Coercion: container, portion and measure interpretations of pseudo-partitives

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Main data and question

- 'Mass Ns cannot be directly counted': # *two wines*
  Cardinal Numerical + Mass CN ⇒ Type Mismatch
- How is the type mismatch resolved, if at all?

  CONTEXT: Wine and glasses whose volume provides the measure for the wine.
  Possible interpretations (as a first approximation):

(1) a. John carried two wines to the table.
   - **two wines ⇒ two glasses containing wine**
     counting of actual glasses
     Reason: *carried* lexically selects solid objects for its DO argument denotation.

  b. Phil drank two wines.
   - **two wines ⇒ two portions of wine that fills/would fill some glass twice**
     counting of portions of wine
     Reason: *drink* selects liquids for its DO argument denotation.
     (The glass is some context-determined particular glass or some contextually understood prototypical-sized glass, the wine need not have been the contents of any glass.)

  c. # There are about two wines left in the bottle.
   - **two wines** ⇒ # A MEASURE OF WINE TO THE AMOUNT OF TWO GLASSFULS
     the measure interpretation is not (easily) available

Main data and question

(1c) # There are about two wines left in the bottle.

two wines ⇒ # A MEASURE OF WINE TO THE AMOUNT OF TWO GLASSFULS

- **QUESTION**: Why should the measure interpretation for numerical NPs like *two wines* be either hard to get or not available in some contexts at all?
- This is puzzling for at least two reasons:
  - Cognitive: In a context where some glass can be picked out as a unit of measure, we can easily imagine a situation in which (1c) would be felicitous, we can easily figure out the intended meaning of 'wine to the amount of two glassfuls'. Nonetheless most speakers judge (1c) as odd or unacceptable.
  - Linguistic: Contrary to what would seem to be predicted by the analyses of counting and measuring phrases, and how meaning-shifting operations work in the face of type mismatches.

Main data and question

- Standard assumptions about coercion:
- # *two wines* ⇒ Type Mismatch
  may trigger a coercion operation shifting the mass denotation of *wine* into a count denotation
  - an implicit classifier-like item is added to resolve the type mismatch and restore compositionality:
    $[\![wine]\!] \Rightarrow ((\varnothing_{classifier})\ ([\![wine]\!]))$
  - One natural contextually supplied null classifier is GLASS (OF):
    $[\![wine]\!] \Rightarrow ((\varnothing_{glass})\ ([\![wine]\!]))$
  - *two wines* may be understood as having the same interpretation as the corresponding full pseudo-partitive:
    two wines ≈ *two glasses of wine*
- Individuating ('packaging') of mass CNs via null classifiers semantically corresponds to the semantics of full pseudo-partitives.

Note: For *wine* and *beer*, a subkind shift is far more common: *Two wines were served with dinner: a Malbec and a Sauvignon.* We leave them aside here.

Main data and question

- Common assumption: Full pseudo-partitives like *two glasses of wine* have two or more interpretations, at least one of them concerns the measure of stuff, as in (c) below:

(2) a. John carried *two glasses of wine* to the table. **container**
b. Phil drank *two glasses of wine*. **portion**
c. There are about *two glasses of wine* left in the bottle. **measure**
'a measure of wine to the amount of two glassfuls'

- **Prediction**:
  - If *two wines* may be understood in a given context as having an interpretation akin to the corresponding full pseudo-partitive like *two glasses of wine*, and
  - if *two glasses of wine* has at least three interpretations available

    ⇒ then the same three interpretations should also be available for a coerced interpretation of *two wines*.

- **The prediction is not borne out,** because for *two wines* the measure interpretation is hard to get or unavailable.

Proposal - Key ingredients

- Assumption: Ns like *glass, cup, basket, drawer, truck* that denote containers or might be viewed as a container, and correspondingly pseudo-partitive phrases they form, have three main interpretations: **CONTAINER**, **PORTION** and **MEASURE** (Sutton and Filip, 2017b).
- Two hypotheses concerning their relation:

(H1) The classifier **CONTAINER** and **PORTION** interpretations are the default, captured by the dot type **container • portion**.
It is the denotation of count expressions.

(H2) The classifier **MEASURE** interpretation is derived from the **PORTION** interpretation by means of the function that operates on the meaning sort of the **PORTION** constituent type of the dot type: $\mathfrak{g}$(**portion**) = **measure**.
It is the denotation of mass expressions.

- Key independent supporting argument: The relative ease with which full pseudo-partitives (e.g. *three glasses of wine*) participate in co-predication over their **CONTAINER** and **PORTION** interpretations, but not over their **MEASURE** interpretation.

Proposal - Analysis & Modeling

- Analysis
  - inspired by the analyses of the pseudo-partitive phrase and container nouns in Khrizman et al. (2015); Landman (2016); Partee and Borschev (2012), in particular Landman's *Iceberg Semantics*.
  - dot type (in the sense of Pustejovsky (1993, 1995))
- Modeling
  - Mereological enrichments of TTR (Type Theory with Records) (i.a. Cooper, 2012) for the analysis of the mass/count distinction and of pseudo-partitives based on Sutton and Filip (2016, 2017a) and Filip and Sutton (2017)

Interpretations of pseudo-partitives

Interpretations of pseudo-partitives

- Formal semantic analyses of pseudo-partitives, such as ***two glasses of wine***, ***two kilos of apples*** given by Krifka (1989); Doetjes (1997); Schwarzschild (2002, 2006); Rothstein (2009, 2011); Landman (2016); Khrizman et al. (2015); Partee and Borschev (2012), i.a.
- Question:What is the number and nature of distinct interpretations that pseudo-partitives have, and correspondingly also the container nouns like ***glass, cup, basket, drawer*** that form them?
- Here, we will mainly build on Rothstein's work and on Partee and Borschev.

Interpretations of pseudo-partitives

- Partee and Borschev (2012) distinguish CONTAINER+CONTENTS, CONCRETE PORTION, AD HOC MEASURE, STANDARD MEASURE.
- Khrizman et al. (2015); Landman (2016), also following Rothstein (2009, 2011, 2016, 2017)

Table: The interpretations of ***two glasses of wine***

Interpretation	**Paraphrase**	**C/M**
container	two glasses filled with wine (counting of glasses)	COUNT
contents	two portions of wine, each filling an actual glass	COUNT
free portion	two one-glassful sized portions of wine ('which are/were never in a glass')	COUNT
measure	wine to the amount of two glassfuls	MASS

The measure interpretation is MASS, other interpretations are COUNT.
⇒ We accept this position, however, will not review the arguments here.

