Event-internal/external quantification and the mereotopology of events

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SALT 33, May 14th 2023

`bit.ly/salt33-mw`

Introduction

Events vs. individuals: common assumptions

(e.g., Davidson 1967, Parsons 1990; but see, e.g., Morzycki 2009, del Pinal 2015, Zobel 2017, Wągiel 2018, 2021, to appear for challenging views)

- verbs are semantically more complex than nouns
- domain of eventualities $\Rightarrow$ spatiotemporal particulars
- subatomic semantics
- events involve location, time, participants etc.
- individuals are simpler
- can be parts of events, not vice versa
- yet, both show interesting similarities

Introduction

Part-whole structures across various ontological domains

(e.g., Link 1983, Bach 1986, Krifka 1996, Beck & Sharvit 2002, Lahiri 2002, Arstein & Francez 2003, Dotlačil & Nouwen 2016, Schmitt 2019)

- individuals, events, degrees
- information states, times
- propositions, questions, functions

Structured parthood: mereotopology

(e.g., Grimm 2012, Lima 2014, Scontras 2014, Wągiel 2018, 2021, Krifka 2021)

- aggregate nouns: *gravel*, *hair*
- atomizers: *grain of rice*
- subatomic quantifiers: *a half of that apple*
- social collectives: *clergy* $\Rightarrow$ mereotopology of roles

Introduction

Goal

- relevance of structured parthood in abstract domains
- extending mereotopology to the domain of events

Data

- event-internal $\sim$ event-external quantification
- evidence from English, Mandarin Chinese and Polish

(1) The salesman rang the doorbell three times.

Claim

- event-internal quantification $\Rightarrow$ simplex events
- event-external quantification $\Rightarrow$ clusters of simplex events

Event-external/internal distinction

Event quantification

(cf. Cusic 1981, Andrews 1983, Cinque 1999, Landman 2006)

- multiplicatives $\Rightarrow$ systematic ambiguity
- event-external quantification: occasions
- event-internal quantification: acts

(2) Kim knocked on the door three times.

a. On three separate occasions, Kim knocked on the door (once). EVENT-EXTERNAL

b. On one occasion, Kim knocked on the door three times. EVENT-INTERNAL

Event-external/internal distinction

Event quantification

(cf. Cusic 1981, Andrews 1983, Cinque 1999, Landman 2006)

- ambiguity often arises with semelfactives
- instantaneous action required
- possibility of quick repetitions required
- very hard without a rich context otherwise

(3) Kim built a house three times.

a. On three separate occasions, Kim built a house.

EVENT-EXTERNAL

b. #On one occasion, Kim built a house three times.

EVENT-INTERNAL

Event-external/internal distinction

Event quantification

(cf. Cusic 1981, Andrews 1983, Cinque 1999, Landman 2006)

- scope relations between different multiplicatives
- position ⇒ event-external/internal interpretation

(4) Twice, Kim knocked on the door three times.

twice > three times

*three times > twice

(5) Kim knocked on the door three times twice.

twice > three times

*three times > twice

(6) Kim twice knocked on the door three times.

twice > three times

%three times > twice

Event-external/internal distinction

Event quantification

(cf. Cusic 1981, Andrews 1983, Cinque 1999, Landman 2006)

- scope relations between different multiplicatives
- position $\Rightarrow$ event-external/internal interpretation

(7) Kim knocked twice on the door three times.

three times $>$ twice

*twice $>$ three times

(8) Kim knocked on the door twice three times.

three times $>$ twice

*twice $>$ three times

Cross-linguistic perspective

Verbal classifiers in Mandarin Chinese

(cf. Donazzan 2013, Zhang 2017)

- quantification over eventualities in the verbal domain
- event-external/internal distinction

(9) Dàlín zài mén-shàng qiāo-le sān-cì.
Dalin at door-on knock-PFV three-$\mathrm{CLF}_{\mathrm{ext}}$
'On three separate occasions, Dalin knocked on the door.'
%'On one occasion, Dalin knocked on the door three times.'

(10) Dàlín zài mén-shàng qiāo-le sān-xià.
Dalin at door-on knock-PFV three-$\mathrm{CLF}_{\mathrm{int}}$
'On one occasion, Dalin knocked on the door three times.'

Cross-linguistic perspective

Verbal classifiers in Mandarin Chinese

(cf. Donazzan 2013, Zhang 2017)

- preverbal multiplicatives ⇒ event-external interpretation
- position incompatible with event-internal multiplicatives

(11) Dàlín liǎng-cì zài mén-shàng qiāo-le sān-xià.
Dalin two-CLF_{ext} at door-on knock-PFV three-CLF_{int}
'On two separate occasions, Dalin knocked on the door three times.'

(12) #Dàlín sān-xià zài mén-shàng qiāo-le liǎng-cì.
Dalin three-CLF_{int} at door-on knock-PFV two-CLF_{ext}
Intended: 'On two separate occasions, Dalin knocked on the door three times.'

Cross-linguistic perspective

Verbal classifiers in Mandarin Chinese

(cf. Donazzan 2013, Zhang 2017)

- *yǒu*-constructions ⇒ event-external interpretation

(13) yǒu liǎng-cì, Dàlín zài mén-shàng qiāo-le
have two-CLF_{ext} Dalin at door-on knock-PFV
sān-xià.
three-CLF_{int}
'On two separate occasions, Dalin knocked on the door three times.'

(14) #yǒu sān-xià, Dàlín zài mén-shàng qiāo-le
have three-CLF_{int} Dalin at door-on knock-PFV
liǎng-cì.
two-CLF_{ext}
Intended: 'On two separate occasions, Dalin knocked on the door three times.'

Cross-linguistic perspective

Multiplicatives in Polish

- role of aspect in event-internal construals
- imperfectives $\Rightarrow$ iterative/habitual interpretation

(15) Jacek zapukał do drzwi trzy razy.
Jacek knocked.PFV to door three times
'On three separate occasions, Jacek knocked on the door.'
'On one occasion, Jacek knocked on the door three times.'

(16) Jacek pukał do drzwi trzy razy.
Jacek knocked.IMPF to door three times
'On three separate occasions, Jacek knocked on the door.'
'On a number of occasions, Jacek knocked on the door three times.'

Cross-linguistic perspective

Multiplicatives in Polish

- role of aspect in event-internal construals
- imperfectives $\Rightarrow$ no single-ongoing interpretation

(17) ??Jacek pukał do drzwi trzy razy, kiedy zobaczył
Jacek knocked.IMPF to door three times when saw.PFV
Zosię.
Zosia.ACC
Intended: 'Jacek was giving three knocks on the door when he saw Zosia.'

Cross-linguistic perspective

Multiplicatives in Polish

- frequency adverbs
- imperfectives ⇒ only event-external quantification
- iterative/habitual interpretation ⇒ no single-ongoing

(18) Jacek pukał do drzwi często.
Jacek knocked.IMPF to door often
'Jacek often knocked on the door.'
≈ 'On many occasions, Jacek knocked on the door.'

