

Conceptual Modelling with Euler⁺ Diagrams

Uta Priss

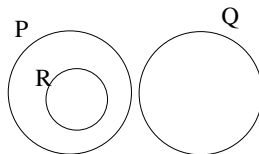
Informatik, Ostfalia,
www.upriss.org.uk

September, 2023

Motivation

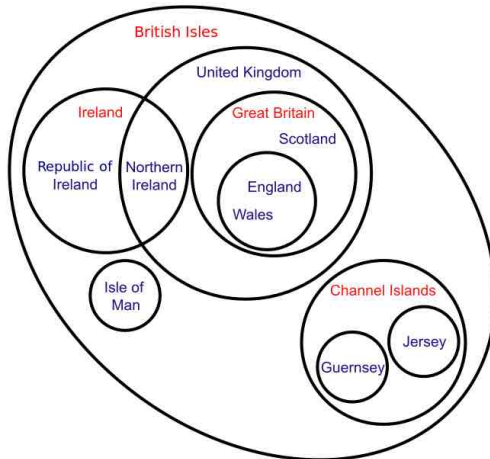
- ★ Teaching mathematics with diagrams
- ★ Reading Euler diagrams is easier than reading Hasse diagrams
- ★ Chapman, P.; Stapleton, G.; Howse, J.; & Oliver, I. (2011).
Deriving sound inference rules for **concept diagrams**.

Euler diagrams are like Venn Diagrams but empty zones are omitted.

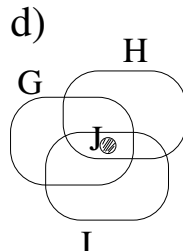
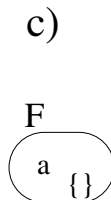
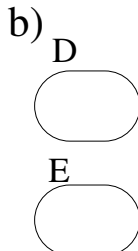
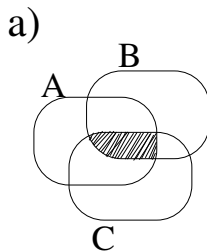


Sometimes shading must be used to express emptiness.

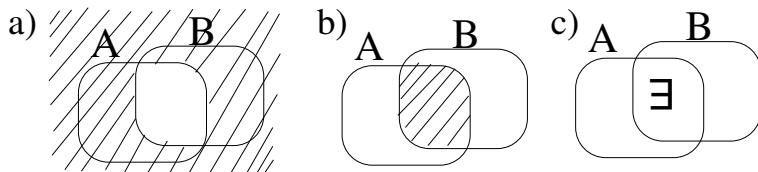
Euler diagrams are easy to read



The empty set is difficult to display

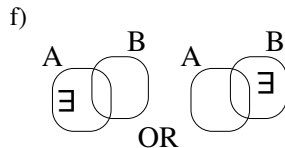
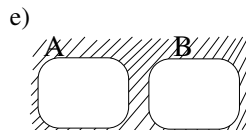
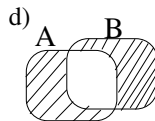


Negation



Boolean logic ($A \cap B = \emptyset$) or set valued ($A \cap B$)

Negation of $A = B$



Traditional Venn and Euler diagrams express

Boolean logic

and not set theory!

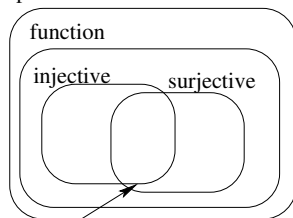
Requirements

3-valued logic:

- ▶ at least one
- ▶ none
- ▶ don't care

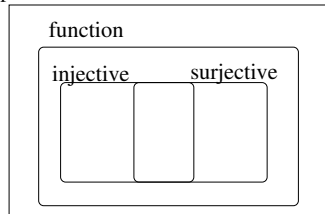
Rectangular Euler diagrams \rightarrow Euler⁺ Diagrams

partial function



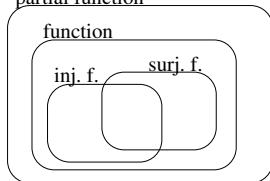
bijective = injective AND surjective

partial function

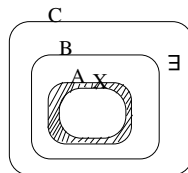


Euler⁺Diagrams

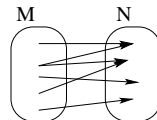
a) partial function



b)



c)



AND

bijective function :=

injective function \cap surjective function

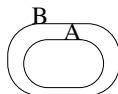
Euler⁺Diagrams

- ▶ diagrams, text (logical expressions), arrows (relations)
- ▶ labels (for sets, elements, relations)
- ▶ 3 states: at least one, none, don't care

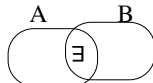
Conditions and semantics: see paper

Quantifiers

a) $\forall (x \in A) x \in B$



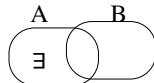
b) $\exists (x \in A) x \in B$



c) $\forall (x \in A) x \notin B$

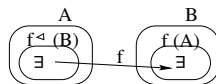


d) $\exists (x \in A) x \notin B$

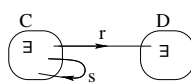


Functions and Relations

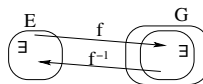
a) partial function



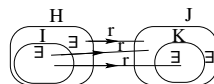
b) total and auto-relation



c) injective function



d) relation

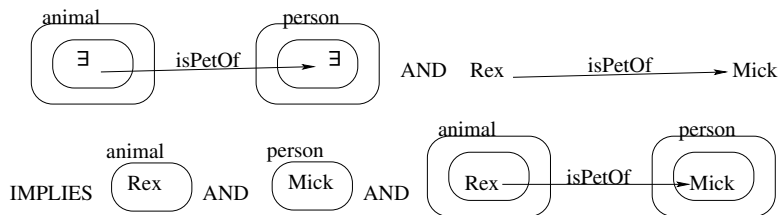


Partial function generates domain and codomain:

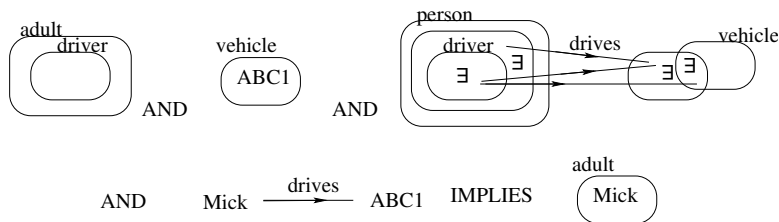
Driver := person who drives

Vehicle := thing that is driven

Example from Chapman et al.



2nd example from Chapman et al.



Conclusion

- ▶ Euler⁺diagrams
- ▶ produce simple diagrams
(reduce, split, combine with text)
- ▶ can be translated into FOL
- ▶ Software for Euler⁺diagrams
- ▶ Algorithms for Euler diagram layout?
- ▶ Evaluating the usability of Euler⁺diagrams

Questions?