Various strategies of multiplication: Differentials in equatives and comparatives

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SinFonIJA 10, Dubrovnik, 20-24.10.2017

Introduction

Starting point

- lexicons of many natural languages distinguish between two types of adverbs of quantification

(1)

a.	twice/doubly	(English)
b.	deux fois/doublement	(French)
c.	dvaždy/vdvojne	(Russian)
d.	kétszer/kétszeresen	(Hungarian)

- puzzling contrasts
- cross-linguistic semantic investigation

Introduction

Aim

- an analysis of such expressions in two typologically distinct languages

(2) a. dvakrát/dvojnásobně (Czech)
b. hai-lần/gấp-đôi (Vietnamese)

Focus

- factor phrases in comparatives and equatives

Terminology

- *twice*-type adverb ⇒ event numeral (EN)
- *doubly*-type adverb ⇒ degree numeral (DN)

Introduction

Puzzle

- contrasts: acceptability of EN/DN in EQ

Claim

- *twice*-type adverb ⇒ degree multiplier
- *doubly*-type adverb ⇒ degree predicate
- two distinct strategies of degree multiplication
- implicit/explicit comparison: construction specific rather than language parametrized

Data

Variation: factor phrases and COMP/EQ (cf. Gobeski 2011)

- English

(3)
a. John is two times taller than Mary.
b. John is two times as tall as Mary.
c. *John is twice taller than Mary.
d. John is twice as tall as Mary.
e. *John is doubly taller than Mary.
f. *John is doubly as tall as Mary.

Data

- Macedonian

(4)
a. Jon e dva pati po visok od Mari.
Jon is two times more tall from Mari
'Jon is two times taller than Mari.'

b. *Jon e dva pati visok kolku Mari.
Jon is two times tall as Mari

c. Jon e duplo po visok od Mari.
Jon is doubly more tall from Mari
'Jon is two times taller than Mari.'

d. *Jon e duplo visok kolku Mari.
Jon is doubly tall as Mari

Data

- German

(5)
a. Hans ist zweimal größer als Maria.
Hans is twice taller than Maria
'Hans is two times taller than Maria.'

b. Hans ist zweimal so groß wie Maria.
Hans is twice so tall how Maria
'Hans is twice as tall as Maria.'

c. *Hans ist doppelt größer als Maria.
Hans is doubly taller than Maria

d. Hans ist doppelt so groß wie Maria.
Hans is doubly so tall how Maria
'Hans is twice as tall as Maria.'

Data

- Polish

(6)
a. Jan jest dwa razy wyższy niż Maria.
Jan is two times taller than Maria
'Jan is two times taller than Maria.'

b. Jan jest dwa razy tak wysoki jak Maria.
Jan is two times so tall how Maria
'Jan is twice as tall as Maria.'

c. *Jan jest podwójnie wyższy niż Maria.
Jan is doubly taller than Maria

d. *Jan jest podwójnie tak wysoki jak Maria.
Jan is doubly so tall how Maria

Data

- Czech

(7)
a. Petr je dvakrát vyšší než Marie.
Petr is twice taller than Marie
'Petr is two times taller than Marie.'

b. Petr je dvakrát tak vysoký jako Marie.
Petr is twice so tall how Marie
'Petr is twice as tall as Marie.'

c. Petr je dvojnásobně vyšší než Marie.
Petr is doubly taller than Marie
'Petr is two times taller than Marie.'

d. *Petr je dvojnásobně tak vysoký jako Marie.
Petr is doubly so tall how Marie

Data

- Vietnamese

(8)
a. Petr cao hơn Marie hai-lần.
Petr tall than Marie twice
'Petr is two times taller than Marie.'

b. Petr cao Marie hai-lần.
Petr tall Marie twice
'Petr is twice as tall as Marie.'

c. Petr cao hơn gấp-đôi Marie.
Petr tall than doubly Marie
'Petr is two times taller than Marie.'

d. Petr cao gắp-đôi Marie.
Petr tall doubly Marie
'Petr is twice as tall as Marie.'

Data

Attested patterns

- Czech

	EN	DN
COMP	✓	✓
EQ	✓	*

- German

	EN	DN
COMP	✓	*
EQ	✓	✓

- Vietnamese

	EN	DN
COMP	✓	✓
EQ	✓	✓

- Macedonian

	EN	DN
COMP	✓	✓
EQ	*	*

Data

Attested patterns

- Polish

	EN	DN
COMP	✓	*
EQ	✓	*

- English

	EN_1	EN_2	DN
COMP	✓	*	*
EQ	✓	✓	*

- possibly more patterns to be observed

Generalization:

- event numerals: always compatible with COMP/EQ
- degree numerals: more variation

Puzzle

EN/DN asymmetry in COMP/EQ

- Czech

	EN	DN
COMP	✓	✓
EQ	✓	*

- Vietnamese

	EN	DN
COMP	✓	✓
EQ	✓	✓

Proposed solution:

- two distinct strategies of degree multiplication
- interaction with the explicit/implicit mode of comparison

More data

Quantification over events

- Czech
  - event numerals ⇒ ✓
  - degree numerals ⇒ *

(9) a. Petr napsal mamince dopis dvakrát.
Petr wrote letter for-mother twice
'Petr wrote the letter to his mother twice.'

b. *Petr napsal mamince dopis dvojnásobně.
Petr wrote letter for-mother doubly

More data

Quantification over events

- Vietnamese
  - event numerals ⇒ ✓
  - degree numerals ⇒ *

(10)
a. Petr đã viết thư cho mẹ hai-lần
Petr already write letter for mother twice
'Petr wrote the letter to his mother twice.'

b. *Petr đã viết thư gấp-đôi cho mẹ.
Petr already write letter doubly for mother

More data

Typal compatibility

- Czech stacked numerals

(11) a. Petrovi se to třikrát dvojnásobně vyplatilo.
for-Petr REFL this thrice doubly payed-off
'For Petr it payed off doubly three times.'

b. *Petrovi se to dvojnásobně třikrát vyplatilo.
for-Petr REFL this doubly thrice paid-off

