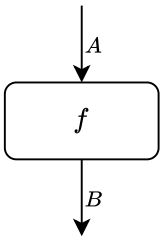
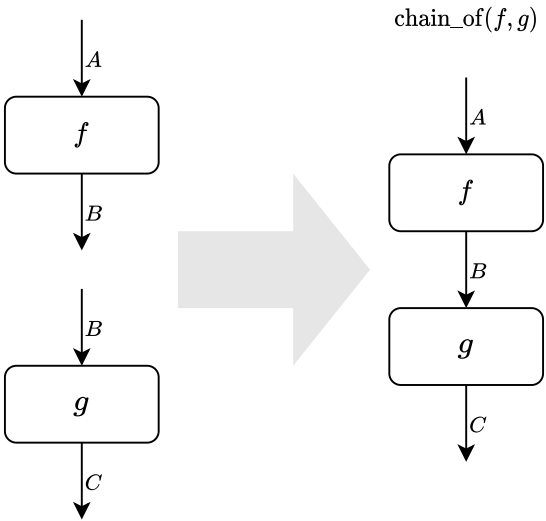
1. Transformation



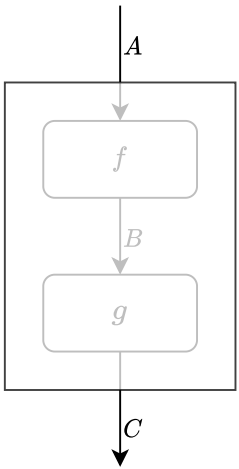
A transformation f
with input of type A
and output of type B

2. Composition



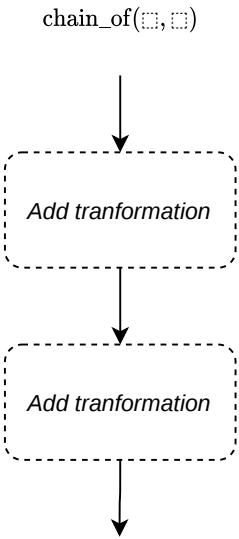
Transformations with
compatible input and output
can be composed

3. Composition is a Transformation



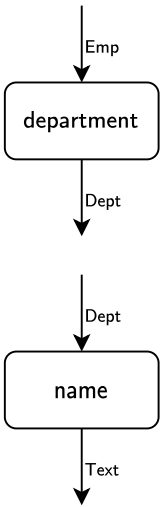
Trivially (but crucially),
a composition of transformations
is again a transformation

