

Counting degrees and events: A cross-linguistic perspective

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Introduction I

- ▶ 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

- ▶ aim: an analysis of such expressions in two typologically distinct languages

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

- ▶ more data from other languages
- ▶ focus on: constructions where degree argument is manipulated – **comparatives** and **equatives** + **factor phrases**
- ▶ terminology:

1. *twice*-type adverbs → **event numerals (EN)**
2. *doubly*-type adverbs → **degree numerals (DN)**

- ▶ main puzzle: contrasts concerning acceptability of event/degree numerals in COMP/EQ
- ▶ claim:
 1. Czech *twice*-type adverbs → **degree/event multiplier**
 2. Czech *doubly*-type adverbs → **predicative degree multiplier**
- ▶ 2 distinct strategies of degree multiplication
- ▶ particular expressions differ wrt to which strategy they employ

- ▶ variation wrt what is (in)compatible with COMP and/or 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.

Macedonian

- (4) a. Jon je **dva puti** po visok od Mari.
Jon is two times more tall from Mari
'John is two times as tall as/taller than Mary.'
- b. *Jon je **dva puti** visok kolku Mari.
Jon is two times tall as Mari

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 as Maria
'Hans is twice as tall as Maria.'
- c. *Hans ist **doppelt** größer als Maria.
Hans is twice doubly than Maria
- d. Hans ist **doppelt** so groß wie Maria.
Hans is doubly so tall as Maria
'Hans is twice as tall as Maria.'

Data I

- ▶ in some contexts Czech *dvakrát* 'twice/two times' and *dvojnásobně* 'doubly/twofold' are synonymous:

- (6) a. Petrovi se to vyplatilo
for-Petr REFL this payed-off
dvakrát/dvojnásobně.
twice/doubly
'For Petr it payed off twice.'
- b. Ceny tady jsou **dvakrát/dvojnásobně**
Prices here are twice/doubly
vyšší než tam.
higher than there
'The prices here are two times higher than there.'

- ▶ however, there are multiple contexts in which they are not

- ▶ Czech and Vietnamese: contrastive analysis
- ▶ Czech: study based on National Czech Corpus (SYN2015)
- ▶ Advs *dvakrát* and *dvojnásobně* in SYN2015
- ▶ 100 random examples + filtering: 98, 99
- ▶ Vietnamese: introspective data (informants)

98 sentences; 77% – events: VPs or AdvPs/PPs

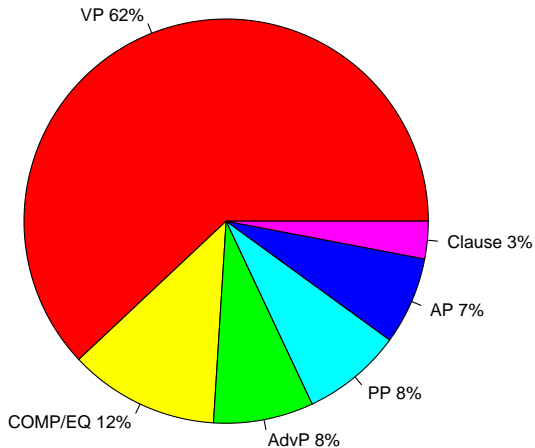


Figure 1: Distribution of *dvakrát*

99 sentences; 90% – scales: APs, deadjectival Vs, COMPs, and secondary pred.