More data

Predicate position

- Czech adjectival degree numerals

(12) ...škoda dosahuje asi 50 tisíc korun.
damage reaches approximately 50 thousand crowns
Hodnota uchráněného majetku je dvojnásobná.
value saved property is double
'...the damages reach approximately 50 000 CZK. The value of saved property is twice as high.' (CNC)

More data

Generalization

- event numerals
  - quantification over events and degree environments
  - our focus: degree environments
  - future research: unified analysis
- degree numerals
  - only degree environments
  - predicate position

Framework

General assumptions

- ontology: degrees (type d) ordered into scales
- scale: $\langle D, >, DIM \rangle$
  - D: a set of degrees
  - $>$: an ordering relation on D
  - DIM: a dimension of measurement, e.g., height
- interval-based approach to degrees (Kennedy 2001, Schwarzschild & Wilkinson 2002)
- measure functions associate entities with scales (Solt 2014)
- semantics of gradable adjectives

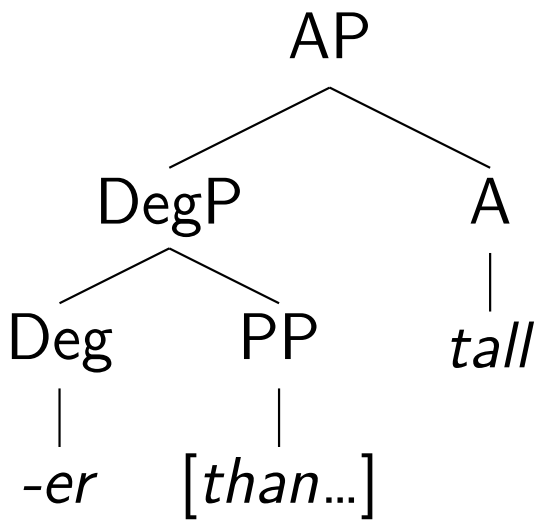
(13) $\quad [\![\mathit{tall}]\!] = \lambda d \lambda x . \mu_{\text{HEIGHT}}(x) \geq d$

Framework

Syntactic structure of comparatives

- small DegP view (Bresnan 1973, Heim 2000)
  - *-er* + *than*-clause ⇒ constituent at LF
  - DegP ⇒ argument of the gradable predicate

(14)



Framework

Clausal comparatives

- elided clause $\Rightarrow$ the maximal interval corresponding to a standard of comparison (Pancheva 2006)

(15) a. Petr is taller than Marie.
b. LF: [$_{IP}$ [$_{IP}$ Petr is d_1-tall] [DegP -*er*$_1$ [$_{PP}$ than [$_{CP}$ Marie is d-tall]]]]

- *than*-clause: a free relative interpreted as a definite description of degrees $\Rightarrow$ type d (Heim 2000)
- -*er*: degree quantifier, type $\langle\langle d, t\rangle, \langle\langle d, t\rangle, t\rangle\rangle$

Framework

Remedy for the type mismatch

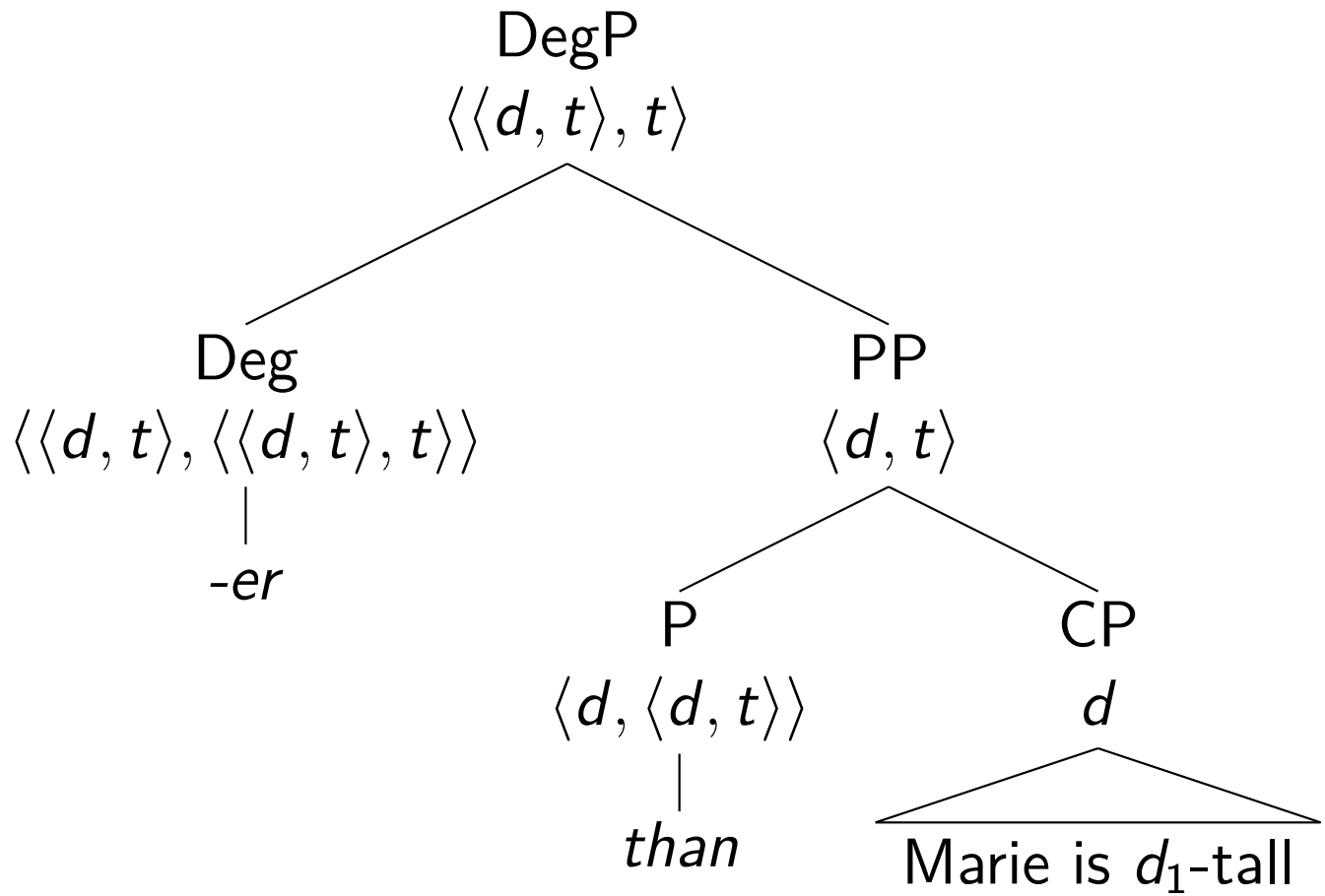
- non-trivial semantics for *than* (cf. von Stechow 1984, Rullmann 1995)
- *than* as a partitive preposition in the domain of degrees (Pancheva 2006)