4. Composition Combinator



Composition is a transformation combinator
with two placeholders

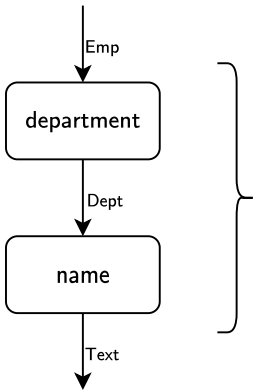
5. Example: Components of a Composition



Maps an employee to
the associated department

Maps a department record
to its name

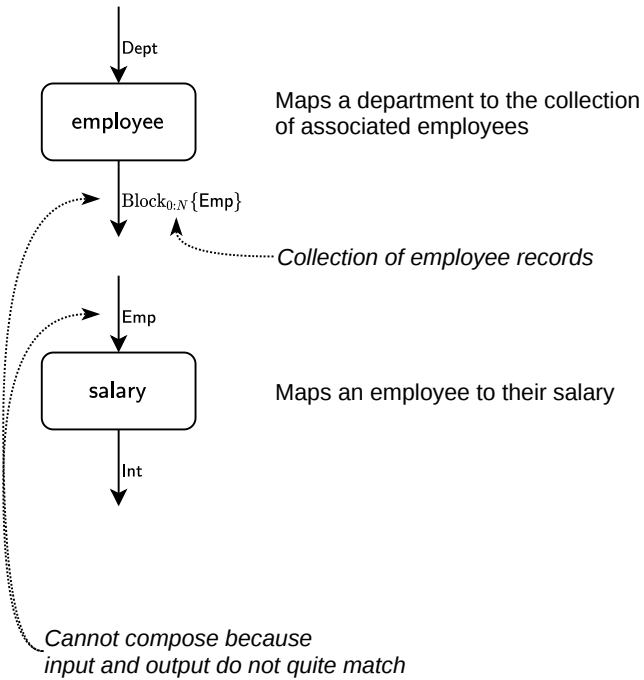
6. Example: Composition



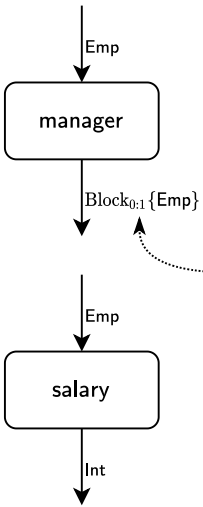
Maps an employee record
to the name of their department

$\mathrm{chain\_of}(\mathsf{department}, \mathsf{name})$

7. Counter-example: Plural Component



8. Counter-example: Optional Component

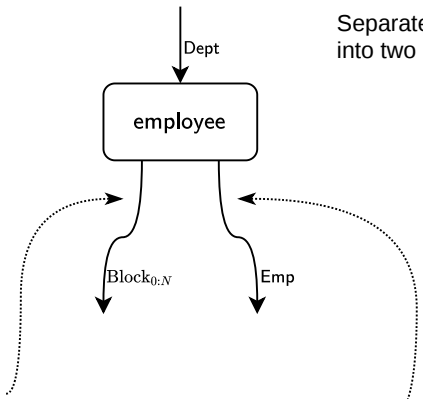


Maps an employee to their manager, if there is one

Collection of 0 or 1 employee records

Can we represent composition of these transformations with an intuitive diagrammatic notation?

9. Idea: Unbundle the Wire

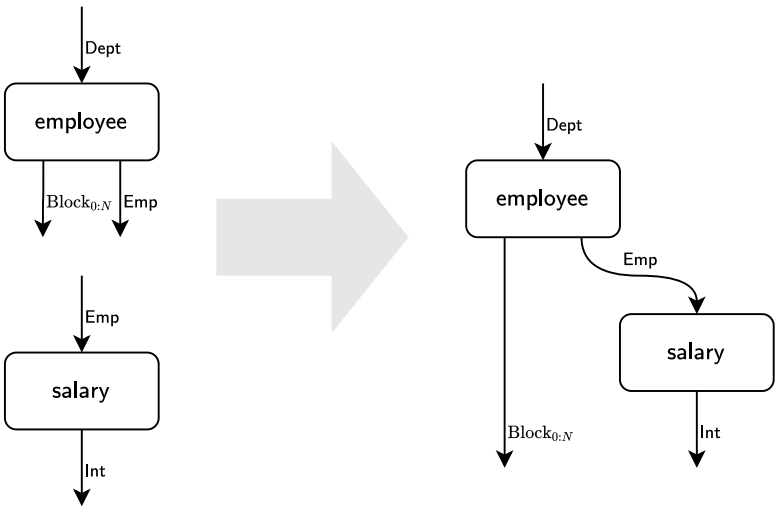


Separate the output wire into two components

Functor wire
Intuitively, it signals the number of output elements

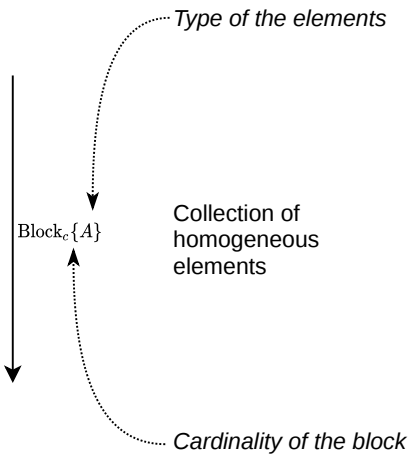
Object wire
Transmits the output elements

