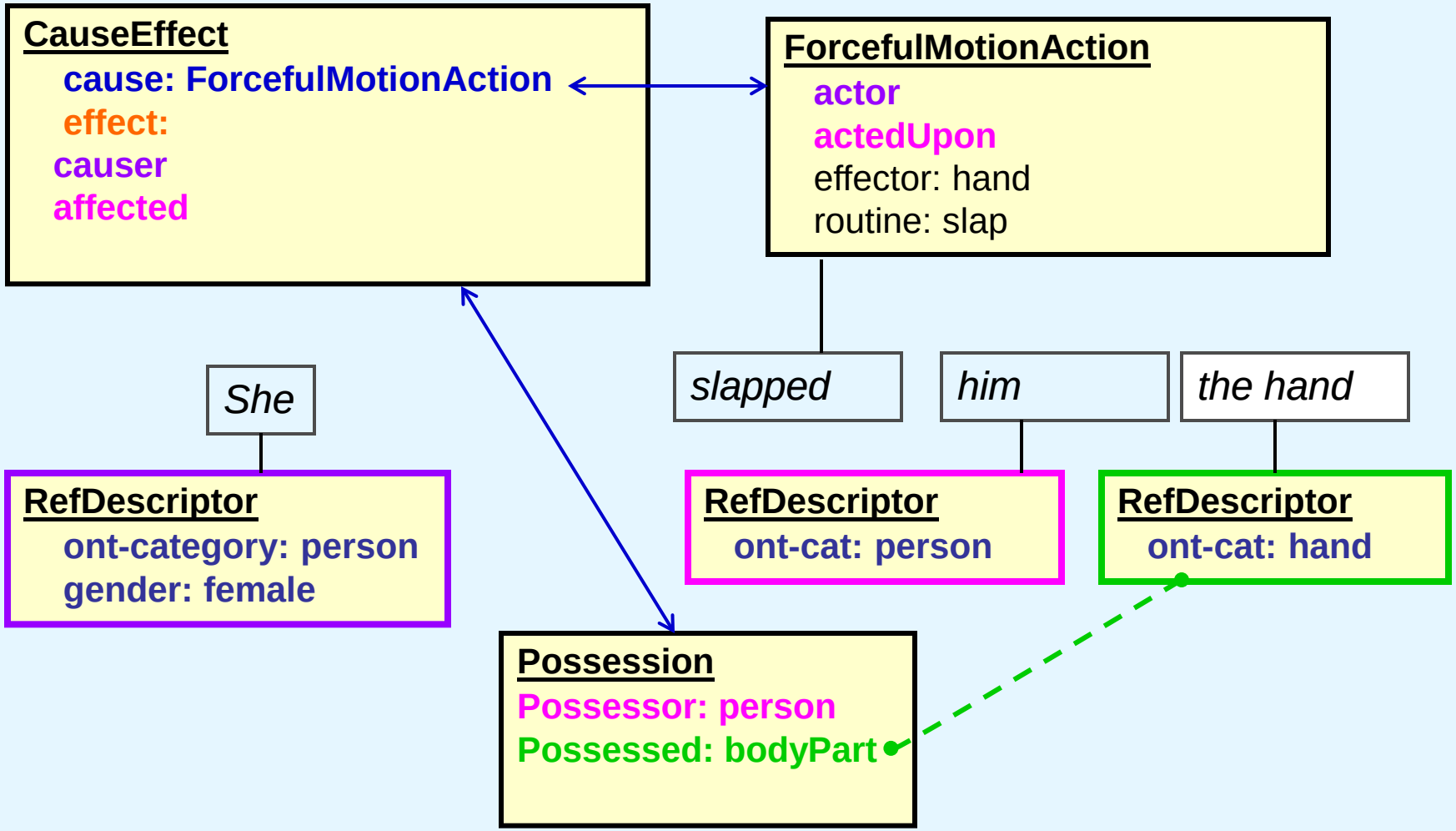

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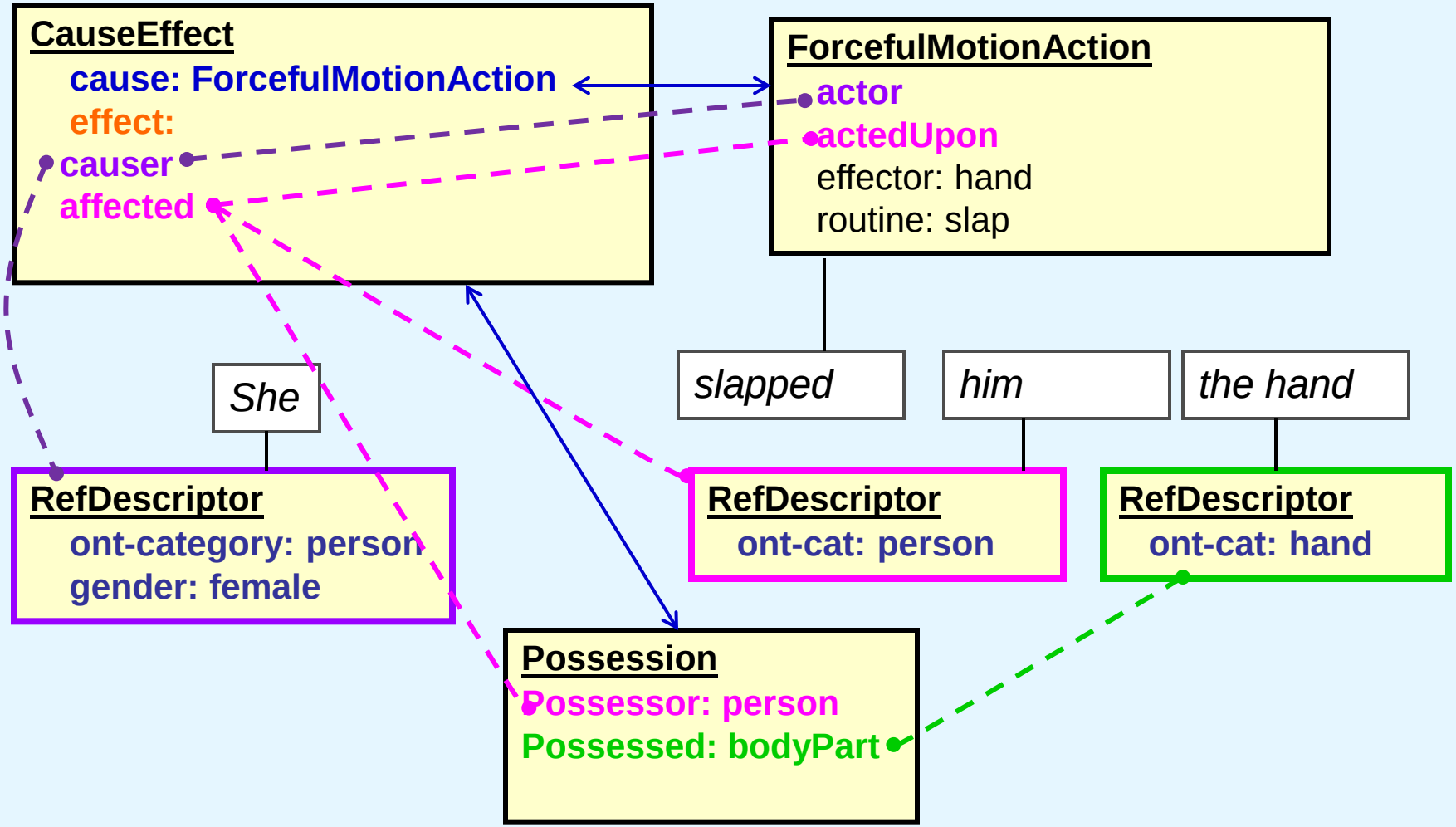

A-S Cxn	Subject	Direct Object	PP-Object
Transitive	Causer Actor	Affected ActedUpon	(*with* Effector)
CauseMotion	Causer Actor	Affected ActedUpon Mover Trajector	Landmark
EffectorMotion	Actor	Effector Trajector	ActedUpon Landmark
PartPossessor	Causer Actor	Affected ActedUpon Possessor (person)	Possession (body part)