Collapsing portion and contents into PORTION

- We assume a three-way distinction: **container, portion, measure**.
- Portion (in our sense) subsumes the **count** meanings of 'contents' and 'free portion' in the sense of Khrizman et al. (2015); Landman (2016).
- Some attested examples of full pseudo-partitives:

(3) a. He turned to reach the two glasses of wine that stood on a bedside table. (BNC)
b. i (*sic.*) should set the record straight with Clayart that two glasses of red wine a day have beneficial health results. [UKWaC]
c. Two glasses of wine is equal to 3 standard drinks of any alcoholic beverage. [UKWaC]

- **container** interpretation (3a): *reach* and *stand* lexically select solid concrete objects as denotations of their DO, so *two glasses of wine* here primarily refers to **glasses**, and counting primarily concerns actual glasses.
- **portion** interpretation (3b): it is the portion of red **wine** measured relative to two glasses that has the beneficial effect on health, the wine need not have been the contents of any actual glass.
- **measure** interpretation (3c): the singular verb form singular verb form in the equative construction signals that the equation concerns the mass meanings of two measures of different alcoholic beverages, one of which is **wine** and their alcoholic content.

Assumption: Three interpretations of pseudo-partitives

Table: *two glasses of wine*

container	two **glasses** filled with wine (counting of actual glasses containing wine)	COUNT
portion	two portions of **wine** (each measured wrt some glass-unit, but not necessarily the contents of any actual glasses)	COUNT
measure	**wine** to the measure of two glassfuls (where ‘glass’ lexicalizes a non-standard extensive measure function)	MASS

- The container interpretation primarily concerns the containers, the actual glasses that are counted.
- The portion and measure interpretations mainly concern the wine and its quantity.

Sortal and relational meanings of ‘container’ nouns:

glass, *cup*, *basket, pot*, *drawer, truck,* ...

Sortal and relational meanings of ‘receptacle’ nouns: *glass*, *cup*, *basket*, *drawer*, *jar, truck, boat*...

- Nouns of this type have a basic **SORTAL** meaning of a concrete container of a certain shape:
  - a non-relational (1-place) P denoting a set of concrete receptacles.
- They systematically shift to classifier-like **RELATIONAL** meanings when they occur in the pseudo-partitive phrase:
  - roughly, a relation between the container or a unit of measure derived from it and the entity-kind of which some *x* contains/fills or could fill it.
- Example: *cup*
  - Basic **SORTAL** meaning: *This **cup** is made of plastic*.
  - **RELATIONAL** (classifier-like) meaning: *There are three **cups** of berries in this pie*.
- The sortal/relational distinction is grammatically relevant: certain constructions clearly distinguish them, whereby sortal nouns do not take arguments, while relational nouns do.
- Different **RELATIONAL** meanings of nouns in the pseudo-partitive phrase are distinguished by their assignment to different syntactic and semantic categories (see e.g., Rothstein (2011); Partee and Borschev (2012).)

Relational meanings

Relational meanings

- Two main perspectives on their derivational nature
- **RELATIONAL** meanings are independent of one another, each directly derived from the basic sortal meaning by a dedicated type-shifting operation: Rothstein (2009, 2011); Khrizman et al. (2015); Landman (2016).
- **RELATIONAL** meanings exhibit varying types of dependencies:
  - A sequence of shifts from concrete container to abstract measure Partee and Borschev (2012).
  - Our proposal:
    – The **CONTAINER** and **PORTION** interpretations are default interpretations, captured by the dot type **container • portion** in the lexical entry of nouns whose shape is container(-like). (H1)

    – The **MEASURE** interpretation is derived from the **PORTION** interpretation by means of the function that operates on the **PORTION** constituent type of the complex dot type: $\mathfrak{g}$(**portion**) = **measure**. (H2)

Relational meanings

- **INDEPENDENCE OF RELATIONAL MEANINGS**
  - classifications of relational meanings:

    —Container+contents and measure (Rothstein, 2009, 2011).

    —Container, contents, portion and measure (Khrizman et al., 2015; Landman, 2016).
  - There is a type-shifting operation (e.g., REL, FUL) for each shifted relational (classifier) meaning.
  - Each type-shifting operation applies directly to the basic **SORTAL** meaning of nouns like *glass*.

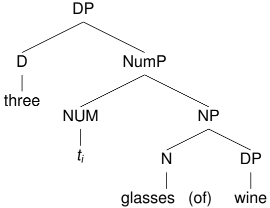
Relational meanings

- Rothstein (2011), similar proposals also in Rothstein (2009, 2016, 2017)
  Pseudo-partitive phrases (her 'classifier phrases') like *three glasses of wine* are two-way ambiguous:
  - **Counting interpretation**:
    - *three glasses of wine* ⇒
      plural objects each of which consists of three individual glasses of wine;
      counting of (reference to) actual glasses containing wine
      'container+contents' semantics
    - count semantics
  - **Measure interpretation**:
    - *three glasses of wine* ⇒
      measures of wine to the amount of three glassfuls;
      the wine need not be in glasses, but its quantity is described using a glass as a unit of measure
    - mass semantics

Relational meanings: Counting versus measuring

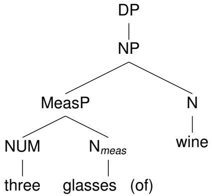
The main semantic split between **CONTAINER+CONTENTS** and **MEASURE** readings is aligned with a two-way syntactic distinction Rothstein (2011, 2016, 2017), and also Partee and Borschev (2012), i.a., Rothstein's (2011) proposal:

CONTAINER+CONTENTS: count semantics



- *glasses* $\langle e, \langle e, t \rangle \rangle$ is the **syntactic head** of the pseudo-partitive, it applies to the predicate *wine* $\langle e \rangle$ denoting what is measured; the numerical *three* $\langle e, t \rangle$ is a modifier giving the cardinality of the plural entities in the denotation of the NP *glasses of wine* $\langle e, t \rangle$ that it modifies.