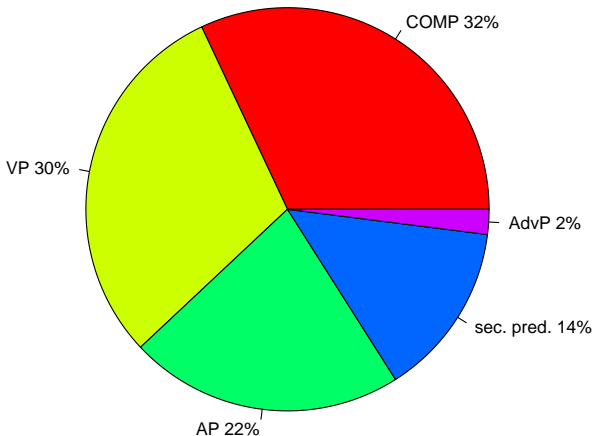


Figure 2: Distribution of *dvojnásobně*

Czech: *dvakrát* ~ *dvojnásobně*

Property	Event numerals	Degree numerals
Morphology	Adv	Adv/A/N
Degree	yes	yes
Diff. in comparatives	yes	yes
Diff. in equatives	yes	no
Diff. in superlatives	no	no
Modify count events	yes	no
Modify homog. events	yes	yes
Events (N)	no	yes
Roles (N)	no	yes

In bold the most frequent cases based on the corpus study (SYN2015)

Vietnamese: *hai-lần* ~ *gấp-đôi* (very partial)

Property	Event numerals	Degree numerals
Morphology	absent	absent
Degree	yes	yes (comparative)
Diff. in comparatives	yes	yes
Diff. in equatives	yes	yes
Adjectival	no	postnominal
Adverbial	postverbal/postadjectival	no

Key contexts I: degree and differential

- ▶ **Czech:** both event and degree numerals: ✓

- (7) a. a tak se dokážou **dvakrát** rychleji
and thus REFL manage twice faster
ohřát nebo zchladit než běžné žehličky
heat or cool-down than ordinary irons
'and thus, they can heat or cool down two times
faster than ordinary irons'
- b. je dnes až **dvojnásobně** větší nebezpečí
is today even doubly bigger danger
ničivých povodní než před 20 lety
destructive floods than before 20 years
'Today, the danger of destructive floods is two
times bigger than 20 years ago.'

Key contexts I: degree and differential

- ▶ **Vietnamese:** both event and degree numerals: ✓

- (8) a. Nam nay giá xăng đắt hơn năm
year this price petrol expensive than year
ngoái **hai-lần**
previous twice
'This year, the price of petrol is twice higher than
the last year.' **comparative**
- b. Năm nay giá xăng đắt gấp-đôi năm
year this price petrol expensive doubly year
ngoái.
previous
'This year, the price of petrol is twice as high as
last year.' **equative**

Key contexts II: count events

- ▶ **Czech**: event numerals: ✓, degree numerals: *

- (9) a. **Dvakrát** se přesvědčím, že jsou dvířka
twice REFL I-will-ensure that are door
zavřená.
closed
'I will make sure twice that the door is closed.'
- b. ***Dvojnásobně** se přesvědčím, že jsou
doubly REFL I-will-ensure that are
dvířka zavřená.
door closed

Key contexts II: count 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

Categorial differences I:

► Czech

(11) dvakrát:

a. Adv: přelo dvakrát
rained twice

'it rained twice'

b. *A: [dvakrát(ní) objem nádrže]
twice.A capacity tank

c. *N: [dvakrát(ek) rychlosti]
twice.N speed

(12) dvojnásob-:

- a. Adv: dvojnásobně dlouhý
doubly long
'two times longer'
- b. A: dvojnásobný objem nádrže
double capacity tank
'double the capacity of a tank'
- c. N: dvojnásobek ceny
double.N price
'double the price'

Categorial differences II:

▶ Vietnamese

(13) hai-lần: ✓ with VPs/ ✓ with APs

a. Anh-ấy đã gõ cửa **hai-lần**.
he already knock door twice
'He knocked on the door twice.'

b. Giá gạo đắt hơn giá bột-mỳ
price rice expensive than price flour
hai-lần.

twice

'The price of rice is two times higher than the price of flour.'

(14) gấp đôi: * with VPs/ ✓ with APs

a. *Anh-ấy đã **gấp-đôi** gõ cửa.
he already doubly knock door

b. Giá gạo đắt **gấp-đôi** giá bột-mỳ.
price rice expensive doubly price flour
'The price of rice is double the price of flour.'