(19) #Jacek pukał do drzwi często, kiedy zobaczył
Jacek knocked.IMPF to door often when saw.PFV
Zosię.
Zosia.ACC
Intended: 'Jacek often knocked on the door when he saw Zosia.'

Cross-linguistic perspective

Multiplicatives in Polish

- perfectives $\Rightarrow$ incompatibility
- frequency adverbs $\neq$ indefinite multiplicatives

(20) #Jacek zapukał do drzwi często.
Jacek knocked.PFV to door often
Intended: 'Jacek often knocked on the door.'
$\approx$ 'On many occasions, Jacek knocked on the door.'

(21) Jacek zapukał do drzwi wiele razy.
Jacek knocked.PFV to door many times
'On many separate occasions, Jacek knocked on the door.'
'On one occasion, Jacek knocked on the door many times.'

Cross-linguistic perspective

Side note: multiplicatives vs. frequency adverbs

(Doetjes 2007, Dočekal & Wągiel 2018)

- multiplicatives $\Rightarrow$ no relational reading

(22) Quand il est à Paris, Pierre va souvent au Louvre.
when he is in Paris Pierre goes often to-the Louvre
'Often when he is in Paris, Pierre goes to the Louvre.'
'Whenever he is in Paris, Pierre goes often to the Louvre.'

(23) Quand il est à Paris, Pierre va trois fois au Louvre.
when he is in Paris Pierre goes three times to-the Louvre
'Whenever he is in Paris, Pierre goes three times to the Louvre.'

Cross-linguistic perspective

Multiplicatives in Polish

- dedicated event-internal multiplicatives (become archaic)
- typically with verbs denoting instantaneous actions
- imperfectives ⇒ iterative/habitual interpretation

(24) %Jacek zapukał do drzwi po trzykroć.
Jacek knocked.PFV to door DISTR thrice
'On one occasion, Jacek knocked on the door three times.'

(25) %Jacek pukał do drzwi po trzykroć.
Jacek knocked.IMPF to door DISTR thrice
'On a number of occasions, Jacek knocked on the door three times.'

Cross-linguistic perspective

Multiplicatives in Polish

- dedicated event-internal multiplicatives
- imperfectives ⇒ no single-ongoing interpretation

(26) #Jacek pukał do drzwi po trzykroć, kiedy
Jacek knocked.IMPF to door DISTR thrice when
zobaczył Zosię.
saw.PFV Zosia.ACC
Intended: 'Jacek was giving three knocks on the door when he saw Zosia.'

Cross-linguistic perspective

Accusative marking on numerals in Hungarian

(cf. Csirmaz 2008)

- quantification over eventualities in the verbal domain
- event-external/internal distinction

(27) Kati három-szor kopogott.
Kati three-MULT knocked
'On three separate occasions, Kati knocked.'
'On one occasion, Kati knocked three times.'

(28) Kati hár(o)m-at kopogott.
Kati three-ACC knocked
'On one occasion, Kati knocked three times.'

Interim summary

Event-external/internal distinction

- multiplicatives $\Rightarrow$ systematic ambiguity
- acts (quick repetitive actions) $\sim$ occasions (series of acts)
- two multiplicatives $\Rightarrow$ scope interactions
- typology of quantificational adverbials

LANGUAGE	EXPRESSION	EVENT-EXT	EVENT-INT
English	*three times*	✓	✓
Polish	*trzy razy*	✓	✓
Mandarin	*sān-cì*	✓	%
Polish	*często*	✓	×
Mandarin	*sān-xià*	×	✓
Polish	*po trzykroć*	×	%

Relationship between acts and occasions

Conceptual issue

- the event-external/internal distinction is real
- acts and occasions are linguistically relevant
- what is the ontological status of these categories?

Option #1: Sorted domains

- acts $\sim$ occasions $\Rightarrow$ different ontological domains
- no straightforward part-whole relation
- some mapping between the two domains required
- yet, both acts and occasions share the same features
- spatiotemporal particulars involving participants etc.
- intuitively, occasions are simply more complex

Relationship between acts and occasions

Option #2: Part-whole relation: occasion-based

- both occasions and acts are eventualities
- occasions are basic
- acts are specific parts of occasions

Analysis in the spirit of treatment of multipliers like *double*

(Wągiel 2018 2020, to appear)

- *double* counts 'essential' parts of the referents of the NP
- parts that have properties 'comparable' to the whole

(29) a. The Pschent is a double crown.
b. ⊨ The Pschent consists of two parts.

(30) a. That crime was a double murder.
b. ⊨ That crime consisted of two parts.

Relationship between acts and occasions

Option #3: Part-whole relation: act-based

- both occasions and acts are eventualities
- acts are basic
- occasions are specific configurations of acts

Analysis in the spirit of treatment of collective nouns

(cf. Landman 2006, Grimm 2012, Henderson 2017, Zwarts 2020, Wągiel 2021)

- occasions $\Rightarrow$ clusters of acts
- clusters $\Rightarrow$ spatiotemporal configurations of objects

(31) a. five plates
b. stack of five plates

(32) a. Kim knocked on the door three times twice.
b. Kim gave two series of three knocks on the door.

Relationship between acts and occasions

Argument against Option #1

- acts $\sim$ occasions $\Rightarrow$ different ontological domains
- no straightforward part-whole relation
- independent pluralities $\Rightarrow$ cumulativity expected
- part-whole relation $\Rightarrow$ no cumulativity

(33) Kim knocked on the door five times twice.

distributive
#cumulative

(34) Kim gave two series of five knocks on the door.

distributive
#cumulative

Relationship between acts and occasions

Group-formation

(Joosten 2010, Zwarts 2020, Wągiel 2021)

- two different modes of collectivity
- spatial collections ⇒ based on topological proximity
- functional collections ⇒ based on abstract membership
- inspiration ⇒ spatial mode of group-formation

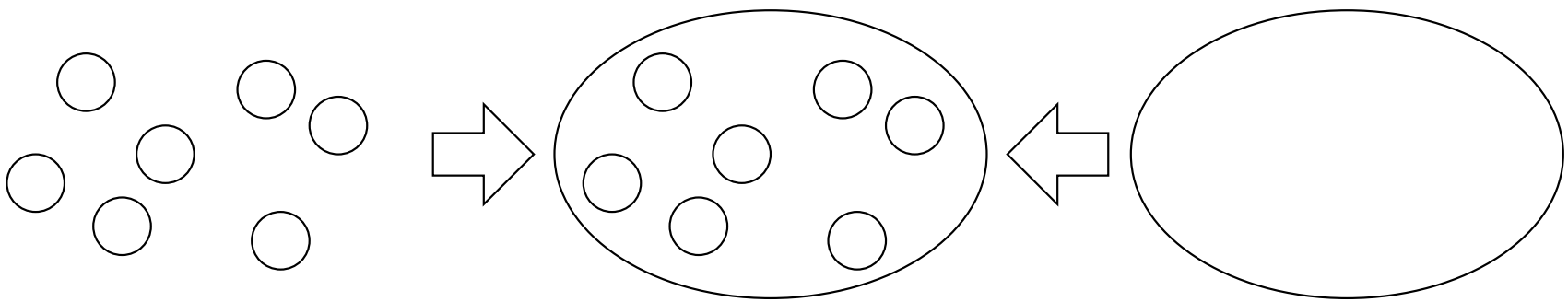


Figure 1: Modes of group-formation

Relationship between acts and occasions

Complex eventualities

(Landman 2006, Henderson 2017)