(16) $[\![\textit{than}]\!] = \lambda d' \lambda d.d$ is part of d' $\langle d, \langle d, t \rangle \rangle$

- *than*: $d \rightarrow$ a set of degrees which d is member of
- example
  - standard of comparison $\Rightarrow$ 170 cm
  - *than*-clause $\Rightarrow$ a set of degrees in the interval 0–170 cm

Framework

(17)



Proposal

Comparative

- standard view: A $>$ B (von Stechow 1984, Heim 2000, Schwarzschild 2008)
- our proposal
  - factor COMP: A $\geq$ B instead of A $>$ B
  - similar approach: percentage differential COMP (Gobeski & Morzycki 2017)

(18) $[\![\text{-}er_{\times}]\!] = \lambda D' \lambda D.\textsc{max}(D) \geq \textsc{max}(D')$ $\langle\langle d,t\rangle,\langle\langle d,t\rangle,t\rangle\rangle$

- pragmatic strengthening: $\geq \rightsquigarrow =$
- independent motivation: differentials
- source (neo-Gricean view)
  - competition between numerals in factor phrases
  - $\Rightarrow$ scalar implicature (Horn 1972)

Proposal

Equative

- elided clause $\Rightarrow$ the maximal interval corresponding to a standard of comparison

(19) a. Petr is as tall as Marie.

b. LF: [$_{IP}$ [$_{IP}$ Petr is d_1-tall] [$_{DegP}$ as... as$_1$ [$_{CP}$ Marie is d-tall]]]

- no preposition/complementizer
  - English: no standard marker *than*
  - Slavic: wh-element, e.g., Czech *jako* ('how')
  - Vietnamese: no marking

Proposal

Equative

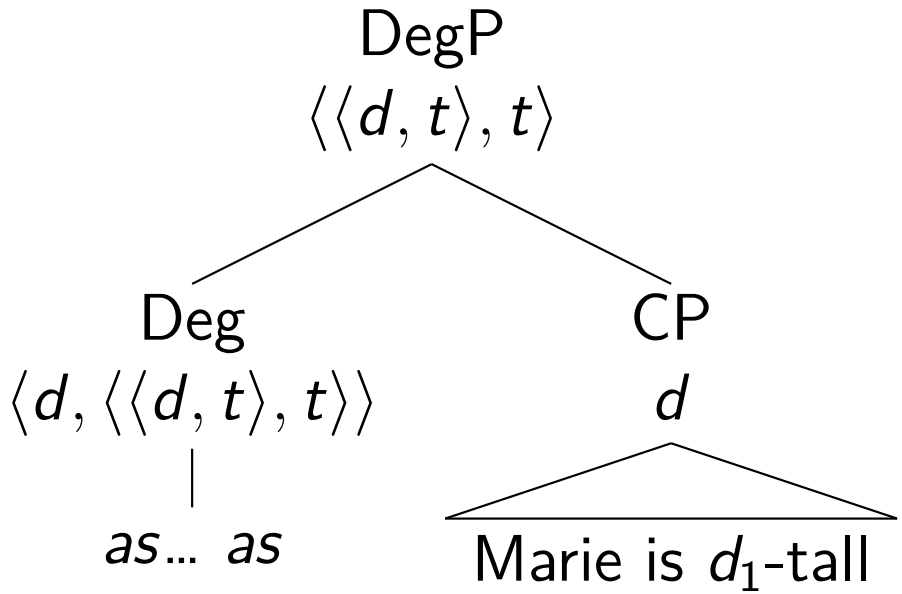
- COMP: degree quantifier, type $\langle\langle d, t\rangle, \langle\langle d, t\rangle, t\rangle\rangle$
- our proposal
  - EQ: operates on d $\Rightarrow$ DegP takes the CP directly
  - similar approach: percentage EQ (Gobeski & Morzycki 2017)

(20) $[\![as... \ as]\!] = \lambda d \lambda D.\textsc{max}(D) = d$ $\langle d, \langle\langle d, t\rangle, t\rangle\rangle$

- COMP vs. EQ: not just $>$ vs. $\geq$ / $=$ (Rett 2013)

Proposal

(21)



Proposal

Strategies of multiplication

- multiplicative
  - basic
  - operation from a degree to a degree multiplied by n
- predicative
  - characteristic function of degrees equal to a contextually salient degree d_c multiplied by n
  - d_c = the MAX value of a standard on a proper scale

Predicate Modification (Heim & Kratzer 1998)