Typal compatibility

- ▶ Czech

- (15) Petrovi se to **tříkrát dvojnásobně**
for-Petr REFL this thrice doubly
vyplatilo.
payed-off
'For Petr it payed off doubly three times.'

Crucial contrast

- ▶ **Czech** degree numerals are less acceptable in equatives than in comparatives

- (16) 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.'
- (17) a. Petr je **dvojnásobně** vyšší než Marie.
Petr is doubly taller than Marie
'Petr is two times taller than Marie.'
- b.??? Petr je **dvojnásobně** tak vysoký jako Marie.
Petr is doubly so tall how Marie

- ▶ SYN2015: no occurrences of EQ with degree numerals

- but **Vietnamese** equatives are acceptable with degree numerals:

- (18) 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 two times as tall as Marie.'
- (19) a. Petr cao hơn **gấp-đôi** Marie.
Petr tall than doubly Marie
'Petr is two times taller than Marie.'
- b. Petr cao **gấp-đôi** Marie.
Petr tall doubly Marie
'Petr is two times as tall as Marie.'

Attested patterns of EN/DN ~ COMP/EQ

- ▶ Czech

	EN	DN
COMP	yes	yes
EQ	yes	no

- ▶ German

	EN	DN
COMP	yes	no
EQ	yes	yes

▶ Vietnamese

	EN	DN
COMP	yes	yes
EQ	yes	yes

▶ Macedonian

	EN	DN
COMP	yes	no
EQ	no	no

▶ English

	EN1	EN2	DN
COMP	yes	no	no
EQ	no	yes	no

- ▶ possibly more patterns to be observed
- ▶ it seems though that ENs are always compatible with COMP/EQ

- ▶ degree numerals are anchored to particular events (no cumulative readings):

- (20) Petrovi a Honzovi se to **třikrát**
for-Petr and for-Honza REFL this thrice
dvojnásobně vyplatilo.
doubly paid-off
'For Petr and Honza it payed off doubly three times.'
- a. for Petr: 3 x (paid-off x 2)
for Honza: 3 x (paid-off x 2)
 - b. for Petr \oplus Honza: 3 x (paid-off x 2)
 - c. #for Petr: 4 x (paid-off x 1)
for Honza: 1 x (paid-off x 2)

Scopal properties of event/degree numerals

- ▶ frequency vs. degree adverbs (Doetjes (2007))

- (21) a. Petr **často** kupoval nějaké pivo.
Petr often bought.ipfv some beer
'Petr often bought some beer.'
- b. *Petr **hodně** kupoval nějaké pivo.
Petr a-lot bought.ipfv some beer
- (22) a. Petr **dvakrát** koupil nějaké pivo.
Petr twice bought.pfv some beer
'Petr bought some beer twice.'
- b. *Petr **dvojnásobně** koupil nějaké pivo.
Petr doubly bought.pfv some beer

- ▶ but frequency adverbs can have a relation reading, whereas event numerals cannot

(23) Když byl Karel v Budapešti, tak byl **často** v
when was Karel in Budapest then he-was often in
Gellértu.

Gellért

'When Karel was in Budapest, he often visited Gellért.'

a. often > when

b. when > often

(24) Když byl Karel v Budapešti, tak byl
when was Karel in Budapest then he-was
dvakrát v Gellértu.

twice in Gellért

'When Karel was in Budapest, he visited Gellért twice.'

a. #twice > when

b. when > twice

- ▶ furthermore, frequency adverbs cannot target scales of degrees → incompatible with comparatives and equatives

- (25) a. #Petr je **často** vyšší než Marie.
Petr is often taller than Marie
- b. #Petr je **často** tak vysoký jako Marie.
Petr is often so tall how Marie

Property	Degree Advs	Event numerals	Frequency Advs
Access degrees	yes	yes	no
Scope over indef.	no	yes	yes
Relational reading	no	no	yes