- group (complex atom) $\Rightarrow$ extended to events
- no account for unstructured/structured configurations
- pluractionals $\Rightarrow$ reference to swarms of events
- intuition: parallel between individuals and events
- temporal connection $\Rightarrow$ mereotopological notion
- some parts of events $\Rightarrow$ convex (contiguous) intervals

(35) The first half of the trip was boring.

(36) The first half of the battle was horrifying.

Mereotopology

Mereology + topological notions

(Grimm 2012; Casati & Varzi 1999, Varzi 2007)

- connectedness (C): primitive notion

(37) $\forall x[\mathrm{C}(x,x)]$ REFLEXIVITY

(38) $\forall x \forall y[\mathrm{C}(x,y) \leftrightarrow \mathrm{C}(y,x)]$ SYMMETRY

- bridging principles: interactions between C and $\sqsubseteq$

(39) $\forall x \forall y[x \sqsubseteq y \rightarrow \mathrm{C}(x,y)]$ INTEGRITY

(40) $\forall x \forall y[x \circ y \rightarrow \mathrm{C}(x,y)]$ UNITY

(41) $\forall x \forall y\big[x \sqsubseteq y \rightarrow \forall z[\mathrm{C}(z,x) \rightarrow \mathrm{C}(z,y)]\big]$ MONOTONICITY

Mereotopology

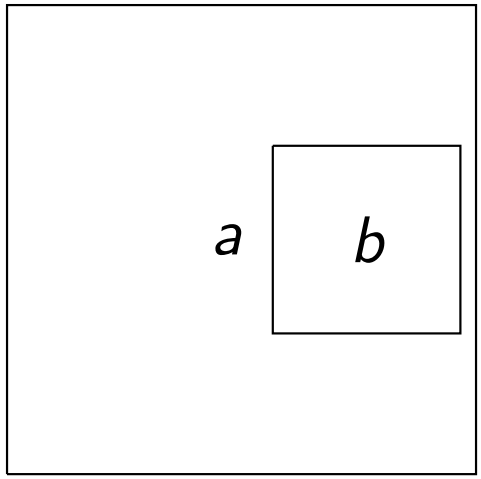


Figure 2: Internal part

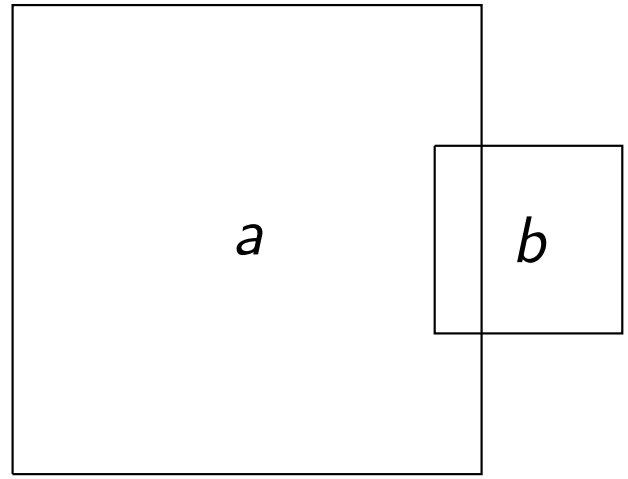


Figure 3: Internal overlap

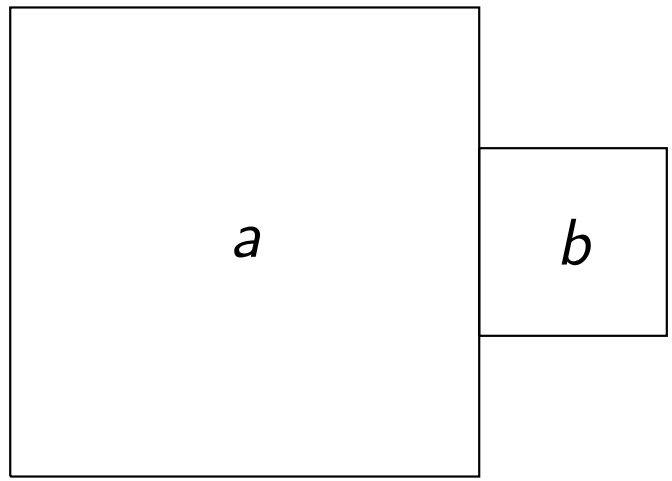


Figure 4: Tangential overlap

Mereotopology

Mereology + topological notions

(Casati & Varzi 1999, Grimm 2012)

- interior, exterior, closure, boundary

(42) Interior

$\textsc{int}(x) \stackrel{\text{def}}{=} \bigsqcup X$ where $X = \{y \ : \ \textsc{ip}(y, x) = \textsc{True}\}$

(43) Exterior

$\textsc{ext}(x) \stackrel{\text{def}}{=} \textsc{int}(-(x))$

(44) Closure

$\textsc{clo}(x) \stackrel{\text{def}}{=} -(\textsc{ext}(x))$

(45) Boundary

$\textsc{b}(x) \stackrel{\text{def}}{=} -(\textsc{int}(x) \sqcup \textsc{ext}(x))$