- applies to degree predicates

Proposal

Semantics for EN/DN

- event numeral $\Rightarrow$ degree multiplier

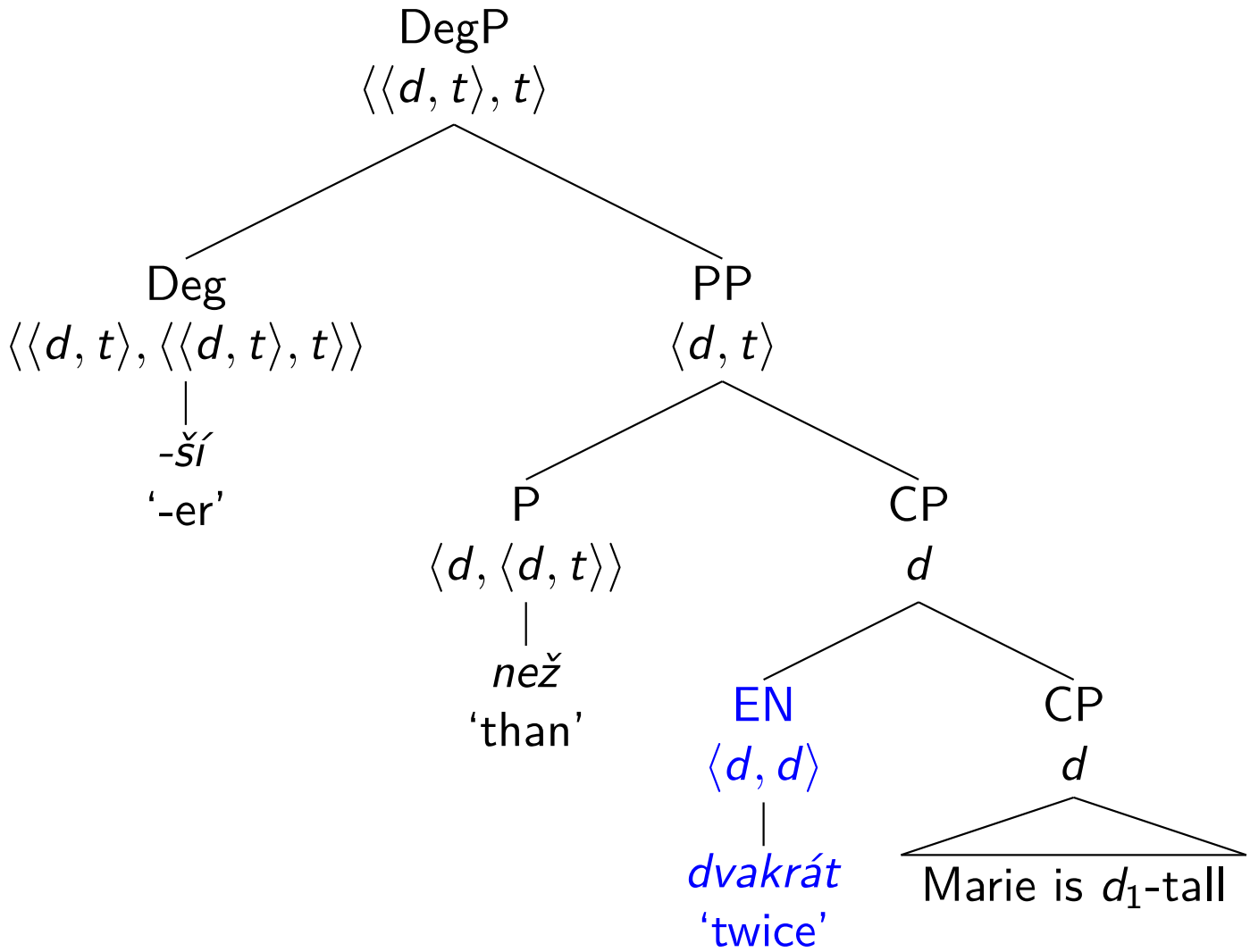
(22)
a. $[\![\textit{dvakrát/hai-lần}]\!] = \lambda d.2 \times d$ $\langle d, d\rangle$
b. $[\![\textit{EN}]\!] = \lambda n \lambda d.n \times d$ $\langle n, \langle d, d\rangle\rangle$

- degree numeral $\Rightarrow$ degree predicate

(23)
a. $[\![\textit{dvojnásobně/gấp-đôi}]\!] = \lambda d.d = 2 \times d_c$ $\langle d, t\rangle$
b. $[\![\textit{DN}]\!] = \lambda n \lambda d.d = n \times d_c$ $\langle n, \langle d, t\rangle\rangle$

Czech factor comparatives

(24)



Czech factor comparatives

Composition

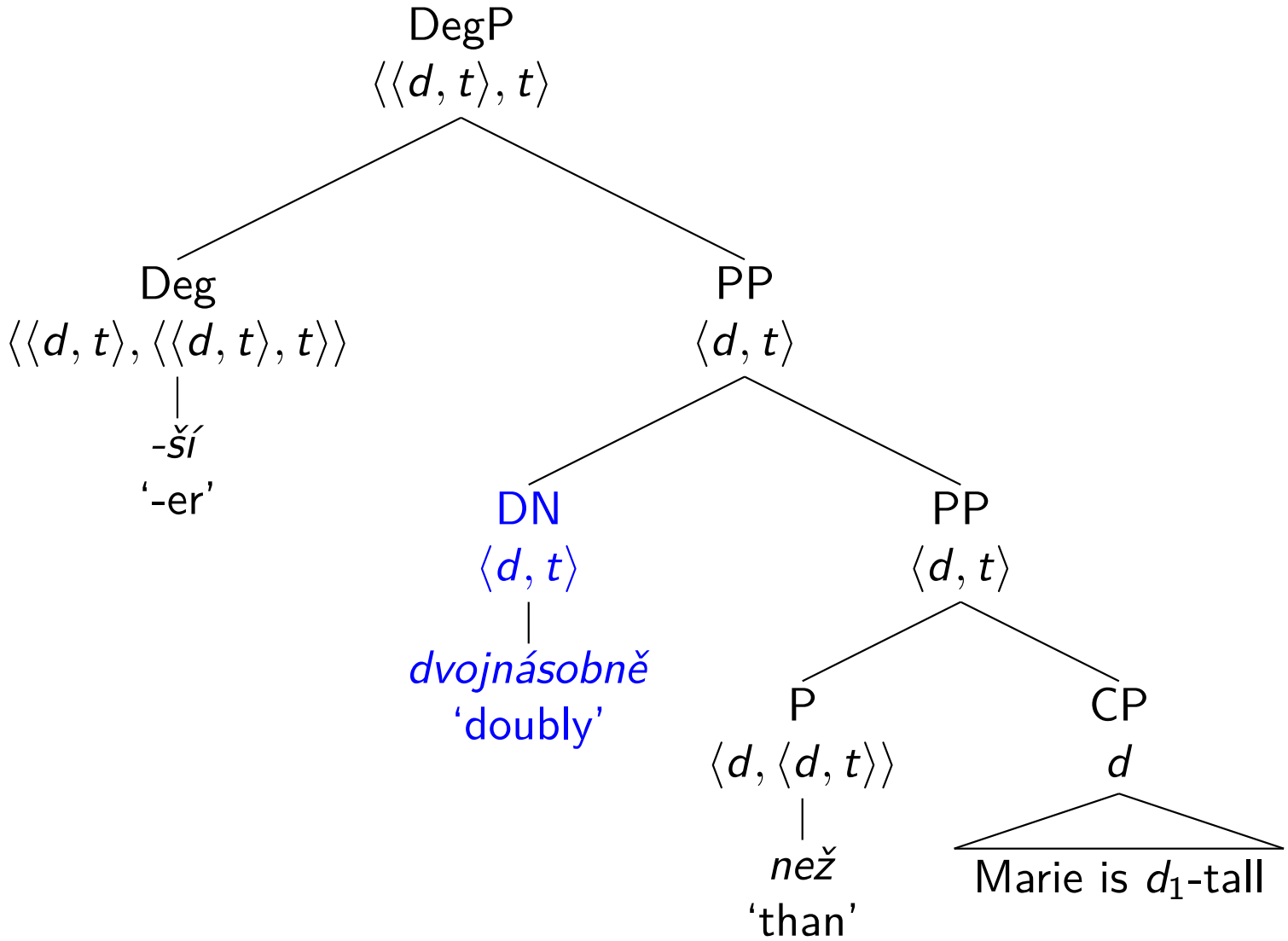
- CP: the maximal interval to which Marie is tall
- EN: the interval is multiplied by 2
- *než*: CP $\rightarrow$ set of degrees which are part of that interval
- *-ší*: $\textsc{max}$ operation picks the maximal interval to which Marie is tall multiplied by 2