Theory

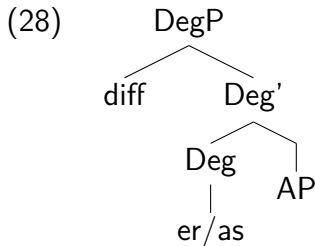
- ▶ following Kennedy (1999) and Kennedy and McNally (2005)
- ▶ adjectives are relations between individuals and degrees – (26-a) ($\langle\langle d, \langle e, t \rangle \rangle\rangle$)
- ▶ degree morphemes, measure phrases and other degree modifiers are of the type $\langle\langle d, \langle e, t \rangle \rangle, \langle e, t \rangle\rangle$

- (26)
- $\llbracket \textit{long} \rrbracket = \lambda d \lambda x. \mu_A(x) \geq d$
 - $\llbracket 2 \textit{ meters} \rrbracket = \lambda d \lambda g \lambda x. \max(g)(x) \geq 2 \textit{ meters}$
 - John is $[\lambda x. \max(\textit{long})(x) \geq 2 \textit{ meters}]$

- ▶ standard comparative and equative in Kennedy style of degree analysis:

- (27) a. $\llbracket -er/more\ than \rrbracket = \lambda d \lambda g \lambda x. max(g)(x) > d$
 b. $\llbracket as\ as \rrbracket = \lambda d \lambda g \lambda x. max(g)(x) \geq d$

- ▶ we assume DegP (functional layer of AP) part of the tree loosely corresponding to (27):



- ▶ adding the differential slot requires more “active” semantics of the differential
- ▶ evidence for this comes from many types of differential semantics like in (30) (compare Solt (2014))

(29) $\llbracket -er/more\ D(iff)\ than \rrbracket = \lambda d \lambda g \lambda D \lambda x. [\max(g)(x) > d \wedge \max(g)(x) = D]$

(30) John is $\llbracket [about\ 3\ years] \text{ older than Mary.} \rrbracket$

a. $\llbracket [about\ 3\ years] \rrbracket \approx \lambda d. d = d_M + 3$

(31) a. John is about three years older than Mary.

... $> d_M + 3$

b. John is about three years younger than Mary.

... $< d_M - 3$

c. John is two times older than Mary. ... $= d_M * 2$

Hypothesis (typological)

- ▶ generally we assume two strategies of multiplication:
 1. predicative – in Czech case degree numerals
 2. multiplicative – in Czech case event numerals
- ▶ different expressions in different languages can employ strategy 1) or strategy 2)

Czech degree numerals (*dvojnásobně*) I

- ▶ the comparative examples reveal the true nature of degree numerals

(32) Petr je dvojnásobně vyšší než Marie.

Petr is doubly higher than Marie

- 1 in all situations where the gap between Petr's and Marie's height is equal to the height of Marie
- $\mu_{\text{HEIGHT}}(\text{Petr}) = 180 \wedge \mu_{\text{HEIGHT}}(\text{Marie}) = 90, \dots$

- ▶ the degree numeral specifies an interval of the gap between the correlate (Petr) and the standard (Marie) by multiplication the standard value on an appropriate scale

- ▶ first approximation: a characteristic function of degrees equal to a contextually salient degree d_c multiplied by n
- ▶ d_c = the MAX value of standard on the appropriate scale

(33) $\llbracket \text{Degree Numeral} \rrbracket : \lambda n \lambda d. d = n * d_c$ type $\langle n, \langle d, t \rangle \rangle$
 a. $\llbracket \text{dvojnásobně} \rrbracket : \lambda d. d = 2 * d_c$

- ▶ Rett (2014a) and Rett (2014b): quantity words such as *many, much, ...* → degree modifiers denoting relations between sets of degrees (D) and their measure (d)
- ▶ Czech degree numerals differ in: (i) explicitly specifying d , (ii) determining d via multiplication

- ▶ denotations of degree numerals:

(34) Petr is doubly higher than Marie. (cs)