Mereotopology

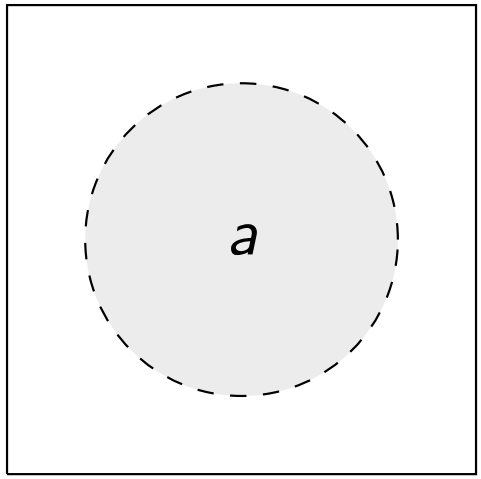


Figure 5: Interior

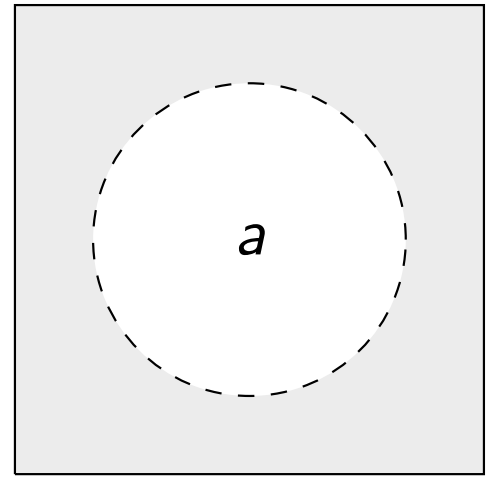


Figure 6: Exterior

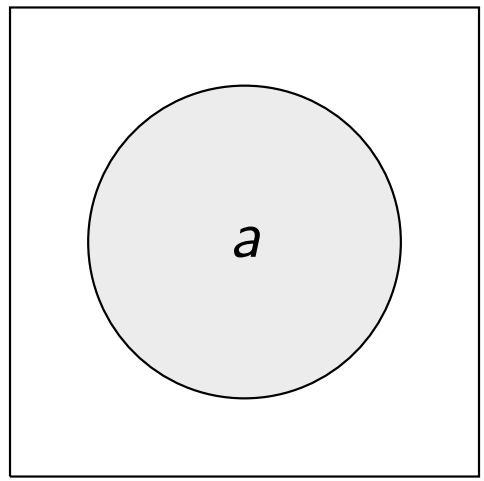


Figure 7: Closure

Mereotopology

Self-connected entity

(46) $\text{SC}(x) \stackrel{\text{def}}{=} \forall yz[\forall w(\text{O}(w,x) \leftrightarrow (\text{O}(w,y) \vee \text{O}(w,z))) \rightarrow \text{C}(y,z)]$

- any two parts that form the whole are connected to each other

Strongly self-connected entity

(47) $\text{SSC}(x) \stackrel{\text{def}}{=} \text{SC}(x) \wedge \text{SC}(\text{INT}(x))$

- entity's interior is self-connected $\Rightarrow$ excludes touching objects

Mereotopology

Maximally strongly self-connected relative to a property

(48) $\textsc{mssc}(P)(x) \stackrel{\text{def}}{=}$
$P(x) \wedge \textsc{ssc}(x) \wedge \forall y[P(y) \wedge \textsc{ssc}(y) \wedge \textsc{o}(y, x) \rightarrow y \sqsubseteq x]$

Strongly self-connected

- every part of the entity is connected to (overlaps) the whole

Maximality

- anything else which has that property, is strongly self-connected, and overlaps is part of it

Mereotopology

Capturing objects

- integrated wholes $\Rightarrow$ parthood and connectedness
  - MSSC $\Rightarrow$ maximally strongly self-connected property
  - overlapping interior + maximality
- arbitrary sums $\Rightarrow$ only parthood
  - no topological notions involved

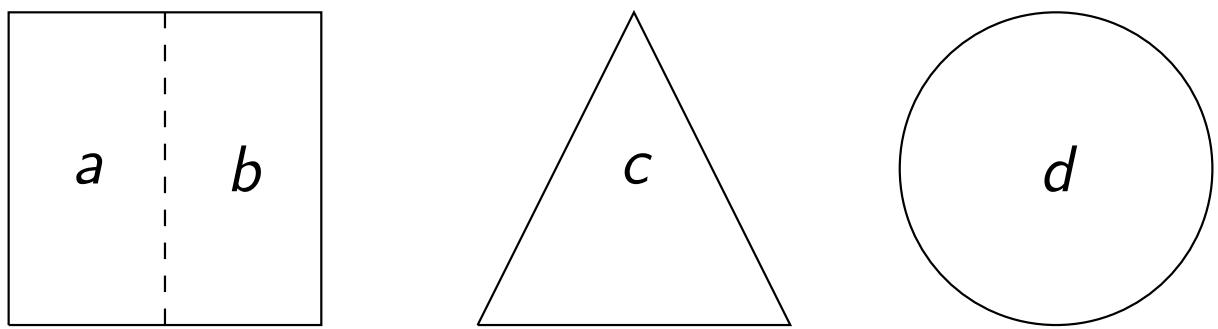


Figure 8: Wholes vs. sums

Mereotopology

Clusters

(see Grimm 2012; here: revised definitions from Wągiel 2021)

- transitive connection $\mathrm{TC} \Rightarrow$ through mediating entities

(49) For a finite sequence $Z = \langle z_1, \ldots, z_n \rangle$,
$\mathrm{TC}(x, y, P, C, Z)$ holds iff $z_1 = x, z_n = y, \mathrm{C}(z_i, z_{i+1})$ holds for $1 \leq i < n$ and $P(z_i)$ holds for $1 \leq i \leq n$.

- cluster $\Rightarrow$ plurality of transitively connected entities

(50) $\mathrm{CLSTR}_C(P)(x) \stackrel{\mathrm{def}}{=}$
$\exists Z[x = \bigsqcup Z \wedge \forall z \forall z' \in Z \exists Y \subseteq Z[\mathrm{TC}(z, z', P, C, Y)]]$

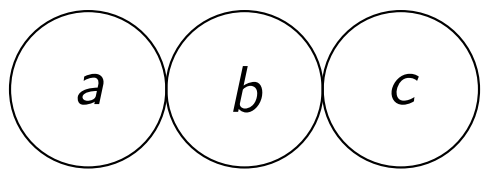


Figure 9: Cluster

Mereotopology of events

Ontology of events

(e.g., Davidson 1967, Carlson 1984, Bach 1986, Dowty 1989, Parsons 1990)

- events ⇒ conceptualized as spatiotemporal particulars
- involve time, location, participants etc.
- both time and location are linguistically relevant
- focus ⇒ temporal dimension

(51) a. The riot took place on Thursday.
b. The riot took place in Westminster, London.

(52) a. #The crowd took place on Thursday.
b. #The crowd took place in Westminster, London.