MEASURE: mass semantics



- *wine* $\langle e, t \rangle$ is the **syntactic** and **semantic head** of the pseudo-partitive, which is semantically mass; *glasses* $\langle n, \langle e, t \rangle \rangle$ combines with *three* $\langle n \rangle$ to form the MeasP *three glasses* $\langle e, t \rangle$ (meaning of an intersective P) which applies to the nominal head *wine* $\langle e, t \rangle$.

Count ‘Container+Contents’ interpretation: REL operation on ‘receptacle’ concepts (Rothstein, 2011)

- The ‘container+contents’ interpretation of *glass*, as in *three glasses of wine* (where *glass* is the syntactic head), requires that it shift from its basic sortal meaning into the relational meaning of type $\langle e, \langle e, t \rangle \rangle$ in order to combine with *wine*, which is its argument of type $\langle e \rangle$ (kind-denoting).
- The type-shifting operation REL (adapted from Rothstein (2011)):

$$
\begin{aligned}
[\![\text{glasses}]\!] &= \lambda x.\exists X \subseteq {}^{*}\text{GLASS} : x = \sqcup X \\
[\![\text{glasses of wine}]\!] &= (\text{REL}([\![\text{glasses}]\!]))([\![\text{wine}]\!]) \\
&= (\lambda z.\lambda x.\exists y.\exists X \subseteq {}^{*}\text{GLASS} : x = \sqcup X \\
&\qquad \wedge \text{CONTAIN}(x, y) \wedge y \in {}^{\cup}z)\ (\textbf{wine}) \\
&= \lambda x.\exists y.\exists X \subseteq {}^{*}\text{GLASS} : x = \sqcup X \\
&\qquad \wedge \text{CONTAIN}(x, y) \wedge y \in {}^{\cup}\textbf{wine} \\
[\![\text{three glasses of wine}]\!] &= \lambda x.\exists y.\exists X \subseteq {}^{*}\text{GLASS} : x = \sqcup X \\
&\qquad \wedge \text{CONTAIN}(x, y) \wedge y \in {}^{\cup}\textbf{wine} \wedge \text{CARD}(x) = 3
\end{aligned}
$$

wine denotes a kind; $^{\cup}$**wine** denotes a predicate (Chierchia’s $^{\cup}$ operation shifts a kind-denoting expression to a predicate interpretation); $^{*}X$ indicates the upward closure of the set X under mereological sum; $\sqcup X$ is the (sum) entity that is the supremum of the set X.

Measure interpretation: FUL operation on receptacle concepts (Rothstein, 2011)

- *Glass*, as in *three glasses of wine*, first combines with the numerical *three* to form the MeasP *three glasses* of type $\langle e, t\rangle$ which applies to *wine* $\langle e, t\rangle$ (the syntactic head of the pseudo-partitive). This requires that *glass* shift from its basic sortal meaning into the measure property: type $\langle n, \langle e, t\rangle\rangle$, taking a numerical as argument and returning the value *n* glasses on the scale of volume.

- The type-shifting operation FUL is introduced explicitly by *-ful* or by its null correlate. (The definition below is based on formulas in Rothstein (2011)):

$$[\![\text{-ful}]\!] = [\![\varnothing_{ful}]\!] = \text{FUL} = \lambda P.\lambda n.\lambda x.\text{MEAS}_{\text{volume}}(x) = \langle P, n\rangle$$

$$[\![\text{three glasses}]\!] = \lambda x.\text{MEAS}_{\text{volume}}(x) = \langle \text{GLASS}, 3\rangle$$

$$[\![\text{three glasses of wine}]\!] = \lambda x.x \in {}^{\cup}\textbf{wine} \wedge \text{MEAS}_{\text{volume}}(x) = \langle \text{GLASS}, 3\rangle$$

- The measure meaning of *glass* is analogous to that of measure nouns:

$$[\![\text{LITER}]\!] = \lambda n.\lambda x.\text{MEAS}_{\text{volume}}(x) = \langle \text{LITER}, n\rangle$$

$$[\![\text{three liters}]\!] = \lambda x.\text{MEAS}_{\text{volume}}(x) = \langle \text{LITER}, 3\rangle$$

Relational meanings

- Partee and Borschev (2012):
  - Meaning-shifting operators produce consecutive meanings:

    sortal meaning (concrete 'receptacle') > **CONTAINER+CONTENTS** > **CONCRETE PORTION** > **(AD HOC) MEASURE** > lexicalized **STANDARD MEASURE**

    The sequence of four meaning-shifts reflects the order of historical development of senses of container nouns.
- The four meaning-shifts apply quite **productively** to container nouns (cf. *For this trip we will need two tankfuls of gasoline*), except for the final step of lexicalization which applies only to some nouns like *cup, teaspoon* in English.
- Only the first shift from the sortal concrete container meaning to the relational **CONTAINER+CONTENTS** meaning is strictly speaking a **type-shift** involving a function that applies to one meaning to give the next; the other shifts 'tweak' the meanings in small incremental steps.
- "the Container+Contents reading should in principle be analyzed as a **dotted type** reading with reference to both container and contents. (...) But we have no proposals to offer."
  – The possibility of a dot type analysis also suggested by Duek and Brasoveanu (2015), but no formal analysis provided.

Relational meanings: Our proposal

- **dot type container • portion and meaning shifts**
  - **container • portion** analysis of ‘receptacle’ nouns suggested by Peter Sutton, independently of Partee and Borschev (2012) and Duek and Brasoveanu (2015)
- Dot type predicates can refer simultaneously to the **CONTAINER** and **PORTION** contained in it.
  - *Mary put the **packet** of rice into the boiling pot.*
  - **container • portion**: *packet*
- The **CONTAINER** and **PORTION** constituent types are distinguished by
  - different selectional restrictions
  - different anaphoric possibilities.
- Pustejovsky (1993, 1995) introduced a dot type to represent the meaning of an expression that simultaneously incorporates two distinct sorts. Co-predication examples: e.g., *book* is of dot type **phys • info**, standing for its ‘physical object’ and ‘informational object’ meaning sorts.
  - *Amy picked up and read a book*.
    – *pick up* selects a ‘physical object’ sort **phys**
    – *read* selects ‘informational print matter’, so directly the dot type sort **phys • info**

Relational meanings: Our proposal

- Two hypotheses concerning the interpretation of Ns like *glass* that form a pseudo-partitive phrase:

(H1) The classifier **CONTAINER** and **PORTION** interpretations are the default, captured by the dot type **container • portion**.
It is the denotation of count expressions.