- $\llbracket \text{doubly} \rrbracket = \lambda d. d = 2 * d_M$
- $\llbracket \text{-er/more } D(\text{iff}) \text{ than} \rrbracket =$
 $\lambda d \lambda g \lambda D \lambda x. [\max(g)(x) > d \wedge \max(g)(x) = D]$
- Petr is $[\lambda x. [\max(\text{tall})(x) > d_M \wedge \max(\text{tall})(x) =$
 $\max(\lambda d. d = 2 * d_M)]]$

- ▶ equative is ungrammatical with degree numerals since it doesn't have a differential version:

(35)???Petr is doubly as high as Marie. (cs)

- $\llbracket \text{doubly} \rrbracket = \lambda d. d = 2 * d_M$
- $\llbracket \text{as as} \rrbracket = \lambda d \lambda g \lambda x. \max(g)(x) \geq d$
- (35-a) + (35-b) semantic/syntactic(?) incompatibility

Czech event numerals (*dvakrát*) I

- ▶ Czech event-numerals are different, they can combine even with EQ without differential
- ▶ and maybe with COMP with differential too (ambiguity?)
- ▶ they are degree/event/time(?) multipliers:

(36) Petr is twice as high as Mary. (cs)

- $\llbracket \textit{twice} \rrbracket = \lambda d.2 * d$
- $\llbracket \textit{as as} \rrbracket = \lambda d \lambda g \lambda x. \max(g)(x) \geq d$
- Petr is $\llbracket \lambda x. [\max(g)(x) \geq d_M * 2] \rrbracket$

- ▶ analysis based on the classification of Doetjes (2007)

Scopal properties of adverbs of quantification

Property	Degree Advs	Event numerals	Frequency Advs
Access degrees	yes	yes	no
Scope over indef.	no	yes	yes
Relational reading	no	no	yes

- ▶ **frequency adverbs** (*often*)
- ▶ → quantification over times, scope over indefinites
- ▶ **degree adverbs** (*a lot*)
- ▶ → degree modification, do not scope over indefinites
- ▶ event numerals \approx frequency adverbs
- ▶ degree numerals \approx degree adverbs

- ▶ quantification over situations and a hidden domain anaphor (von Stechow 1994)
- ▶ abstract restrictor *times* (Doetjes 2007)

(37) *dvakrát*: 2 [_{restriction} times][_{nuclear scope} VP/IP]

- ▶ → unary quantification and wide scope

- (38) a. Petr **dvakrát** koupil nějaké pivo.
 Petr twice bought.perf some beer
 'Petr bought five beers twice'
- b. $\exists ex[\mu(e) = 2 \wedge Buy(e) \wedge \Theta_1(e) = Petr \wedge \Theta_2(e) = x \wedge Beer(x)]$

- ▶ quantification over events is wide scope reading \leftrightarrow
cumulative scopelless reading is not possible:

(39)??Dvakrát Petr koupil nějaké pivo dvakrát.

Twice Petr bought some beer twice

- a. cumulative reading: $\exists ex[\mu(e) = 2 \wedge \mu(e) = 2 \wedge Buy(e) \wedge \Theta_1(e) = Petr \wedge \Theta_2(e) = x \wedge Beer(x)]$

Our contribution

- ▶ event numerals denote a function which yields a multiplied value of a degree/time
- ▶ the common property of degrees and times ...totally ordered scale

(40) a. $\llbracket \textit{event numeral} \rrbracket = \lambda n \lambda d. n * d$
b. $\llbracket \textit{dvakrát} \rrbracket = \lambda d. 2 * d$

- ▶ type $\langle \langle n, d \rangle, d \rangle$
- ▶ event numerals are operators which can QR (similar to cardinals)
- ▶ \rightarrow multiplication via variable binding (λ -abstraction) \rightarrow wide scope

(41) Petr je **dvakrát** tak vysoký jako Marie.
Petr is twice so high how Marie
'Petr is twice as high as Marie.'