Strengthening

- competition: *dvakrát* and higher EN
- scalar implicature: $\geq \rightsquigarrow =$

Czech factor comparatives

(25)



Czech factor comparatives

Composition

- CP: the maximal interval to which Marie is tall
- *než*: CP $\rightarrow$ set of degrees which are part of that interval
- DN + PP: Predicate Modification
  - each member of the set multiplied by 2
  - set of degrees that are 2 $\times$ bigger than Marie's height
- *-ší*: MAX operation picks the maximal interval to which Marie is tall multiplied by 2

Strengthening

- competition: *dvojnásobně* and higher DN
- scalar implicature: $\geq \rightsquigarrow =$

Czech factor comparatives

Interpretation

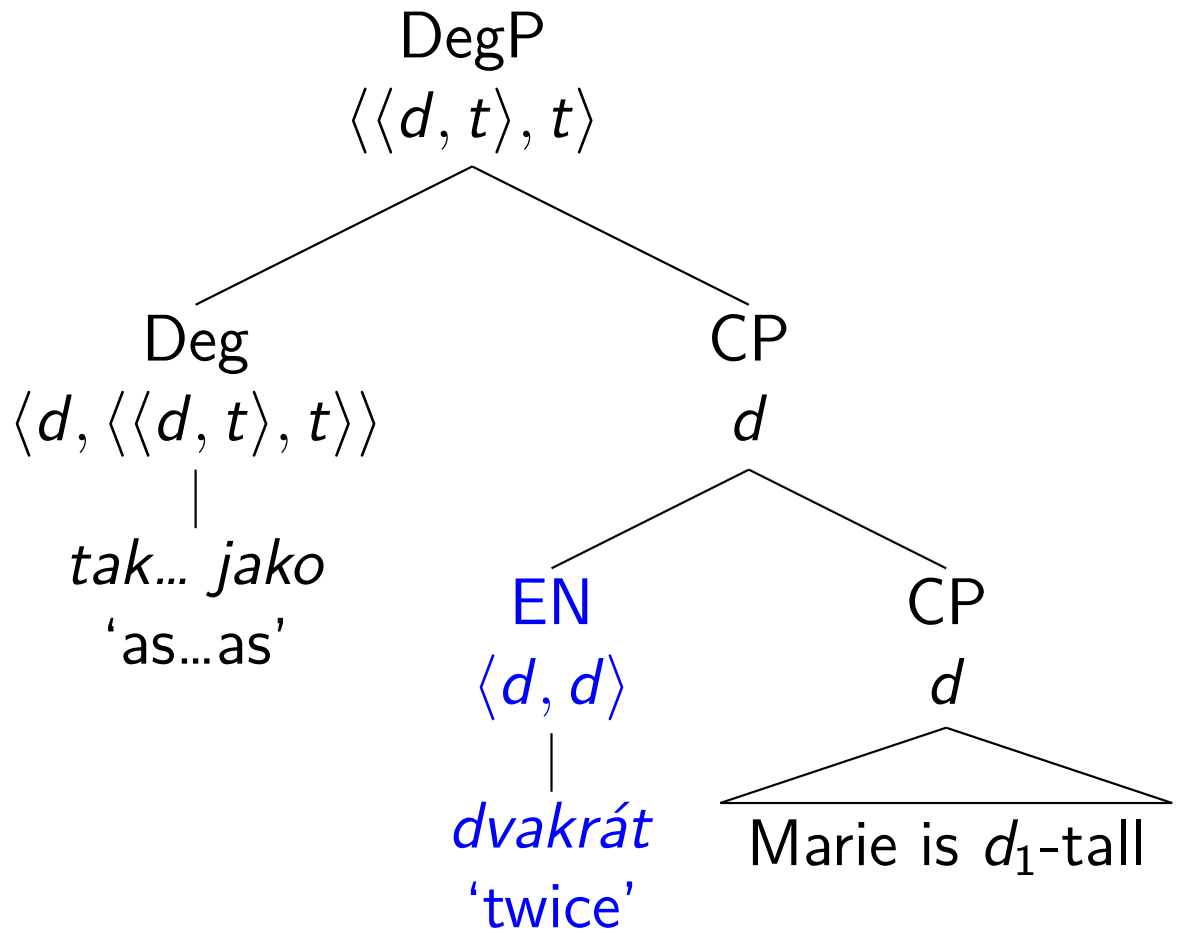
(26) a. $[\![\text{(7-a)/(7-c)}]\!] = \text{MAX}(\lambda d.\mu_{\text{HEIGHT}}(\textit{Petr}) \geq d) \geq \text{MAX}(\lambda d'.d' = 2 \times \mu_{\text{HEIGHT}}(\textit{Marie}))$

b. $\rightsquigarrow \quad \text{MAX}(\lambda d.\mu_{\text{HEIGHT}}(\textit{Petr}) \geq d) = \text{MAX}(\lambda d'.d' = 2 \times \mu_{\text{HEIGHT}}(\textit{Marie}))$