(H2) The classifier **MEASURE** interpretation is derived from the **PORTION** interpretation by means of the function that operates on the meaning sort of the **PORTION** constituent type of the dot type: $\mathfrak{g}$(**portion**) = **measure**.
It is the denotation of mass expressions.

Motivation for H1: **container $\bullet$ portion** type

Intuitive motivation for H1: **container • portion** type

- Lexicographic practice: a part of the OED's lexical entry for *glass*:
  - "4.a. A glass vessel or receptacle. Also, the contents of the vessel.
  - 5. A drinking-vessel made of glass; hence, the liquor contained, and (fig.) drink."
- The **CONTAINER** and **PORTION** (contents of the container) senses of *glass* are treated as its two related (polysemous) senses.
- The **MEASURE** sense is NOT a part of its lexical entry. It is derived 'on the fly' via a meaning shift. This holds for the senses of most 'receptacle' Ns.
- Some 'receptacle' nouns have the **MEASURE** meaning which has become lexicalized as a standard measure; it is listed in their lexicon entry along with their basic sortal meaning and other relational meanings:
  - *cup* (US English) has a lexicalized standard measure meaning a part of the Merriam Webster's lexical entry for *cup*
    - "1 : an open usually bowl-shaped drinking vessel (...)
    - 7 : a half pint : eight fluid ounces." (= 250 ml - 8 fl. oz)
- There are also standard measures, such as *pint* (British English), which shifted to and have become lexicalized as container/portion relational concepts.

Empirical evidence for H1: **container • portion** type

(H1) The CONTAINER and PORTION interpretations are default interpretations, captured by the dot type **container • portion**.

Evidence from co-predication I: Container and portion meanings

- The **container** (C) and **portion** (P) interpretations of pseudo-partitives like *two glasses of wine* easily allow co-predication on the same object:

(4) The two glasses of wine with tall, thin stems are being drunk by Rachel and Matt. (C-P)

(5) Loretta and Fiona are drinking the two glasses of wine with tall, thin stems. (P-C)

- This can be motivated if we assume that a noun like *glass* that forms the pseudo-partitive has simultaneously accessible the **container** (C) and **portion** (P) interpretation, i.e., is of dot type **container • portion**.

Motivation for H2: $\mathfrak{g}(\textbf{portion}) = \textbf{measure}$

Empirical evidence for H2: $\mathfrak{g}$(**portion**) $=$ **measure**

(H2) The **MEASURE** interpretation is derived from the **PORTION** interpretation.

- *Derived ...*
  - Recall the common sense assumption, reflected in lexicographic practice: The concrete container and portion interpretations are taken to be two (polysemous) senses of 'receptacle' nouns. For most 'receptacle' nouns, the measure interpretation is not listed in their lexical entries.
- *... from the* **PORTION** *interpretation:*
  - The **PORTION** interpretation of nouns like *glass* is a quantity of substance that it can contain (but the substance in question need not be actually in it); its container property assumes the function of a unit of measure.
  - Proposed **measure** paraphrase:
    three glasses of wine $\approx$ *wine that measures 3 with respect to a scale on which one glass-sized portion of wine measures 1.*
- Some function $\mathfrak{g}$ such that $\mathfrak{g}$(**portion**) $=$ **measure**
  - Formal details to follow.

Empirical evidence for H2: $\mathfrak{g}$(**portion**) = **measure**

(H2) The **MEASURE** interpretation is derived from the **PORTION** interpretation: $\mathfrak{g}$(**portion**) = **measure**.

Evidence from co-predication II: Portion and measure meanings

- Co-predications over the **portion** (P) and **measure** (M) interpretations of pseudo-partitives like *two glasses of wine* are accepted only by some speakers, while others find them less than fully felicitous.

(6) (#) The two glasses of wine with a sour flavour were the last two in the bottle from two days ago. (P-M)

(7) (#) The last two glasses of wine in the bottle were drunk by Carl at lunch and Harry at dinner. (M-P)

- This behavior of pseudo-partitives like *two glasses of wine* can be motivated, if we assume
  - that $\mathfrak{g}$ operates on the **PORTION** constituent type of the complex dot type $\mathfrak{g}$(**portion**) = **measure** of *glass*, which
  - requires that both the mass (**measure**) and the count (**portion**) interpretation of the pseudo-partitive be simultaneously accessible in the same context, which may be cognitively burdensome for some speakers.

Empirical evidence for H2: $\mathfrak{g}$(**portion**) $=$ **measure**

Evidence from co-predication III: Container and measure meanings

- Co-predications over the **container** (C) and **measure** (M) interpretations of pseudo-partitives like *two glasses of wine* are odd, or unacceptable to some speakers at least.

(8) # The two glasses of wine with tall, thin stems were the last two left in the bottle. (C-M)

(9) # The last two glasses of wine in the bottle have thin stems. (M-C)

- This behavior follows from our two hypotheses for the meanings of nouns like *glass*:
  - As a result of $\mathfrak{g}$(**portion**) $=$ **measure** (H2), the type-shifting operation to the **measure** interpretation,
  - the **container** interpretation (corresponding to the **container** constituent type of the dot type **container • portion** (H1) 'disappears', and is no longer accessible for co-predication.

Interim summary

- The data and hypotheses so far suggest the following partial order for felicity of combinations of meanings of nouns like *glass*, and corresponding pseudo-partitives, in co-predications:

Most Felicitous				Least Felicitous
C-P P-C	>	M-P P-M	>	C-M M-C

- The **container** (C) and **portion** (P) are constituent types of a complex dot type **container • portion** of nouns like *glass* (H1)
  - easily accessible for co-predication
- If $\mathfrak{g}$(**portion**) $=$ **measure** (H2), we can motivate why some, but not all, speakers may be able to reconstruct **portion** (P) from **measure** (M) for co-predications.
- If $\mathfrak{g}$(**portion**) $=$ **measure** (H2), we can motivate why the meaning shift to **measure** (M) blocks access to **container** (C) in co-predications.
- It is unclear how the above insights regarding co-predication could be captured by accounts that derive all the relational meanings of nouns like *glass, cup, jar* by mutually independent type-shifting functions that are directly applied to their basic sortal meanings (Rothstein, 2009, 2011; Khrizman et al., 2015; Landman, 2016).