(42) Petr is twice as high as Mary. (cs)

a. $\llbracket \textit{twice} \rrbracket = \lambda d. 2 * d$

b. $\llbracket \textit{as as} \rrbracket = \lambda d \lambda g \lambda x. \textit{max}(g)(x) \geq d$

c. Petr is $[\lambda x. [\textit{max}(g)(x) \geq d_M * 2]]$

- ▶ on the other hand, degree numerals are predicative

Vietnamese equatives

- ▶ recall: **Vietnamese** equatives are acceptable with degree numerals:

(43) Petr cao gấp-đôi Marie.
Petr tall doubly Marie
'Petr is doubly as tall as Marie.'

- ▶ sidenote: Vietnamese comparative is built on the equative and allows regular differentials:

- (44) Petr cao hơn Marie 10 cm
Petr tall than Marie 10 cm
'Petr is 10 cm taller than Marie.'
- (45) Petr cao hơn gấp-đôi Marie
Petr tall than doubly Marie
'Petr is doubly taller than Marie.'

- ▶ why Vietnamese and Czech equatives differ w.r.t. the degree numerals acceptability?
- ▶ reasonable hypothesis: Vietnamese equatives use the **implicit comparison** strategy (Kennedy (2007))
- ▶ implicit comparison: equative ordering by manipulating the context that the positive form (A) is true both of x and y
- ▶ no degree operator in equatives unlike in degree questions e.g.:

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

- ▶ Czech equatives use the **explicit comparison** strategy: the equative ordering is achieved by the degree argument binding \leftrightarrow the same free relative wh-word as in degree questions:

(47) **Jak** chytrý je ten kocour?
how smart is that tomcat
'How smart is the tomcat?'

(48) Ten kocour je chytrý **jak** ten pes.
that cat is smart how that dog
'The cat is as smart as the dog.'

- ▶ explicit strategy: the degree standard
- ▶ implicit strategy: the individual serves as a standard
- ▶ formally:

(49) a. $\llbracket -er_D \rrbracket = \lambda d \lambda g \lambda x. \max(g)(x) \geq d$
 b. $\llbracket -er_I \rrbracket = \lambda y \lambda g \lambda x. \max(g)(x) \geq \max(g)(y)$

- ▶ pseudo-Czech explicit (degree) equative plus degree numerals → incompatibility in types
- ▶ pseudo-Vietnamese implicit (context) equative plus degree numeral → restrictive modification ... set of individuals of Mary's height
- ▶ similar to Kennedy's analysis of Japanese clausal standard as relative clauses

(50)???Petr is doubly as high as Marie. (cs)

- $\llbracket \text{doubly} \rrbracket = \lambda d. d = 2 * d_M$
- $\llbracket \text{as as} \rrbracket = \lambda d \lambda g \lambda x. \max(g)(x) \geq d$
- (50-a) + (50-b) semantic/syntactic(?) incompatibility

(51) a. Petr tall doubly Marie.

- Petr
is $[\lambda x. \max(\text{tall})(x) \geq \max(\text{tall})(y \mid \mu_A(y) \geq 2 * d_M)]$

- ▶ similar to the style of cross-linguistic analysis initiated by Kennedy (2007) and Beck et al. (2009)
- ▶ but the data look more complex – Vietnamese allows subcomparatives (52), degree questions (53) + negative islands are ungrammatical in VN (54):

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

(53) Anh-ấy thông-minh thế-nào?
 he smart much-how
 ‘How smart is he?’