- TRUE iff the degree to which Petr is tall = the degree to which Marie is tall multiplied by 2
- exemplary scenario
  - $\text{MAX}(\mu_{\text{HEIGHT}}(\textit{Marie})) = 90$
  - $\text{MAX}(\mu_{\text{HEIGHT}}(\textit{Petr})) = 180$

Czech factor equatives

(27)



Czech factor equatives

Composition

- CP: the maximal interval to which Marie is tall
- EN: the interval is multiplied by 2
- no partitive preposition to shift the modified CP
- no additional MAX operation required
- *tak...jako*: equates the maximal interval to which Marie is tall multiplied by 2 to another degree

Czech factor equatives

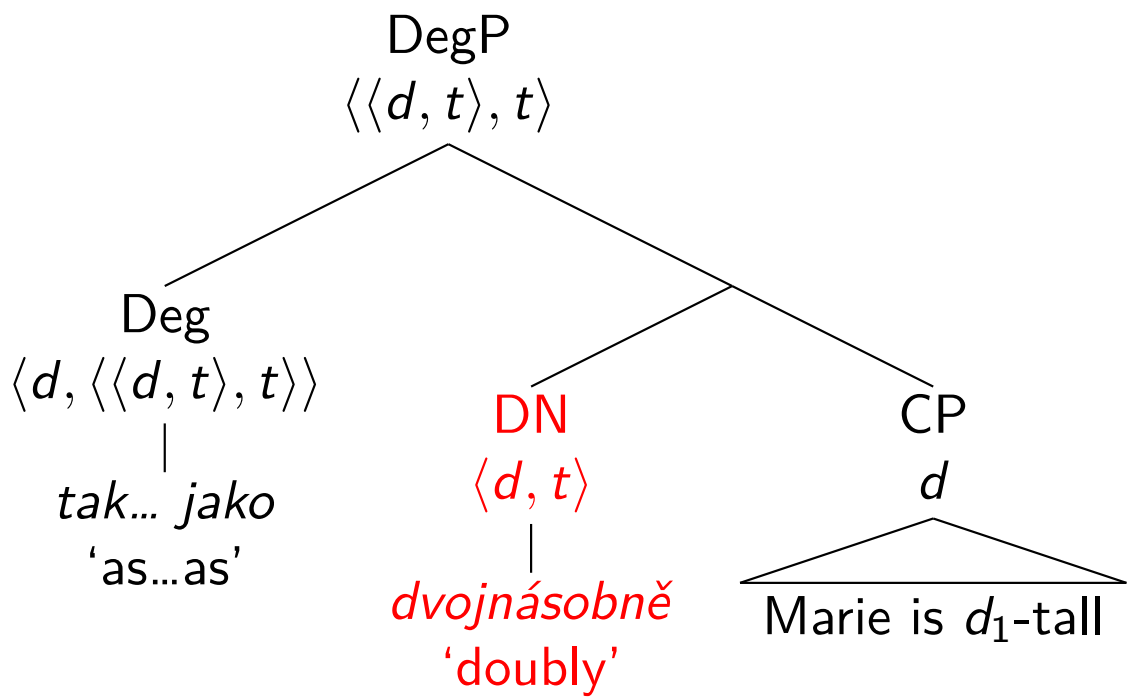
Interpretation

(28) $[\![\text{(7-b)}]\!] = \text{MAX}(\lambda d.\mu_{\text{HEIGHT}}(\textit{Petr}) \geq d) =$
$\text{MAX}(\lambda d'.d' = 2 \times \mu_{\text{HEIGHT}}(\textit{Marie}))$

- TRUE iff the degree to which Petr is tall = the degree to which Marie is tall multiplied by 2
- exemplary scenario
  - $\text{MAX}(\mu_{\text{HEIGHT}}(\textit{Marie})) = 90$
  - $\text{MAX}(\mu_{\text{HEIGHT}}(\textit{Petr})) = 180$

Czech factor equatives

(29)