Main proposal idea

Main proposal idea

- Main puzzle (recall): The **MEASURE** interpretation of numerical NPs like *two wines* is generally difficult to get, while the **CONTAINER** and **PORTION** straightforwardly available (via coercion).

(10) a. John carried two wines to the table. **CONTAINER**

b. Phil drank two wines. **PORTION**

c. # There are about two wines left in the bottle. **MEASURE**

Main proposal idea

(11) a. John carried two wines to the table. CONTAINER
b. Phil drank two wines. PORTION
c. # There are about two wines left in the bottle. MEASURE

- **Acceptability** of the CONTAINER and PORTION meaning in (a) and (b) straightforwardly follows from H1 and a coercion operation:
  - The mismatch between *two* and *wine* triggers a coercion operation that adds an implicit contextually-determined classifier item to resolve the type mismatch and restore compositionality:
    $[\![wine]\!] \Rightarrow ((\varnothing_{classifier}) ([\![wine]\!]))$.
  - Suppose GLASS (OF) is the requisite null classifier:
    $[\![wine]\!] \Rightarrow ((\varnothing_{glass}) ([\![wine]\!]))$.
  - *Glass* is of dot type **container • portion** (count), following H1, and so is its null classifier correlate $\varnothing_{glass}$.
  - The verb *carry* and *drink* each selects a different subcomponent of the null classifier type $\varnothing_{glass}$: *carry* selects the CONTAINER and *drink* the PORTION, both of which are count. The type mismatch is predicted to be easily resolved.

Main proposal idea

(12) a. John carried two wines to the table. **CONTAINER**
b. Phil drank two wines. **PORTION**
c. # There are about two wines left in the bottle. **MEASURE**

- **Previous accounts**: It is unclear how the **unacceptability/oddity** of the mass **MEASURE** meaning could be motivated on accounts which derive the relational **MEASURE** meaning of nouns like *glass* directly from their basic **SORTAL** meaning (Rothstein, 2009, 2011; Khrizman et al., 2015; Landman, 2016):
  - The mismatch between *two* and *wine* would trigger a coercion operation which, based on some implicit contextually-determined glass and the requisite measure type-shifting operation, would add the null MEASURE CLASSIFIER meaning, akin to something like ($\varnothing_{glass-measure}$), to the logical representation and restore compositionality.
  - Consequently, (c) would seem to be predicted to be acceptable.

Main proposal idea

(13) a. John carried two wines to the table. CONTAINER
b. Phil drank two wines. PORTION
c. # There are about two wines left in the bottle. MEASURE

- The **unacceptability/oddity** of the MEASURE meaning in (c) follows, assuming our H1+H2:
- they predict that there is no shifting operation available for *wine* to shift it to the right interpretation so that for *two wines* the intended measure meaning of 'wine to the amount of two glassfuls' could be derived.
- The putative meaning shift would have to involve two meaning shifts ...

Main proposal idea

- Context: salient glasses

  # There are about two wines left in the bottle. **MEASURE**

- First shift (coercion): to the **PORTION** meaning, exploiting the dot type **container • portion** (H1), and given that $\mathfrak{g}$(**portion**) = **measure** (H2). The shifted **PORTION** meaning involves the null classifier meaning $\varnothing_{\textbf{glass-portion}}$: 'two portions of wine, each (could) fill an IMPLICIT GLASS'.
- Second shift: to the intended **MEASURE** meaning 'wine to the amount of two glassfuls'. Problem:
  - not a coercion operation, there is no triggering type mismatch between an overt functor and its overt argument.
  - the function $\mathfrak{g}$ would have take the meaning of the null portion classifier $\varnothing_{\textbf{glass-portion}}$ and transform it to the measure meaning which corresponds to the null measure classifier $\varnothing_{\textbf{glass-measure}}$.

    ⇒ Meaning shifting operations do not seem to operate over implicit meaningful material that is recovered from context to repair a type mismatch.
- There is no shifting operation available for *wine* to shift to the right interpretation so that *two wines* could be analyzed in terms of 'wine to the amount of two glassfuls'.

Summary

There are about two wines left in the bottle.

- Motivation for the oddity cannot depend on the speculation that an interpretation process leading to the intended meaning of 'wine to the amount of two glassfuls' is too cognitively burdensome. We can easily construe what the intended meaning might be in a suitable context.

- The constraints that motivate the unacceptability of the above sentence, what blocks the successful reference to the intended quantity of wine, are basically linguistic, semantic:

  – lexical semantics with types enriched with a dot type

  – type-shifting operations

  – a grammaticized lexical mass/count distinction*

  Louise McNally's introduction to the *Formal Ontology* panel: the relevant constraints lie in 'pure' semantics neither intersected with syntax nor with psychology/philosophy (cognitive semantics)?

*It is unclear how could accounts, such as Pelletier (2012) and Borer (2005), that assume that English has no grammaticized lexical mass/count distinction account for constraints on admissible mass-to-count shifts, including the unacceptability of sentences like # *There are about two wines left in the bottle*.

Summary (continued)

- Ontology of dot types?
  - The mereological status of the pair-conception of objects of complex type is unclear (Asher 2011 finds such a conception “flawed”). The sum of two entities formed by means of a special coincidence relation?
  - Not everything that might be used as a container can belong to the sort **container**: *# a safe of documents* (Partee and Borschev 2012); the constraints on what could be a predicate of dot type **container • portion** will lie at the intersection of the lexicon with other sorts of knowledge we bring to bear on the properties associated with containers and their contents (metaphysics of containers and their contents).
- Adequate formal implementation ?
  (Partee and Borschev, 2012) “the Container+Contents reading should in principle be analyzed as a **dotted type** reading with reference to both container and contents.
  (...) Formalizing such a reading requires a theory of the semantics of dotted types.
  (...) (Asher 2008) looks like it could in principle solve our problem
  (...) But because the formalism goes considerably beyond simple type theory, we will not try to implement it.
  (...) a new sort of multi-dimensionality in syntactic-semantic analysis [needed]. But we have no proposals to offer.”