Concluding Remarks

- Important to recognize and represent:
  - Inherent complexity of conceptual structure (and participant roles) utilized by linguistic constructions
  - Importance of inter-related schematic structures for compositional analysis
  - Use of constraints to support best-fit analysis process
- ECG formalism facilitates analysis

References

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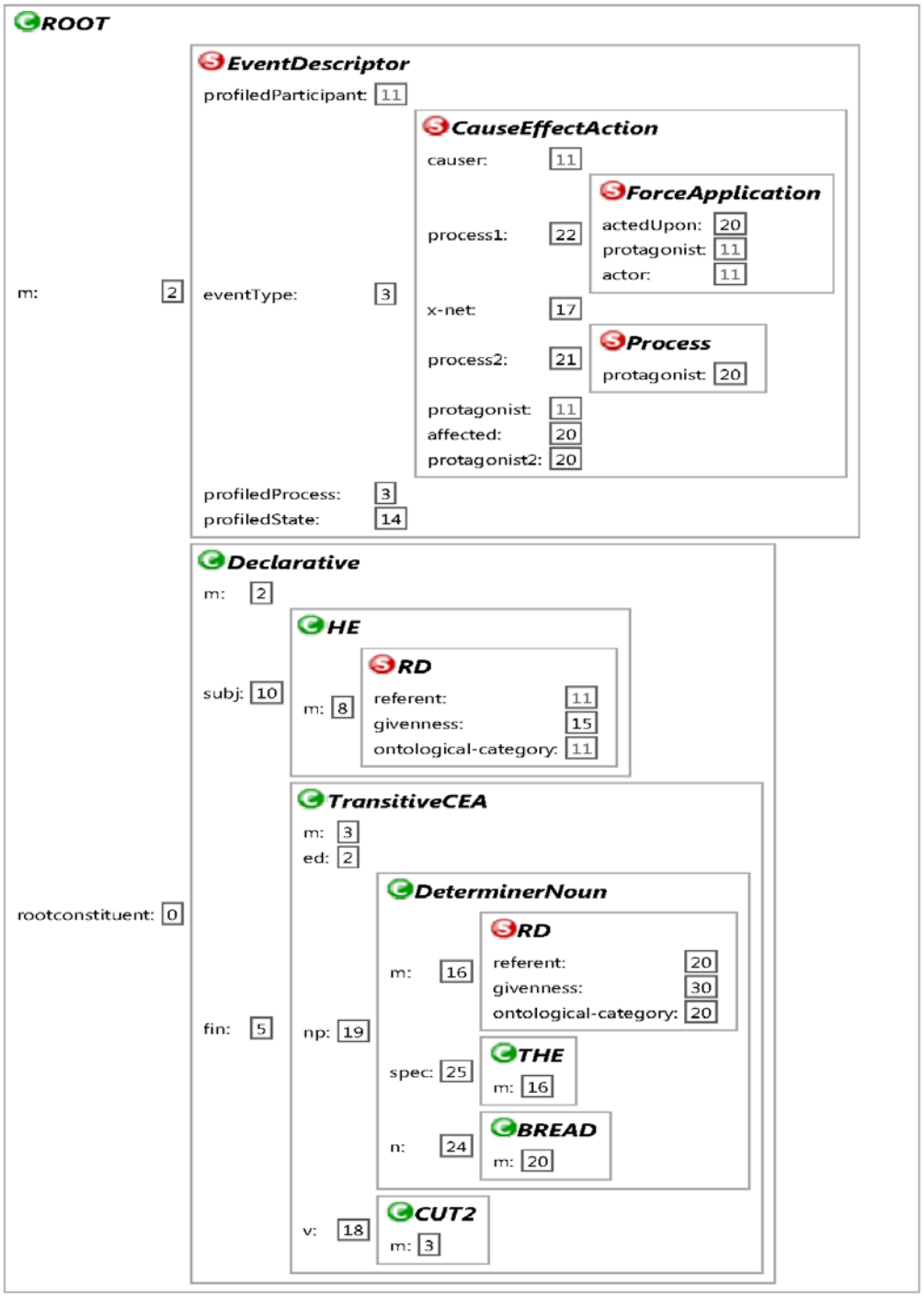

SemSpec generated by ECG workbench for analysis of

He cut the bread