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

- ▶ unexpected in Beck et al. (2009)'s framework \leftrightarrow
languages allowing sumcomparatives, degree questions
and exhibiting negative islands use explicit comparison
strategy (do allow syntactic binding of a degree variable
in Beck's terms)
- ▶ empirically: VN is very different from the Mandarin
Chinese and Japanese data

- ▶ the data seems to indicate that the implicit/explicit mode of comparison is construction specific rather than language parametrized

(55) Petr cao bằng Marie *gấp-đôi
Petr tall equal Marie *doubly
'Petr equals with Marie in height doubly'

Summary

Observations:

- ▶ factor phrases target comparatives and equatives
- ▶ factor phrases involve event numerals and degree numerals
- ▶ in different languages event/degree numerals differ wrt acceptability in COMP and EQ

Proposal:

- ▶ 2 strategies of multiplication: predicative $\langle d, t \rangle$ and multiplicative $\langle d, d \rangle$
- ▶ event/degree numerals differ wrt to which strategy they employ
- ▶ the implicit/explicit comparison strategy also plays a role
- ▶ event numerals cannot be reduced to quantifiers over events

Thanks!

Appendices

Appendix I: comparative

- ▶ strictly speaking (56) requires scenarios like $d_M=100$, $d_P>200$, ...: pragmatic hallo?

(56) Petr is twice higher than Mary. (cs)

- $\llbracket \textit{twice} \rrbracket = \lambda d.2 * d$
- $\llbracket \textit{-er/more than} \rrbracket = \lambda d \lambda g \lambda x. \textit{max}(g)(x) > d$
- Petr is $[\lambda x. [\textit{max}(g)(x) > d_M * 2]]$

Appendix 2: Theory 2

- ▶ application to the comparative example:
- ▶ standard semantics for the comparative (Von Stechow (1984); Heim (2000); Schwarzschild (2008)):
 $\llbracket -er \rrbracket = \lambda D' \lambda D. MAX(D) > MAX(D')$
- ▶ comparative and degree numerals are both degree modifiers $\rightarrow \wedge$

(57) Petr je dvojnásobně vyšší než Marie.
Petr is doubly higher than Marie

- $\llbracket \text{comparative} \rrbracket = MAX_1(\lambda d''. \mu_{HEIGHT}(Petr)) > MAX_2(\lambda d'''. \mu_{HEIGHT}(Marie)) \wedge$
- $\llbracket \text{dvojnásobně} \rrbracket : MAX_1 = 2 * MAX_2$

- ▶ the proposed semantics is predicative ($\langle n, \langle d, t \rangle \rangle$): explains the predicative usage, ungrammatical for event numerals:
- ▶ plus acceptable conjunction with measure phrases

(58) a. Petrův plat je letos dvojnásobný.

Petr's salary is this year double.

b.???Petrův plat je letos dvakrát.

Petr's salary is this year twice.

(59) Letošní finálový zápas byl 240 minut dlouhý a dvojnásobný proti loňsku.

This year final match was 240 minutes long and double against last year.

- ▶ degree numerals do not (at least semantically) fill the differential slot of the comparative
- ▶ the formalization can explain the observed oddity of equative constructions with degree numerals

- ▶ again standard semantics for the equative:

$$\llbracket as \rrbracket = \lambda D' \lambda D. MAX(D) \geq MAX(D')$$

(60)??? Petr je dvojnásobně tak vysoký jako Marie.

- $\llbracket equative \rrbracket = MAX_1(\lambda d. \mu_{HEIGHT}(Petr)) \geq MAX_2(\lambda d'. \mu_{HEIGHT}(Marie)) \wedge$
- ... pragmatically strengthened to
 $\llbracket equative \rrbracket = MAX_1(\lambda d. \mu_{HEIGHT}(Petr)) = MAX_2(\lambda d'. \mu_{HEIGHT}(Marie)) \wedge$
- $\llbracket dvojnásobně \rrbracket : MAX_1 = 2 * MAX_2$
- (60-b) + (60-c) ... \perp

Back to Czech

- ▶ the contradiction can be avoided if the equative isn't strengthened analogically to examples such as:

- (61) a. The kids dove as deep as their parents (did).
(i) ... Each parent dove 10m deep and their children dove 15m deep.
(ii) #. . . Each child dove 10m deep and their parents dove 15m deep.
- (62) Petr a Marie chodí spolu, ale je to bláznivá dvojice, protože jsou úplně rozdílně vysokí. Je to skoro tak, že Petr je **dvojnásobně** tak vysoký jako Marie.
'Petr and Marie are together, but they are a weird couple, because they are of totally different heights. It's almost as if Petr is twice as tall as Marie.'