(53) a. sequence of riots
b. outburst of riots

Mereotopology of events

Mereotopology of time

(Mazzola 2019)

- temporal precedence $\Rightarrow$ implicit mereotopological assumptions
- temporal overlap assumes linear time + no gaps allowed
- connectedness $\mathrm{C} \Rightarrow$ abstract notion applicable to time
- longer intervals composed from shorter intervals
- wholes composed from parts
- mereotopological interval structure (MTI)
- various temporal models possible
- absence/existence of loops
- absence/existence of branches

Mereotopology of events

Mereotopology of time

(Mazzola 2019)

- temporal models

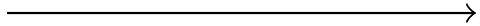


Figure 10: Linear

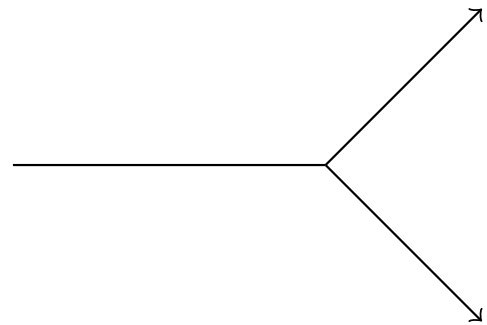


Figure 11: Forking

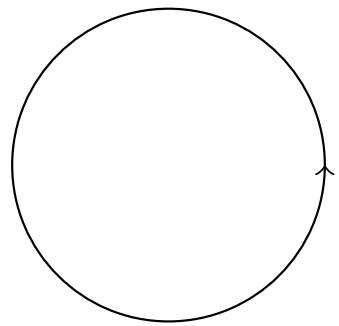


Figure 12: Circular

Proposal

General assumptions and components

- linear model of time + no gaps between intervals
- temporal connection TEMP
- predicates of MSSC/CLSTR eventualities

(54) $\text{PMSSC}_{\text{TEMP}}(P) \stackrel{\text{def}}{=} \forall x[P(x) \rightarrow \text{MSSC}_{\text{TEMP}}(P)(x)]$

(55) $\text{PCLSTR}_{\text{TEMP}}(P) \stackrel{\text{def}}{=} \forall x[P(x) \rightarrow \text{CLSTR}_{\text{TEMP}}(P)(x)]$

(56) $\text{PIND}_{\text{TEMP}}(P) \stackrel{\text{def}}{=}$
$\forall x[P(x) \rightarrow \text{MSSC}_{\text{TEMP}}(P)(x) \vee \text{CLSTR}_{\text{TEMP}}(P)(x)]$

- any individual is an MSSC/CLSTR individual relative to the relevant property and connection

Proposal

General assumptions and components

- instantaneous verbs denote sets of $\textsc{mssc}$ events
- not necessarily all verbs are such
- thematic roles compose with the verb via special heads
- verb combined with all its arguments $\Rightarrow$ existential closure

(57) $[\![\text{knocked}]\!] = \lambda e_v[\textsc{mssc}_{\textsc{temp}}(\textsc{knocked})(e)]$

(58) $[\![\textsc{ag}]\!] = \lambda P_{\langle v,t\rangle}\lambda x_e\lambda e_v[P(e) \wedge \textsc{ag}(e) = x]$

(59) $[\![\textsc{ec}]\!] = \lambda P_{\langle v,t\rangle}\exists e_v[P(e)]$

Proposal

General assumptions and components

- clustering introduced by a special head
- numerals $\Rightarrow$ names of numbers (type n)
- *times* $\Rightarrow$ shifts a number to a counting device

(60) $[\![\text{CLSTR}]\!] = \lambda P_{\langle v,t\rangle} \lambda e_v [\text{CLSTR}_{\text{TEMP}}(P)(e)]$

(61) $[\![\text{three}]\!] = 3$

(62) $[\![\text{times}]\!] =$
$\lambda n_n \lambda P_{\langle v,t\rangle} : \text{PIND}_{\text{TEMP}}(P)\ \lambda e_v [P(e) \wedge \#_{\text{PIND}}(P)(e) = n]$

(63) $[\![\text{three times}]\!] = [\![\text{times}]\!]([\![\text{three}]\!]) =$
$\lambda P_{\langle v,t\rangle} : \text{PIND}_{\text{TEMP}}(P)\ \lambda e_v [P(e) \wedge \#_{\text{PIND}}(P)(e) = 3]$

(64) $\forall P_{\langle v,t\rangle} \forall e_v [\#_{\text{PIND}}(P)(e) = 1 \text{ iff } \text{PIND}_{\text{TEMP}}(P)(e)]$

Proposal

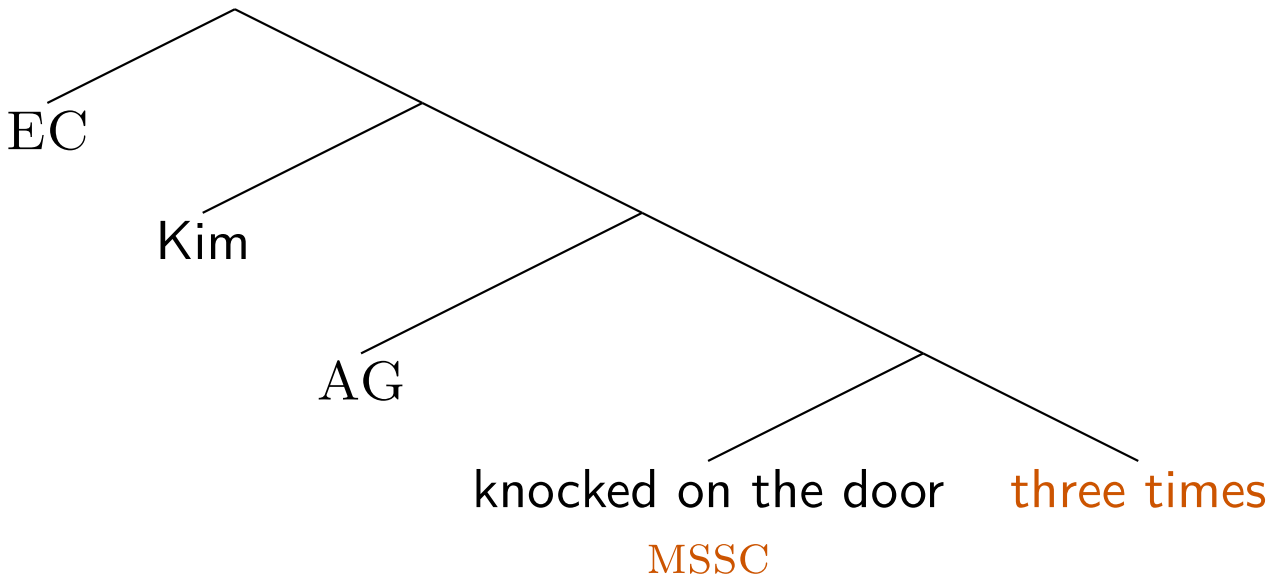
Ambiguous structures

- event-external construal

3 separate knocks

(65) Kim knocked on the door three times.

