University of
South Australia

MULTI‘24 Warehouse Challenge: Modelling a Warehouse with the Multi-Level Modelling Framework - SLICER

Yuhong Fu, Matt Selway, Georg Grossmann, Karamjit Kaur, Markus Stumptner

Industrial AI Research Centre, University of South Australia

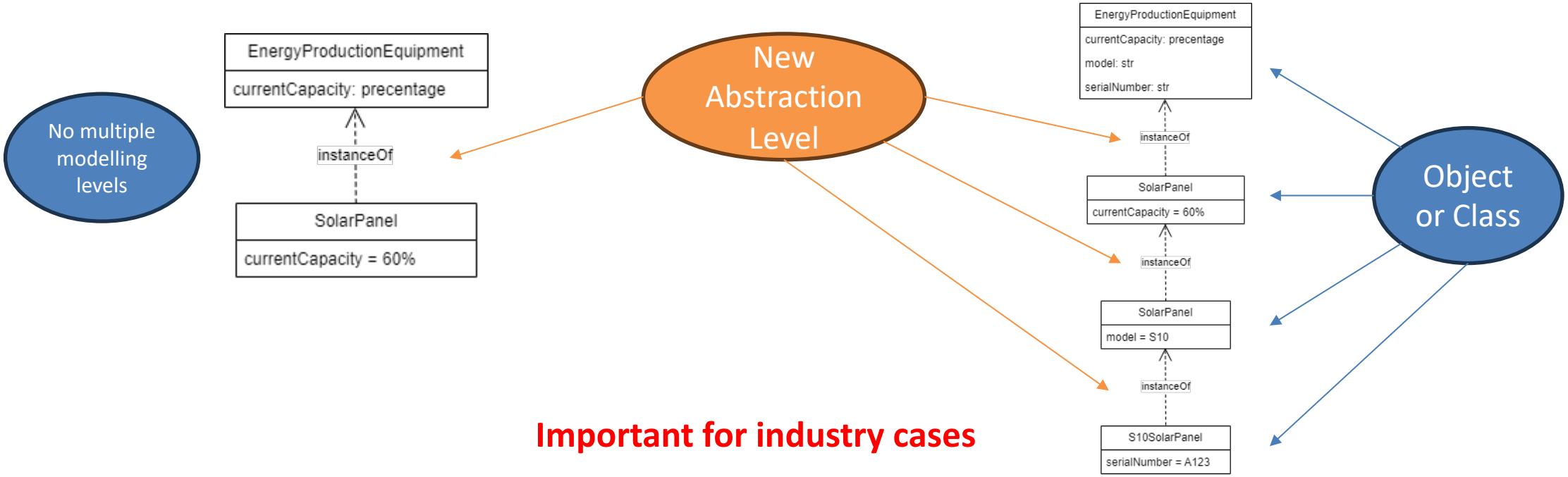
Presentation Outline

- Background
- SLICER
- Warehouse Model
- Demonstration

Background – Multi-Level Modelling

Traditional Modelling Approaches (e.g. UML)