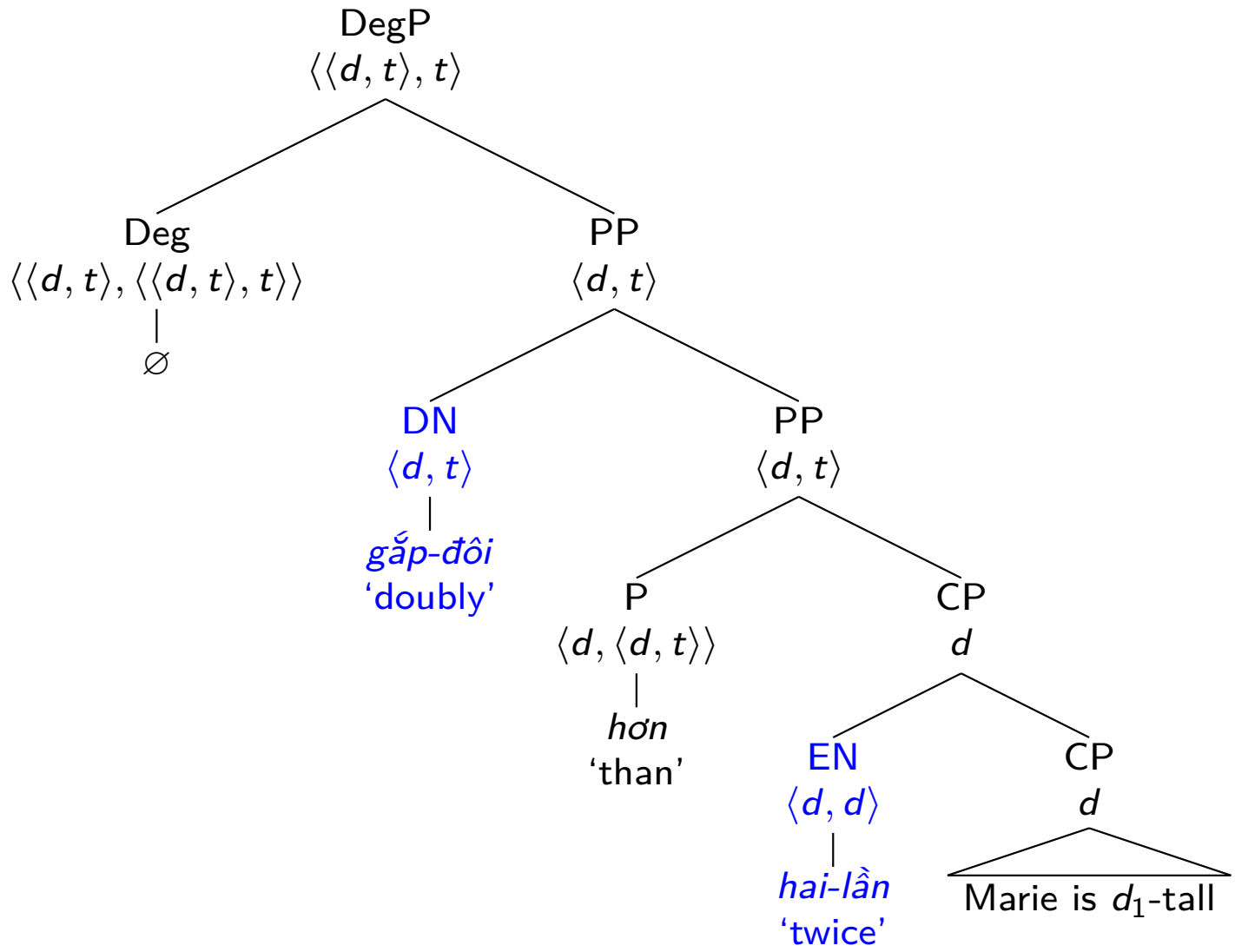
Czech factor equatives

Why are degree numerals * in EQ?

- type-driven incompatibility
- DN: type $\langle d, t \rangle$
- CP: type d
- no partitive preposition to shift the CP $\Rightarrow$ no node $\langle d, t \rangle$
- Predicate Modification: unavailable
- Function Application: $[\![\text{DN}]\!]([\![\text{CP}]\!]) \Rightarrow$ type t, # with Deg
- inevitable type mismatch $\Rightarrow$ ungrammaticality

Vietnamese comparatives

(30)



Explicit vs. implicit comparison

Modes of comparison (Kennedy 2007)

- explicit: standard of comparison ⇒ degree

(31) Petr is taller than Marie.

(32) $[\![\text{COMP}_d]\!] = \lambda d \lambda g \lambda x . max(g)(x) \geq d$

- implicit: standard of comparison ⇒ individual

(33) Compared to Marie, Petr is tall.

(34) $[\![\text{COMP}_e]\!] = \lambda y \lambda g \lambda x . max(g)(x) \geq max(g)(y)$

Explicit vs. implicit comparison

Degree parameter in Vietnamese (Beck at al. 2009)

- subcomparatives

(35) Xe-ô-tô to hơn đường hẹp này.
CL-car big than road narrow this
'The car is bigger than the road is narrow.'

- degree questions

(36) Anh-ấy thông-minh thế-nào?
he smart much-how
'How smart is he?'

Explicit vs. implicit comparison

Degree parameter in Vietnamese (Beck at al. 2009)

- negative islands are ungrammatical

(37) *Petr thông-minh hơn không-ai-cả ở trong lớp.
Petr smart than nobody AUX inside class
'*Petr is smarter than nobody in his class.'

Explicit/implicit mode of comparison

- construction specific rather than language parametrized

Explicit vs. implicit comparison

Scenario 1

- book A is 400 pages long, book B is 200 pages long

(38) a. Quyển A dầy quyển B hai-lần.
book A thick book B twice
'Book A is twice as long as book B.'

b. Quyển A dầy gấp-đôi quển B.
book A thick dubly book B
'Book A is twice as long as book B.'

Explicit vs. implicit comparison

Scenario 2

- book A is 400 pages long, book B is 250 pages long

(39) a. #Quyển A dầy quyển B hai-lần.
book A thick book B twice
'Book A is twice as long as book B.'

b. Quyển A dầy gấp-đôi quển B.
book A thick dubly book B
'Book A is twice as long as book B.'