(66)



Proposal

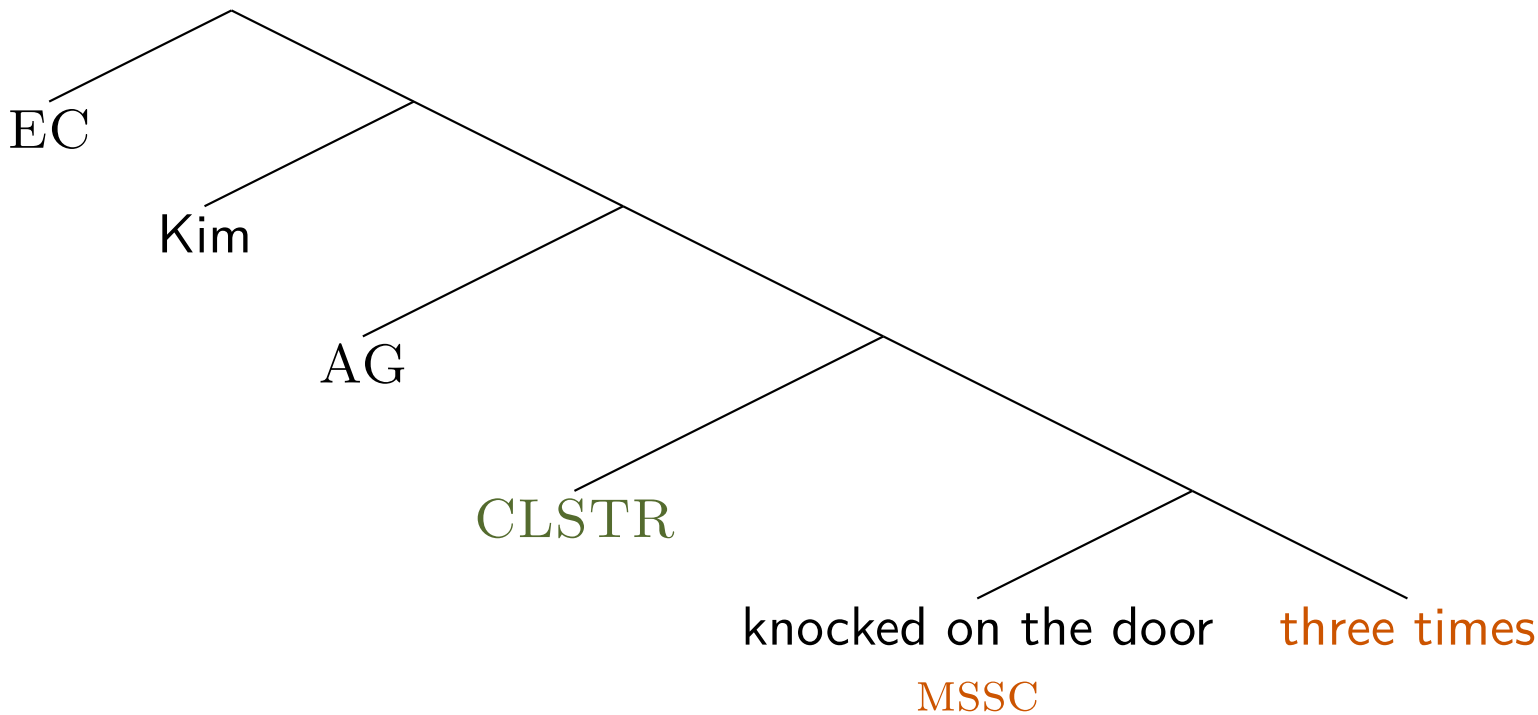
Ambiguous structures

- event-internal construal

1 series of 3 knocks

(67) Kim knocked on the door three times.

(68)



Proposal

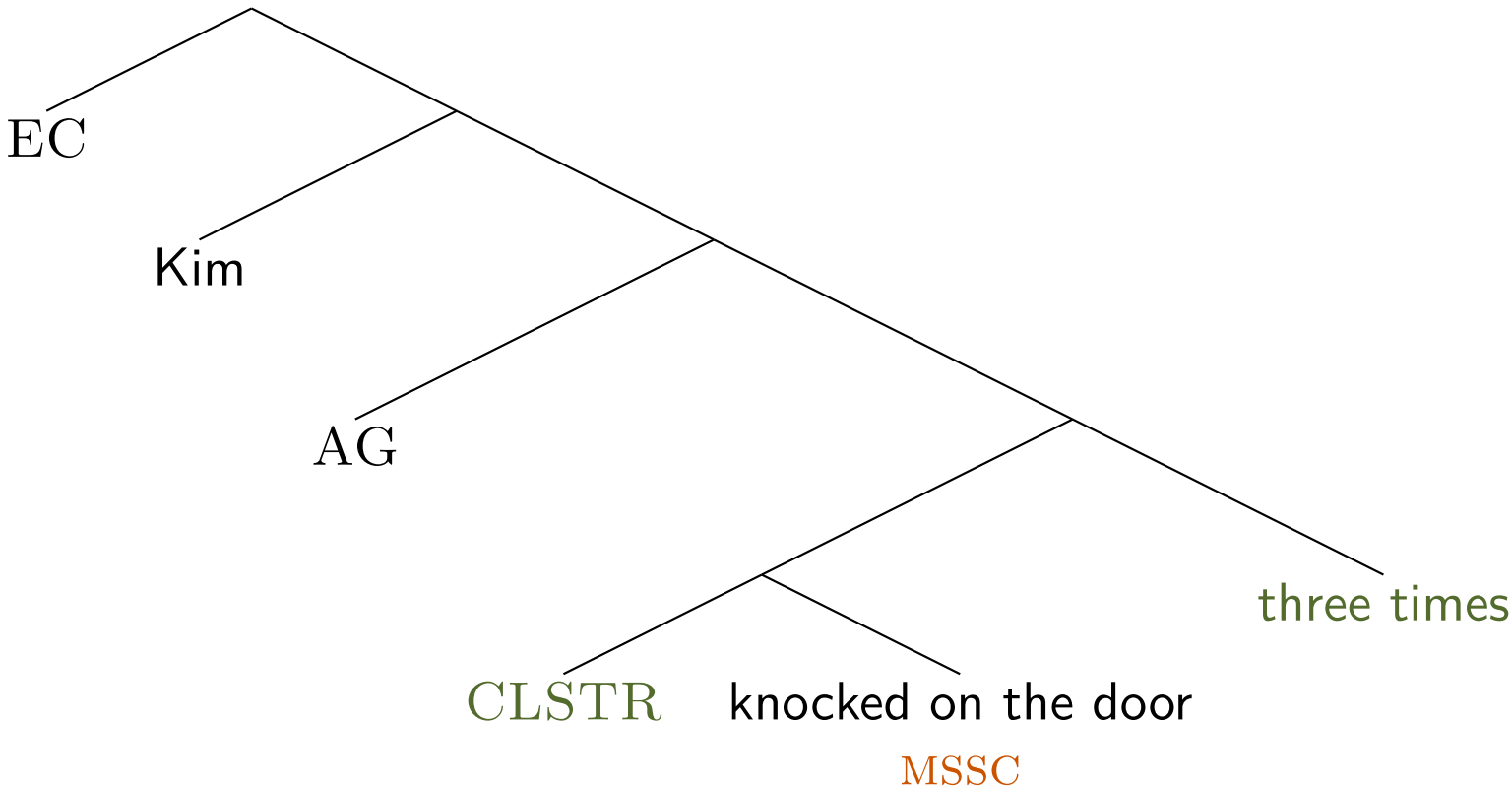
Ambiguous structures

- event-external construal

3 series of knocks

(69) Kim knocked on the door three times.