Formal implementation

Mereology cum TTR

Sources of inspiration:

- Type theory with records (TTR)
- Other frame semantics (Fillmore, 1976; Barsalou, 1992; Löbner, 2014)
- Landman's *Iceberg Semantics* ($\langle$**body**, **base**$\rangle$)

Why a different formalism:

- Simpler than TTR, but retains ability to represent dot types
- Like TTR, retains Montague-style compositional semantics (other frame semantics lose this)
- Ability to represent richer lexical structures than Landman's *Iceberg Semantics*.

Standard features:

- functional types formed from basic types e, t, w, n, d (n for numbers, d for dimensions (e.g. volume))
- typed variables and constants, λ-abstraction

Non-standard features:

- Propositions are frames (sets of (recursive) labelled fields)

  Example:

$$[\![\text{n}]\!] = \lambda x. \begin{bmatrix} \text{cbase} & = & \lambda y.P(y) \\ \text{ext} & = & {}^*P(x) \end{bmatrix}$$

  - Set of Ps or sums of Ps individuated in terms of the property $\lambda y.P(y)$.
  - Of type $\langle ef \rangle$ with f a basic type for *frame*

- Modification can be done on specific fields (parts of a frame)
  - Labels can be used to refer to properties or propositions in frames:

$$\text{cbase}([\![\text{n}]\!](x)) \leftrightarrow \lambda y.P(y)_{:\langle et \rangle}$$
$$\text{ext}([\![\text{n}]\!](x)) \leftrightarrow {}^*P(x)_{:t}$$

Sutton & Filip's account of the mass/count distinction

Expression	Type	Description
glass, wine, ...	$\langle et \rangle$	Predicates. Stand-ins for e.g., bundle of perceptual, functional, and topological properties
$\mathcal{O}$	$\langle et, et \rangle$	Object unit function: A function from predicates to predicate for entities that can count as 'one'
$\mathcal{S}_{i>0} \in \mathbb{S}$	$\langle et, et \rangle$	Individuation Schema: A function from predicates P to predicate with an extension that is a maximally disjoint wrt the extension of P
$\mathcal{S}_0 \in \mathbb{S}$	$\langle et, et \rangle$	The Null Individuation Schema: The identity function. More formally: $\mathcal{S}_0(P) = \bigcup_{\mathcal{S}_{i>0} \in \mathbb{S}} \mathcal{S}_i(P)$)

Inspirations and origins:

- $\mathcal{O}$: Landman's (2011) generator sets, Krifka's (1995) OU function
- $\mathcal{S}_{i>0}$: Landman's (2011) variants, Rothstein's (2010) default counting contexts
- $\mathcal{S}_0$: Landman's (2011) contexts for object mass nouns
- The context sensitivity of individuation: (Chierchia, 2010; Rothstein, 2010)
- (More in our work with TTR) mereotopological properties in a theory of individuation (Grimm, 2012)

Expression	Type	Description
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Examples:

$$[\![\text{glasses}]\!]^{\mathcal{S}_i} = [\![\text{glasses}]\!](\mathcal{S}_i) = \lambda s.\lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.s(\mathcal{O}(glass))(y) \\ \text{ext} & = & {}^{*}s(\mathcal{O}(glass))(x) \end{bmatrix}(\mathcal{S}_i)$$

Set of individual glasses/sums of individual glasses under schema $\mathcal{S}_i$. Disjoint counting base. Quantized extension.

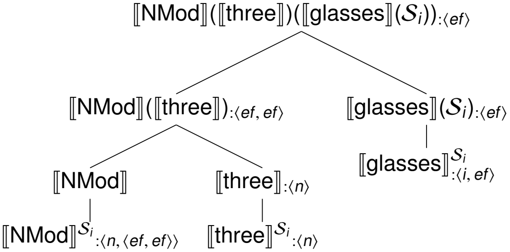
$$[\![\text{wine}]\!]^{\mathcal{S}_i} = [\![\text{wine}]\!] = \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.\mathcal{S}_0(wine)(y) \\ \text{ext} & = & \mathcal{S}_0(wine)(x) \end{bmatrix}$$

Set of all possible partitions of wine. Overlapping counting base. Cumulative extension.

$$[\![\text{furniture}]\!]^{\mathcal{S}_i} = [\![\text{furniture}]\!] = \lambda x.\begin{bmatrix} \text{cbase} & = & \lambda y.\mathcal{S}_0(\mathcal{O}(furniture))(y) \\ \text{ext} & = & {}^{*}\mathcal{S}_0(\mathcal{O}(furniture))(x) \end{bmatrix}$$

Set of pieces of furniture and sums thereof. Overlapping counting base. Cumulative extension.

Three glasses



- NMod shifts numeral to adjective (amo Landman, 2004)
- $\mathcal{S}_i$ only impacts interpretation of *glasses*
- i := type for individuation schema, abbreviates $\langle et, et\rangle$

$$
\begin{aligned}
&[\![\text{three glasses}]\!]^{\mathcal{S}_i}\\
&= [\![\text{NMod}]\!]^{\mathcal{S}_i}([\![\text{three}]\!]^{\mathcal{S}_i})([\![\text{glasses}]\!]^{\mathcal{S}_i})\\
&= [\![\text{NMod}]\!]([\![\text{three}]\!])([\![\text{glasses}]\!](\mathcal{S}_i))\\
&= \lambda F.\lambda x.\begin{bmatrix}\text{cbase} & = \text{cbase}(F(x))\\ \text{ext} & = \text{ext}(F(x))\\ \text{restr} & = \mu_{card}(x, cbase(F(x)), 3)\end{bmatrix}\left(\lambda x.\begin{bmatrix}\text{cbase} & = \lambda y.\mathcal{S}_i(\mathcal{O}(glass))(y)\\ \text{ext} & = {}^*\mathcal{S}_i(\mathcal{O}(glass))(x)\end{bmatrix}\right)\\
&= \lambda x.\begin{bmatrix}\text{cbase} & = \lambda y.\mathcal{S}_i(\mathcal{O}(glass))(y)\\ \text{ext} & = {}^*\mathcal{S}_i(\mathcal{O}(glass))(x)\\ restr & = \mu_{card}(x, \lambda y.\mathcal{S}_i(\mathcal{O}(glass))(y), 3)\end{bmatrix}
\end{aligned}
$$