Multi-Level Modelling Approaches



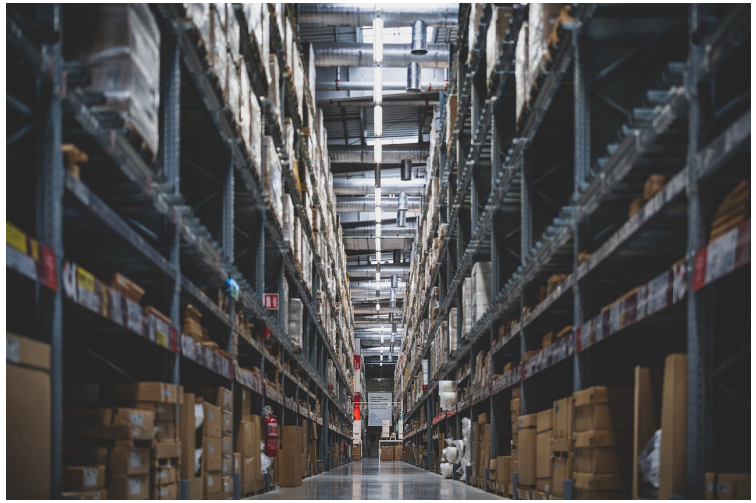
Important for industry cases

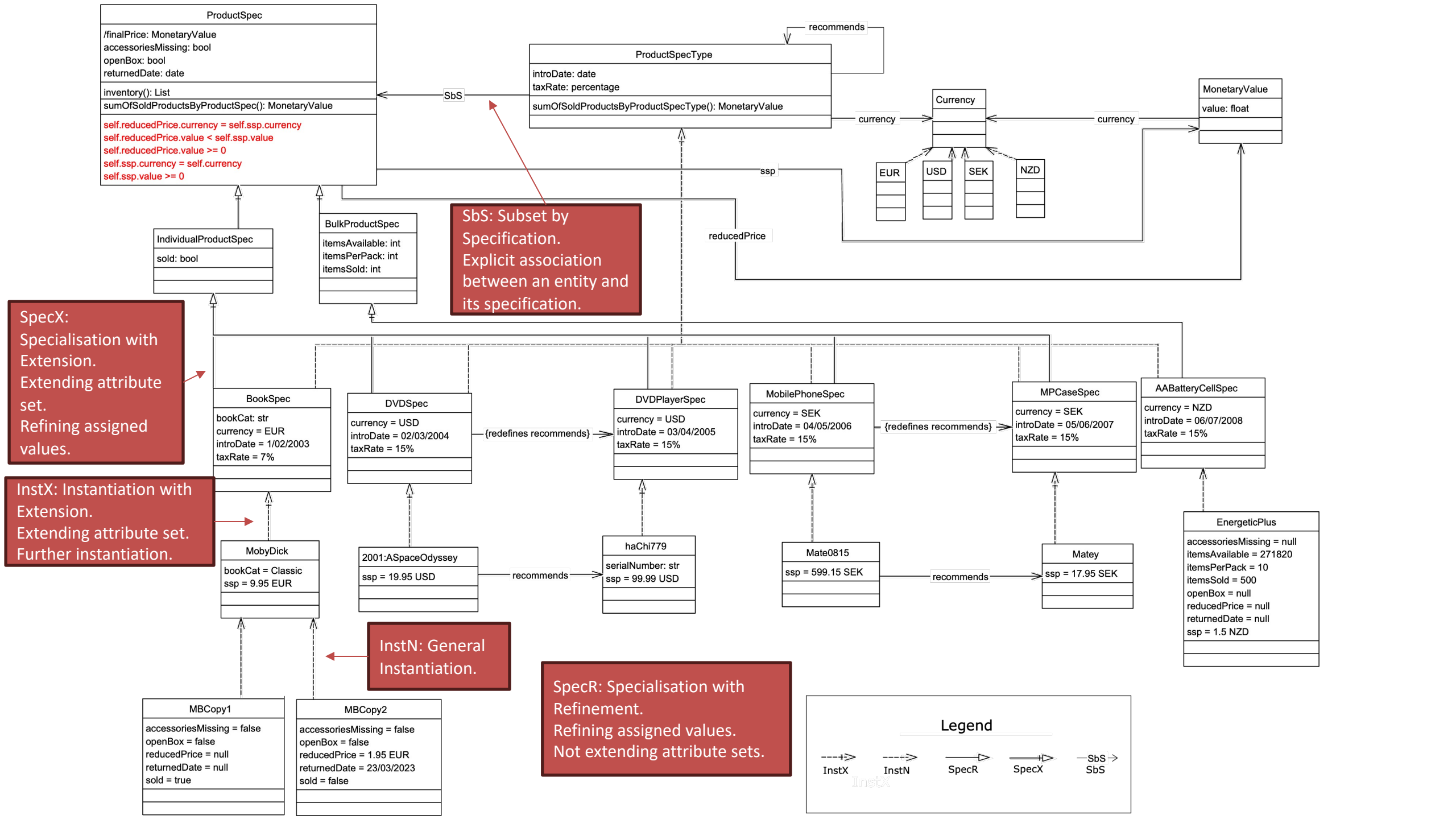
SLICER

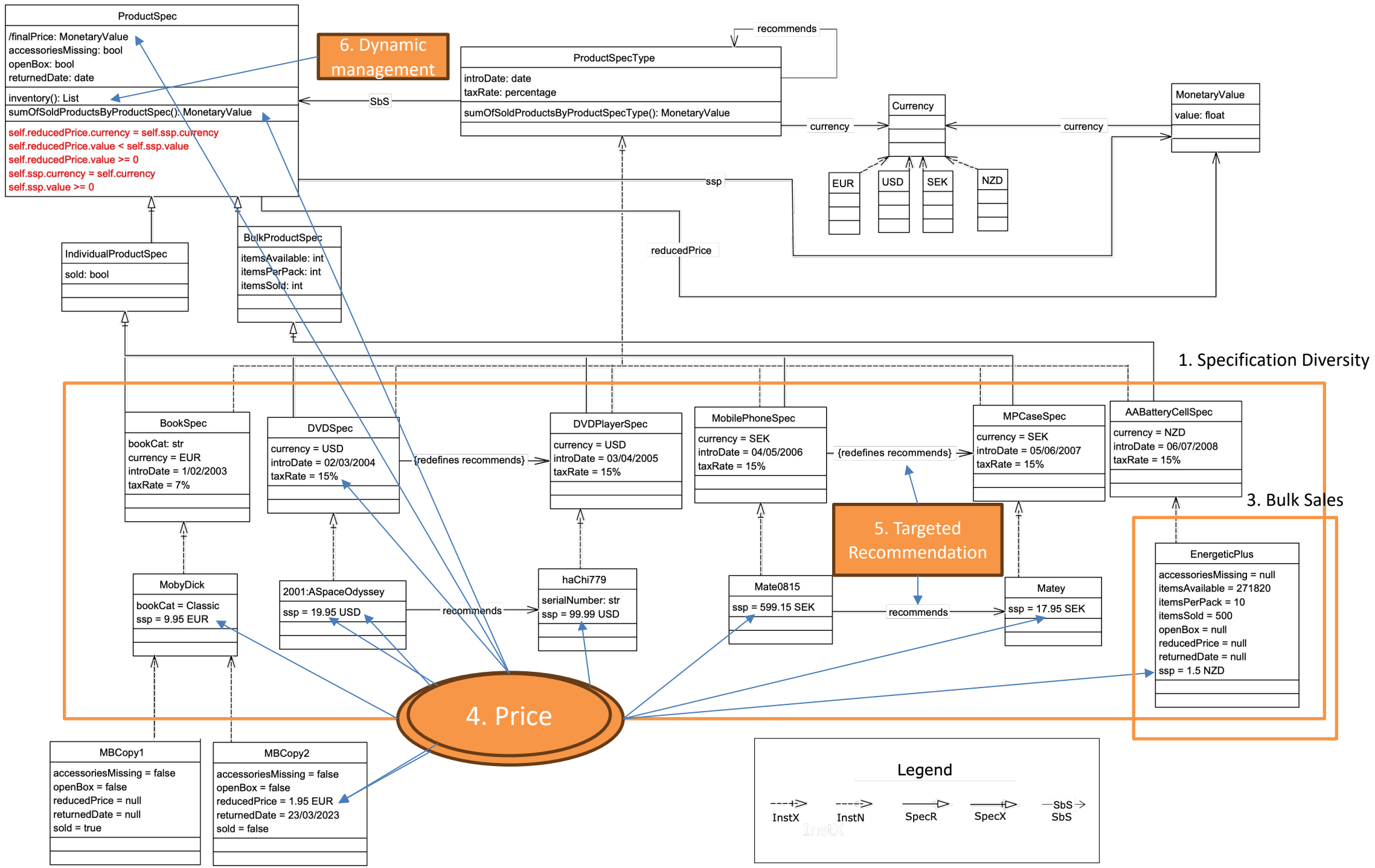
- SLICER was first introduced at the ER 2015 conference by our research lab.
- Motivation: Enhancing interoperability between large-scale heterogeneous systems
- Main Contribution
  - Separating the specification from the entity (e.g. maxTemp is an attribute of the specification for Pump)
  - Distinguishing refinement and extension from general specialisation relationships
- Logic formalisation
- Implemented in the F-Logic language

Warehouse Model – Requirement

1. Specification Diversity
   - Product copy attributes
   - Specification type categorisation
2. Currency
   - Price attribute with currency unit
   - Consistent currency per specification
   - Different currency across specifications
3. Bulk Sales
4. Price
   - SSP
   - Reduced price < SSP
   - Total price
   - Tax rate
   - Final price
5. Targeted Recommendation
6. Dynamic management
   - Add and remove
   - Iterating all products for inventory purpose