Explicit vs. implicit comparison

Vietnamese equatives

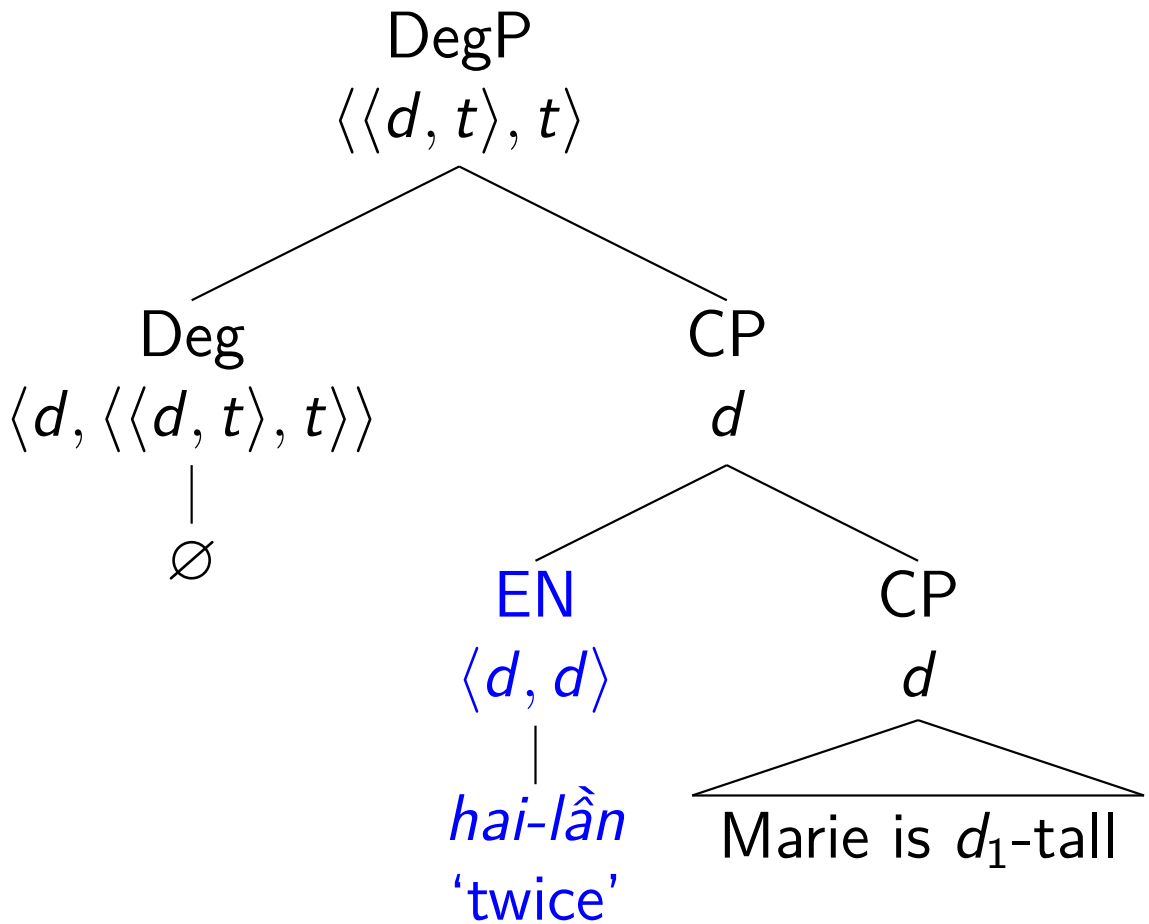
- deficient marking
- underspecification
- ambiguity: explicit/implicit comparison
- distinct linearizations $\Rightarrow$ different structures
  - Vietnamese EN: explicit comparison
  - Vietnamese DN: implicit (covers explicit)

Implicit comparison

- null ImplComp: type $\langle e, \langle \langle d, t \rangle, t \rangle \rangle$
- individual $\rightarrow$ degree serving as a standard
- EQ ordering manipulates the context $\Rightarrow$ the positive form is true of both standard and correlate
- vague value

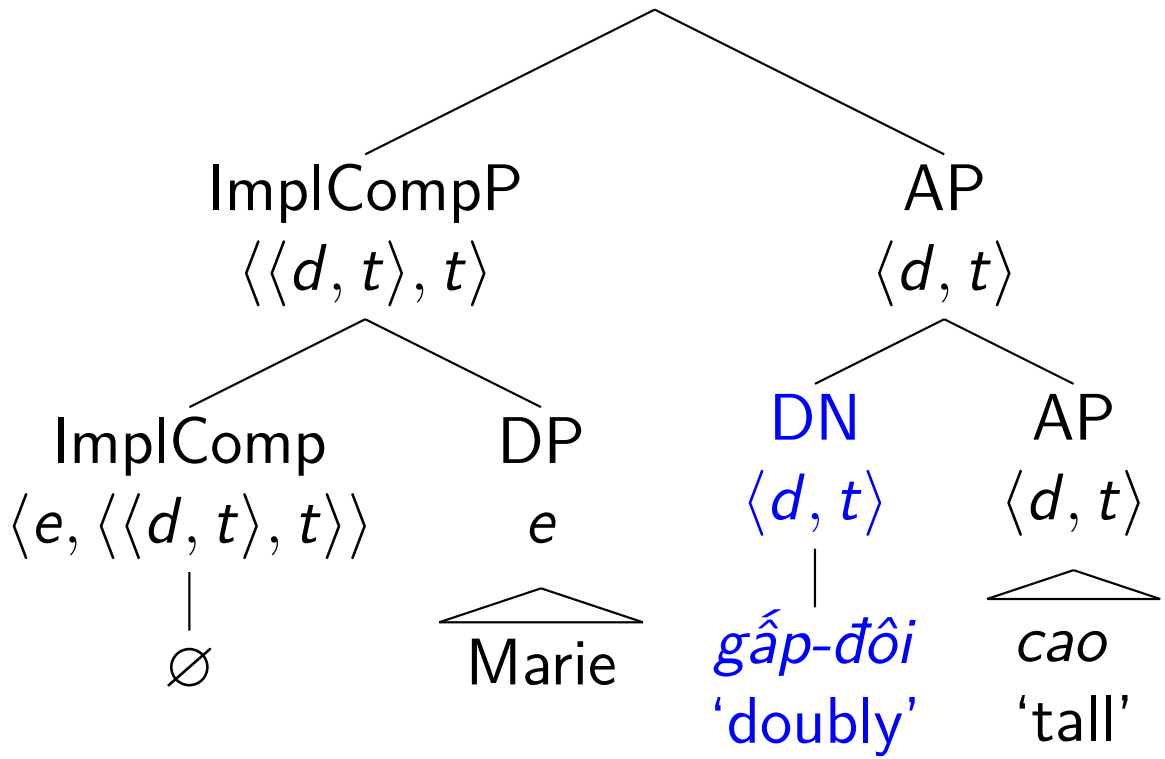
Vietnamese explicit equatives

(40)



Vietnamese implicit equatives

(41)



Vietnamese explicit equative structures

Different equative structures

- sufficient marking: equative verbs
- explicit mode of comparison

(42) Petr cao bằng/nhu Marie.
Petr tall equal Marie
'Petr is equal to Marie in height.'

(43) *Petr cao bằng/nhu Marie gấp-đôi
Petr tall equal Marie doubly

Conclusion

Observations:

- factor phrases target comparatives and equatives
- factor phrases involve event numerals and degree numerals
- EN/DN: cross-linguistic variation in COMP and EQ

Proposal:

- 2 strategies of multiplication
  - EN: multiplicative $\langle d, d \rangle$
  - DN: predicative $\langle d, t \rangle$
- interaction with the implicit/explicit mode of comparison
- more interactions to be explored

Thanks!

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