A set of sums of individual glasses that have cardinality 3 wrt the property $\lambda y.\mathcal{S}_i(\mathcal{O}(glass))(y)$

Dot types

Inspired by Cooper's (2011) treatment in TTR

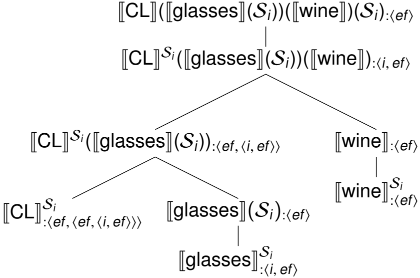
- TTR approach is close to Asher's (2011) proposal
- Asher's approach recommended by (but not implemented in) Partee and Borschev (2012)

$$\lambda x. \begin{bmatrix} \text{cntnr} & = & \begin{bmatrix} \text{cbase} & = & \lambda y.P(y) \\ \text{ext} & = & P(x) \end{bmatrix} \\ \text{prtn} & = & \begin{bmatrix} \text{cbase} & = & \lambda y.Q(y) \\ \text{ext} & = & Q(x) \end{bmatrix} \end{bmatrix}$$

Requires some leeway with the type for *x* (here, no details about the requisite rich type theory)

- *x* is a container/portion...
  - ...with the container aspect represented in the *cntnr* field
  - ...with the portion aspect represented in the *prtn* field

glasses of wine (container and portion)



- CL derives a relational **container • portion** concept
- $[\![\mathrm{CL}]\!]^{\mathcal{S}_i}([\![\mathrm{glasses}]\!])$ could be stored as a discrete sense
- $\mathcal{S}_i$ ensures apportioning of contained stuff

$$[\![\mathrm{CL}]\!]^{\mathcal{S}_i} = \lambda F.\lambda G.\lambda s.\lambda x.$$

$$\begin{bmatrix} \mathrm{cntnr} = \begin{bmatrix} \mathrm{cbase} = \mathrm{cbase}(F(x)) \\ \mathrm{ext} = \mathrm{ext}(F(x)) \\ \mathrm{restr} = \forall y \exists z.[y \sqsubseteq x \wedge \mathrm{cbase}(F(x))(y) \rightarrow \mathrm{ext}(G(z)) \wedge \mathit{contain}(y, z)] \end{bmatrix} \\ \mathrm{prtn} = \begin{bmatrix} \mathrm{cbase} = \lambda y.s(\mathrm{cbase}(G(x)))(y) \\ \mathrm{ext} = \lambda y.^{*}s(\mathrm{ext}(G(y)))(x) \\ \mathrm{restr} = \forall y.\exists w.\exists z.[y \sqsubseteq x \wedge \mathrm{cbase}(G(x))(y) \rightarrow \\ \qquad \mathrm{cbase}(F(x))(z)(w) \wedge \mathit{contain}(z, y)(w)] \end{bmatrix} \end{bmatrix}$$

Container: E.g., glasses (F) containing wine (G)
Portion: E.g., portions of wine (G) at $\mathcal{S}_i$, that could each be contained in a glass (F).

$$[\![\mathrm{CL}]\!]^{\mathcal{S}_i}([\![\mathrm{glasses}]\!]^{\mathcal{S}_i})([\![\mathrm{wine}]\!]^{\mathcal{S}_i}) = [\![\mathrm{CL}]\!]([\![\mathrm{glasses}]\!](\mathcal{S}_i))([\![\mathrm{wine}]\!])(\mathcal{S}_i) =$$

$$\lambda x.\begin{bmatrix} \mathrm{cntnr} = \begin{bmatrix} \mathrm{cbase} = \lambda y.\mathcal{S}_i(\mathcal{O}(glass))(y) \\ \mathrm{ext} \quad = \mathcal{S}_i(\mathcal{O}(glass))(x) \\ \mathrm{restr} \quad = \forall y \exists z.[y \sqsubseteq x \wedge \mathcal{S}_i(\mathcal{O}(glass))(y) \\ \qquad \rightarrow \mathcal{S}_0(wine)(z) \wedge contain(y,z)] \end{bmatrix} \\ \mathrm{prtn} = \begin{bmatrix} \mathrm{cbase} = \lambda y.\mathcal{S}_i(wine)(y) \\ \mathrm{ext} \quad = {}^*\mathcal{S}_i(wine)(x) \\ \mathrm{restr} \quad = \forall y.\exists w.\exists z.[y \sqsubseteq x \wedge \mathcal{S}_i(wine)(y) \\ \qquad \rightarrow \mathcal{S}_i(\mathcal{O}(glass))(z)(w) \wedge contain(z,y)(w)] \end{bmatrix} \end{bmatrix}$$

Container:	Sums of/single individual glasses containing wine Disjoint cbase. Quantized ext.
Portion:	Portions of wine (wine partitioned by $\mathcal{S}_i$) that could each be contained in a glass. Disjoint cbase. Quantized ext.
Contents:	Portions of wine (wine partitioned by $\mathcal{S}_i$) that are actually contained in a glass ($w = w_0$). Disjoint cbase. Quantized ext.

three glasses of wine (container and portion)