Quantification over amounts (N)

- ▶ adjectival degree numerals modify degree nominals

- (63) a. dvojnásobný objem
double volume
'double volume'
- b. dvojnásobný plat
double salary
'double salary'

Events (N) and Social roles (N)

- ▶ adjectival degree numerals modify nominals denoting events

(64) dvojnásobná vražda
double murder
'double murder'

- ▶ adjectival degree numerals modify nominals denoting social roles

(65) dvojnásobný mistr
double champion
'two-time champion'

Contrasts

► contrast 1:

- (66) a. dvojnásobné množství čaje
double amount tea
'double the amount of tea'
- b. *dvojnásobný hrnek čaje
double cup tea
- (67) a. dva hrnky čaje
two cups tea
'two cups of tea'
- b. *dvě množství čaje
two amount tea

► contrast 2:

- (68) a. dvojnásobek rychlosti
double.N speed
'double the speed'
- b. *dvojnásobek mistra
double.N champion
- c. *dvojnásobek sebevraždy
double.N suicide

- contrast 3 (\approx monotonicity constraint as in Schwarzschild 2002):

- (69) a. **Dvojnásobná** rychlost je **dvakrát** větší
double speed is twice bigger
rychlost.
speed
'Double speed is two times higher speed.'
- b. ??**Dvojnásobný** mistr je **dvakrát** větší
double champion is twice bigger
mistr.
champion
- c. ??**Dvojnásobná** sebevražda je **dvakrát** větší
double suicide is twice bigger
sebevražda.
suicide

- ▶ the social role and event readings are mappings – via Rett's Op_e or Op_d which maps entities into degrees (see Rett (2014b) & Rett (2014a)) but the other way round:

- (70) a. Pět piv bylo svrchně kvašených.
five beers was top fermented
'Five beers were top-fermented'
- b. Pět piv bylo pro Karla dost/Karlovi
five beers was for Karel enough/for-Karel
stačilo.
was-enough
'For Karel, five beers were enough'
- (71) Dvojnásobný plat Karlovi stačil.
double salary for-Karel was-enough
'For Karel, double salary was enough'

- ▶ for degree numerals, the degree use is the basic one (unlike for cardinal numerals)

(72) Bratr Čuchraj je idiot a lhář a já
 brother Čuchraj is idiot and liar and I
dvojnásobný idiot...
 double idiot
 'Frater Čuchraj is an idiot and a liar and I am a double idiot...'

- ▶ measure nouns ('double volume') map entities to degrees which the degree numeral quantifies over (\approx Rett's M-OP)

(73) a. M-OP $\rightarrow \lambda P \lambda d \lambda x. P(x) \wedge \mu(x) = d$ attributive
 b. M-OP $\rightarrow \lambda d \lambda x. \mu(x) = d$

Social role interpretation:

- ▶ time trace function (Krifka (1989), Lasersohn (1995)): maps an event to its running time (= the smallest time at which it occurs)
- ▶ *dvojnásobný mistr* 'two-time champion': we map a property P (being a champion) to its running time (the time of being a champion) and the degree numeral quantifies over these running times

- ▶ *dvojnásobně velký* – the dimension (μ) ← the adjective
- ▶ *dvojnásobná délka lana* – the dimension ← the measure noun (μ)
- ▶ event interpretation: *dvojnásobná vražda* ‘double murder’ ← mapping between events and entities, the two victims reading is obtained
- ▶ the root quantifies over degrees but doesn’t supply the dimension:
- ▶ the time reading is obtained only for nouns denoting properties which constrained in time (lower-bound) – *champion* or bilaterally bound (*president*)

- (74) a. dvojnásobný mistr (two-time champion) ...
dimension of time (μ ... time)
- b. #dvojnásobný Čech, člověk, pes ‘two-time Czech, human, dog’

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