ProductSpec
/finalPrice: MonetaryValue
accessoriesMissing: bool
openBox: bool
returnedDate: date
inventory(): List
sumOfSoldProductsByProductSpec(): MonetaryValue
self.reducedPrice.currency = self.ssp.currency
self.reducedPrice.value < self.ssp.value
self.reducedPrice.value >= 0
self.ssp.currency = self.currency
self.ssp.value >= 0
recommends
ProductSpecType
introDate: date
taxRate: percentage
sumOfSoldProductsByProductSpecType(): MonetaryValue
SbS
currency
Currency
EUR
USD
SEK
NZD
MonetaryValue
value: float
ssp
reducedPrice
IndividualProductSpec
sold: bool
BulkProductSpec
itemsAvailable: int
itemsPerPack: int
itemsSold: int
SbS: Subset by Specification. Explicit association between an entity and its specification.
SpecX: Specialisation with Extension. Extending attribute set. Refining assigned values.
InstX: Instantiation with Extension. Extending attribute set. Further instantiation.
BookSpec
bookCat: str
currency = EUR
introDate = 1/02/2003
taxRate = 7%
DVDSpec
currency = USD
introDate = 02/03/2004
taxRate = 15%
{redefines recommends}
DVDPlayerSpec
currency = USD
introDate = 03/04/2005
taxRate = 15%
MobilePhoneSpec
currency = SEK
introDate = 04/05/2006
taxRate = 15%
{redefines recommends}
MPCaseSpec
currency = SEK
introDate = 05/06/2007
taxRate = 15%
AABatteryCellSpec
currency = NZD
introDate = 06/07/2008
taxRate = 15%
MobyDick
bookCat = Classic
ssp = 9.95 EUR
2001:ASpaceOdyssey
ssp = 19.95 USD
recommends
haChi779
serialNumber: str
ssp = 99.99 USD
Mate0815
ssp = 599.15 SEK
recommends
Matey
ssp = 17.95 SEK
EnergeticPlus
accessoriesMissing = null
itemsAvailable = 271820
itemsPerPack = 10
itemsSold = 500
openBox = null
reducedPrice = null
returnedDate = null
ssp = 1.5 NZD
InstN: General Instantiation.
MBCopy1
accessoriesMissing = false
openBox = false
reducedPrice = null
returnedDate = null
sold = true
MBCopy2
accessoriesMissing = false
openBox = false
reducedPrice = 1.95 EUR
returnedDate = 23/03/2023
sold = false
SpecR: Specialisation with Refinement. Refining assigned values. Not extending attribute sets.
Legend
InstX
InstN
SpecR
SpecX
SbS
SbS


ProductSpec
/finalPrice: MonetaryValue
accessoriesMissing: bool
openBox: bool
returnedDate: date
inventory(): List
sumOfSoldProductsByProductSpec(): MonetaryValue
self.reducedPrice.currency = self.ssp.currency
self.reducedPrice.value < self.ssp.value
self.reducedPrice.value >= 0
self.ssp.currency = self.currency
self.ssp.value >= 0
6. Dynamic management
recommends
ProductSpecType
introDate: date
taxRate: percentage
sumOfSoldProductsByProductSpecType(): MonetaryValue
SbS
currency
Currency
EUR
USD
SEK
NZD
MonetaryValue
value: float
ssp
reducedPrice
IndividualProductSpec
sold: bool
BulkProductSpec
itemsAvailable: int
itemsPerPack: int
itemsSold: int
1. Specification Diversity
BookSpec
bookCat: str
currency = EUR
introDate = 1/02/2003
taxRate = 7%
DVDSpec
currency = USD
introDate = 02/03/2004
taxRate = 15%
{redefines recommends}
DVDPlayerSpec
currency = USD
introDate = 03/04/2005
taxRate = 15%
MobilePhoneSpec
currency = SEK
introDate = 04/05/2006
taxRate = 15%
{redefines recommends}
MPCaseSpec
currency = SEK
introDate = 05/06/2007
taxRate = 15%
AABatteryCellSpec
currency = NZD
introDate = 06/07/2008
taxRate = 15%
3. Bulk Sales
5. Targeted Recommendation
MobyDick
bookCat = Classic
ssp = 9.95 EUR
2001:ASpaceOdyssey
ssp = 19.95 USD
recommends
haChi779
serialNumber: str
ssp = 99.99 USD
Mate0815
ssp = 599.15 SEK
recommends
Matey
ssp = 17.95 SEK
EnergeticPlus
accessoriesMissing = null
itemsAvailable = 271820
itemsPerPack = 10
itemsSold = 500
openBox = null
reducedPrice = null
returnedDate = null
ssp = 1.5 NZD
4. Price
MBCopy1
accessoriesMissing = false
openBox = false
reducedPrice = null
returnedDate = null
sold = true
MBCopy2
accessoriesMissing = false
openBox = false
reducedPrice = 1.95 EUR
returnedDate = 23/03/2023
sold = false
Legend
InstX
InstN
SpecR
SpecX
SbS
SbS

Advantages and Limitations

Advantages:

- Abstraction
- Natural expression – close to a real-world warehouse
- Constraint and attribute propagation
- Distinguishing between Specialisation and Instantiation
- Dynamic levels

Limitations:

- No default value support
- Pre-restricting the levels at which attributes are instantiated
- Niche constraint language

Demonstration

- Modelling process
- Generating codes from model
- Conflict detection through a reasoning platform
- Highlighting conflicts and conflict resolution

University of
South Australia

Thanks for Listening!