(70)



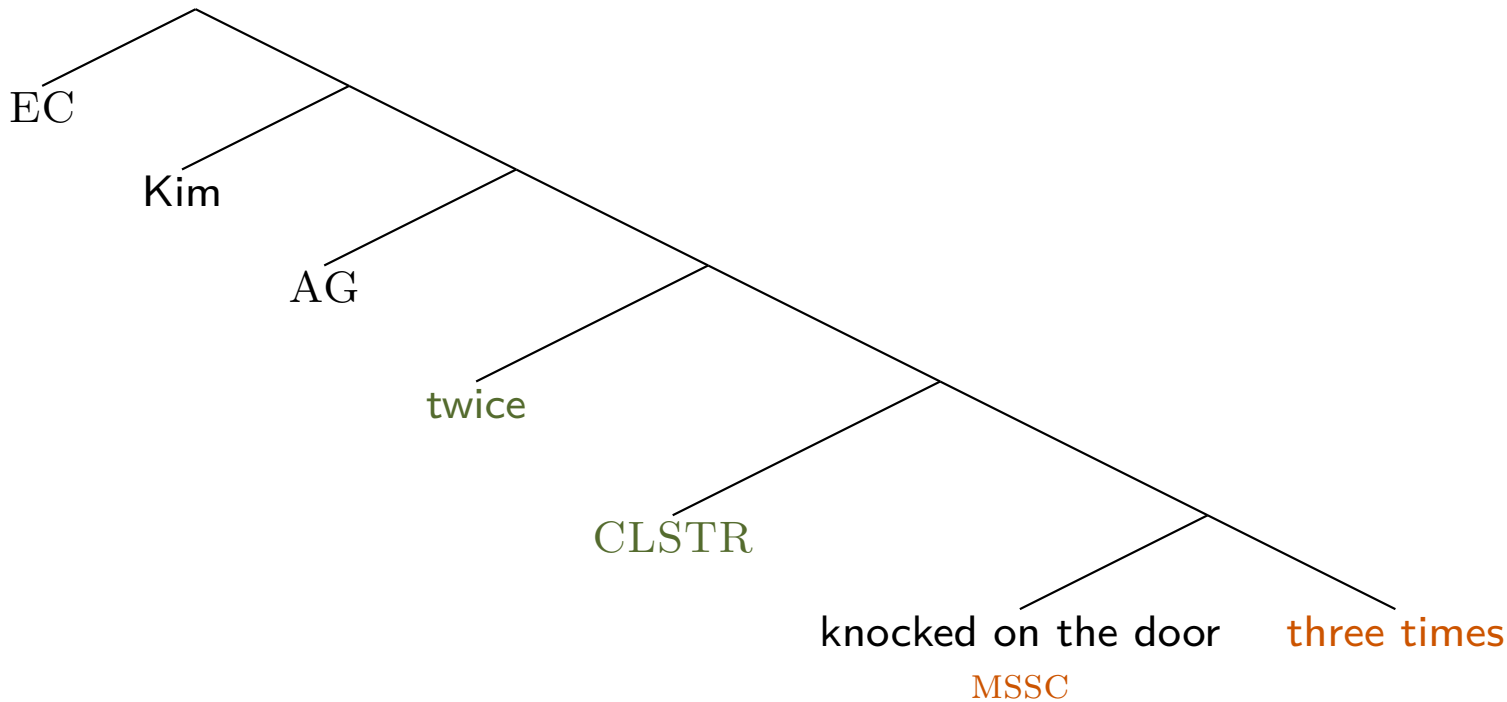
Proposal

Ambiguous structures

- twice $>$ three times

(71) Kim twice knocked on the door three times.

(72)



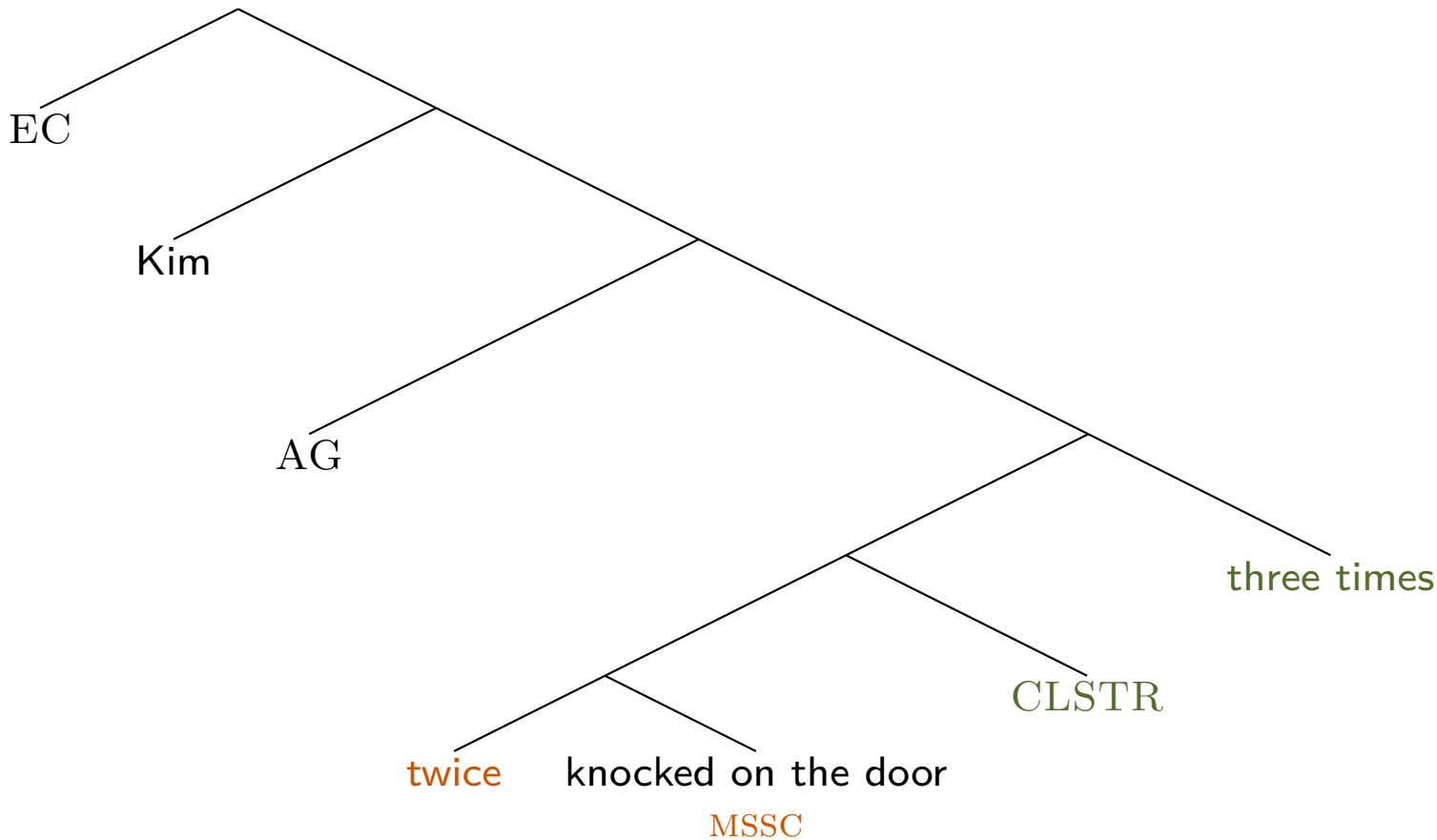
Proposal

Ambiguous structures

- %three times > twice

(73) Kim twice knocked on the door three times.