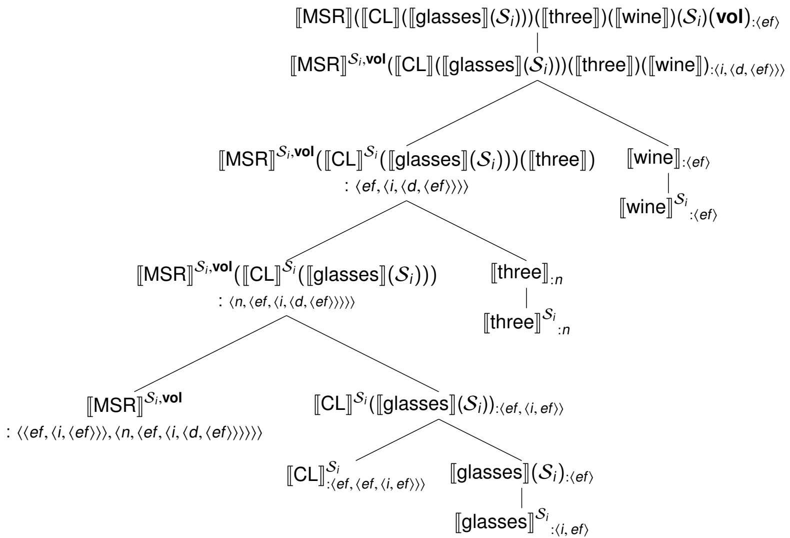
$$[\![\text{NMod}]\!]([\![\text{three}]\!])([\![\text{CL}]\!]([\![\text{glasses}]\!](\mathcal{S}_i))([\![\text{wine}]\!])(\mathcal{S}_i)) =$$

$$\lambda x.\begin{bmatrix} \text{cntnr} = \begin{bmatrix} \text{cbase} = \lambda y.\mathcal{S}_i(\mathcal{O}(\textit{glass}))(y) \\ \text{ext} \quad = \mathcal{S}_i(\mathcal{O}(\textit{glass}))(x) \\ \text{restr} \quad = \forall y \exists z.[y \sqsubseteq x \wedge \mathcal{S}_i(\mathcal{O}(\textit{glass}))(y) \\ \qquad \rightarrow \textit{ext}(G(z)) \wedge \textit{contain}(y,z)] \\ \text{restr}_2 = \mu_{card}(x, \lambda y.\mathcal{S}_i(\mathcal{O}(\textit{glass}))(y), 3) \end{bmatrix} \\ \text{prtn} = \begin{bmatrix} \text{cbase} = \lambda y.\mathcal{S}_i(\textit{wine})(y) \\ \text{ext} \quad = {}^*\mathcal{S}_i(\textit{wine})(x) \\ \text{restr} \quad = \forall y \exists w.\exists z.[y \sqsubseteq x \wedge \mathcal{S}_i(\textit{wine})(y) \\ \qquad \rightarrow \mathcal{S}_i(\mathcal{O}(\textit{glass}))(z)(w) \wedge \textit{contain}(z,y)(w)] \\ \text{restr}_2 = \mu_{card}(x, \lambda y.\mathcal{S}_i(\textit{wine})(y), 3) \end{bmatrix} \end{bmatrix}$$

From now on:

Abbreviate cntnr.restr and portn.restr to **contain**(*glass*, *wine*)

three glasses of wine (measure)



Compatible with, but does not presuppose, the syntactic analysis of Rothstein

$[\![\text{MSR}]\!]^{\mathcal{S}_i,\textbf{vol}}$

$$= \lambda\mathcal{F}.\lambda n.\lambda G.\lambda s.\lambda d.\lambda x.\begin{bmatrix} \text{cbase} = \text{cbase}(G(x)) \\ \text{ext} \quad = \mathit{ext}(G(x)) \\ \text{restr} \quad = \mu(x, d, \lambda z.\text{prtn}(\mathcal{F}(G))(z)(s), n) \end{bmatrix}$$

$[\![\text{MSR}]\!]([\![\text{CL}]\!]([\![\text{glasses}]\!](\mathcal{S}_i)))([\![\text{three}]\!])([\![\text{wine}]\!])(\mathcal{S}_i)(\textbf{vol})$

$$= \lambda x.\begin{bmatrix} \text{cbase} = \lambda y.\mathcal{S}_0(\mathit{wine})(y) \\ \text{ext} \quad = \mathcal{S}_0(\mathit{wine})(x) \\ \text{restr} \quad = \mu(x, \textbf{vol}, \lambda z.\begin{bmatrix} \text{cbase} = \lambda y.\mathcal{S}_i(\mathit{wine})(y) \\ \text{ext} \quad = {}^{*}\mathcal{S}_i(\mathit{wine})(z) \\ \text{restr} \quad = \textbf{contain}(\mathit{glass}, \mathit{wine}) \end{bmatrix}, 3) \end{bmatrix}$$

Set of amounts of wine that measure 3 with respect to volume, and the property of being a glass-sized portion.
– Overlapping counting base.
– Quantized extension.

Summary: Interpretations for receptacle Ns in p-p NPs

Interpretation	Lexically encoded	Countability
Container (C)	Yes: dot type with (P)	Count
Portion (P)	Yes dot type with (C)	
Free portion	◦ container at some possible world	Count
Contents	◦ container at the actual world	Count
Measure (M)	No: derived, via MSR, from (P)	Mass

Felicity patterns in co-predication

Most Felicitous				Least Felicitous
C-P P-C	>	M-P P-M	>	C-M M-C

Explanation: Resolving Type Mismatches

Type mismatches between CD (cardinal determiner) and Mass N are resolved by retrieving a **container • portion** concept from the context

- Type mismatches: CD + Mass N
- Agents must coerce the Mass N into a Count N interpretation.
  - Requires supplying additional relational concept that is salient or conventional (e.g. **container • portion** concept for *glass*).
- Type mismatches are resolved by shifting to a **container • portion** interpretation

Shifting **container • portion** to **measure** would CREATE A CLASH!

- Standard interpretation for [NP [CD] [N]] is to shift CD to an adjective (e.g. ⟦NMod⟧(⟦three⟧)).
- Expression like ⟦MSR⟧(⟦CL⟧)(⟦glass(es)⟧) is NOT of the right type to combine with an adjectival numerical.

Accessibility hierarchy (coercion case)

⟦three⟧ ⟦wines⟧

TYPE CLASH

Apply
NMod to ⟦three⟧

ENUMERATE KINDS
Type clash resolved
See: Sutton and Filip (2017b)

Retrieve **container • portion** relational
concept from the context.
Apply to the meaning of *wines*

↓

⟦CL⟧(⟦glasses⟧($\mathcal{S}_i$))(⟦wine⟧)($\mathcal{S}_i$)
CONTAINER/PORTION interpretation
Type clash resolved

NO TYPE CLASH

↓

Retrieve and apply MSR to
an implicit relational concept of type
container • portion.

CREATES TYPE CLASH

measure is the wrong type
to combine with NMod(⟦three⟧)

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