(74)



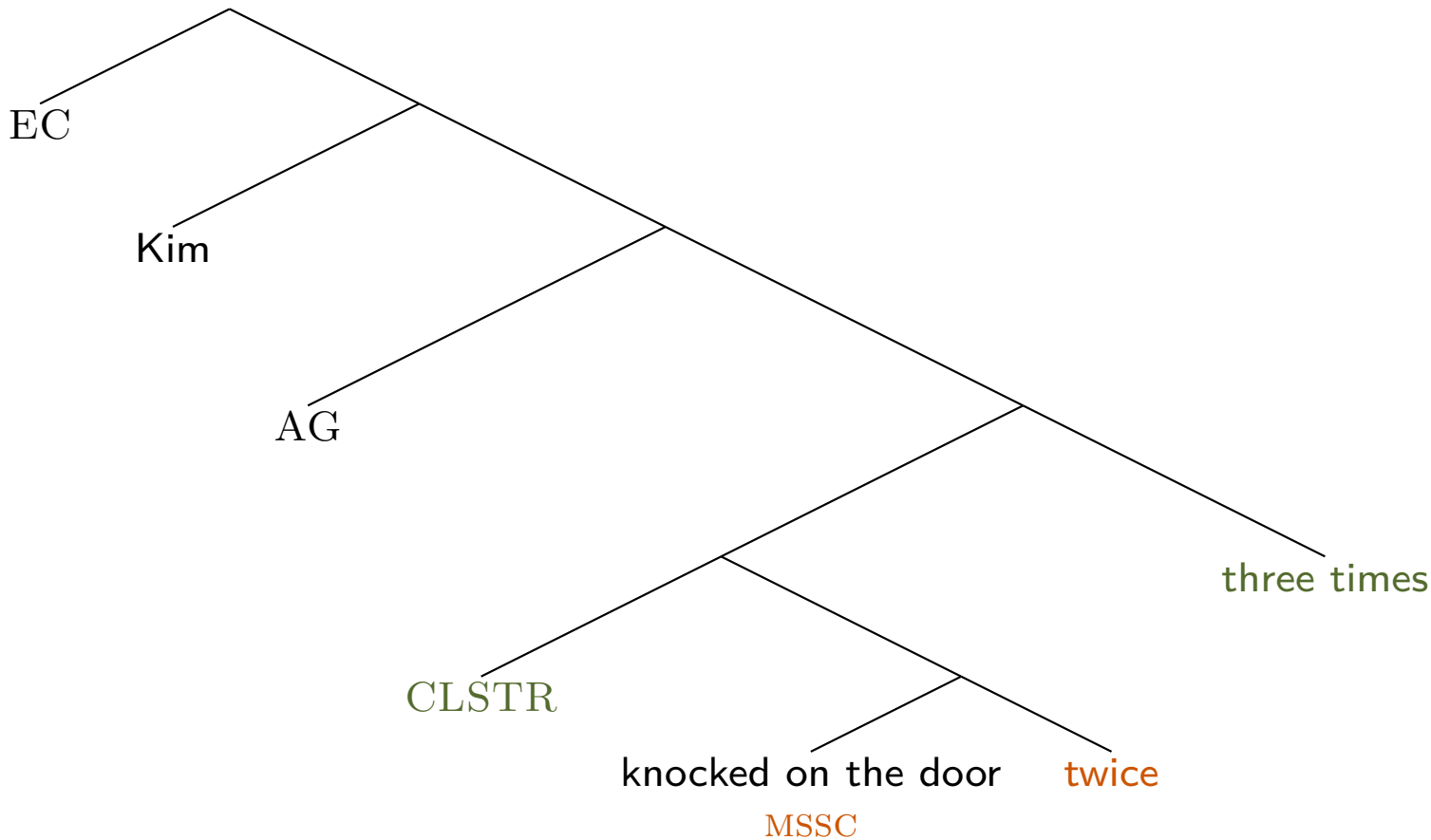
Proposal

Unambiguous structures

- event-internal and event-external quantification

(75) Kim knocked on the door twice three times.

(76)



Proposal

Cross-linguistic variation

- event-external/internal multiplicatives
- different lexical entries
- different measure functions encoded

(77) $[\![\text{trzy razy}]\!] = [\![\text{three times}]\!] =$
$\lambda P_{\langle v,t\rangle} : \text{PIND}_{\text{TEMP}}(P)\ \lambda e_v[P(e) \wedge \#_{\text{PIND}}(P)(e) = 3]$

(78) $[\![\text{sān-cì}]\!] =$
$\lambda P_{\langle v,t\rangle} : \text{PCLSTR}_{\text{TEMP}}(P)\ \lambda e_v[P(e) \wedge \#_{\text{PCLSTR}}(P)(e) = 3]$

(79) $[\![\text{po trzykroć}]\!] = [\![\text{sān-xià}]\!] =$
$\lambda P_{\langle v,t\rangle} : \text{PMSSC}_{\text{TEMP}}(P)\ \lambda e_v[P(e) \wedge \#_{\text{PMSSC}}(P)(e) = 3]$

Conclusion

Empirical relevance

- new perspective on an old puzzle: occasions $\sim$ acts
- typology of event-external/internal multiplicatives

(80) Kim knocked on the door three times twice.

Proposal

- occasions $\Rightarrow$ configurations of acts
- event-internal quantification $\Rightarrow$ counting MSSC events
- event-external quantification $\Rightarrow$ counting clusters thereof

Theoretical relevance

- mereotopology in an abstract domain
- structured parthood in eventualities
- unified mechanism of individuation and counting

Acknowledgements

Many thanks to:

- Marcel den Dikken, Éva Dékány, Kurt Erbach, Nina Haslinger, Uwe Junghanns, Chang Liu, Dorota Klimek-Jankowska, Bożena Rozwadowska, Viola Schmitt, Natalia Shlikhutka, Stavros Skopeteas, Yasu Sudo, Peter Sutton, Jan Wiślicki, Susi Wurmbrand

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Thanks!