10. Idea: Compose Using the Object Wire



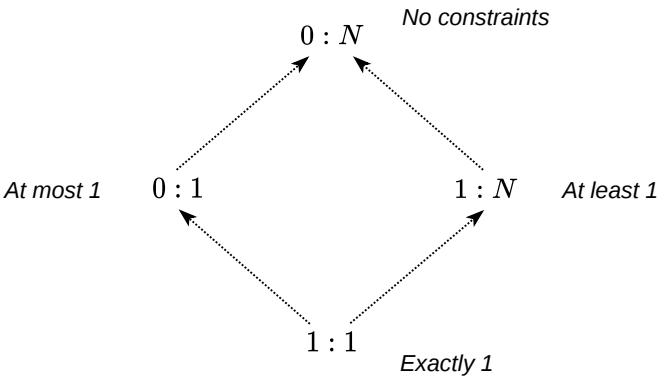
Attaching a transformation to the object wire indicates that the transformation is applied to each element of the collection

11. Block Type

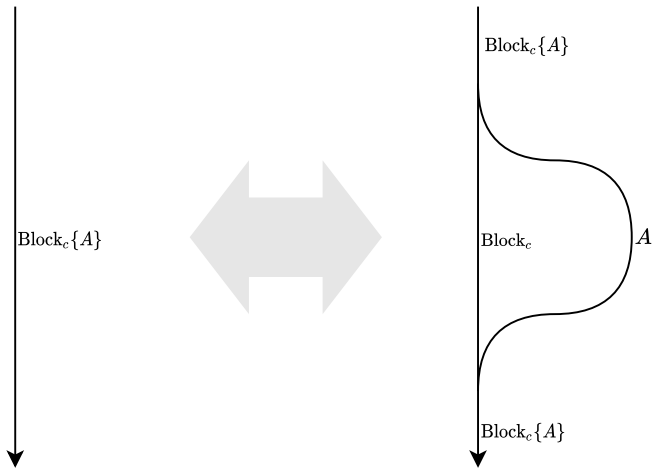


12. Cardinality

Cardinality is a constraint on the number of elements in a block

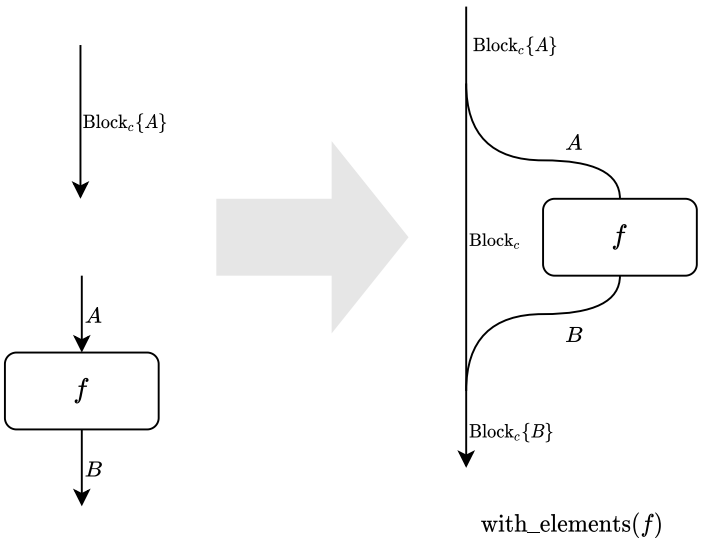


13. Unbundling



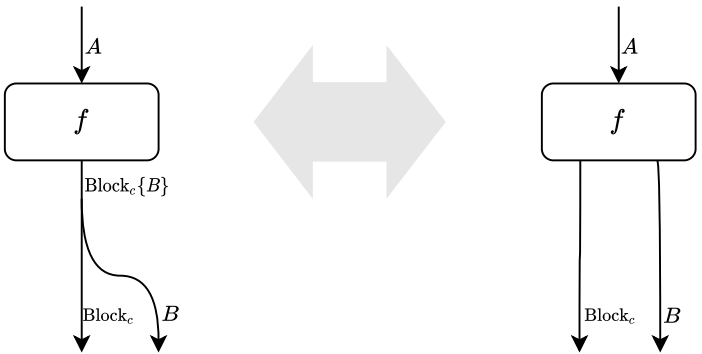
We can unbundle a wire of a block type into a functor and object components

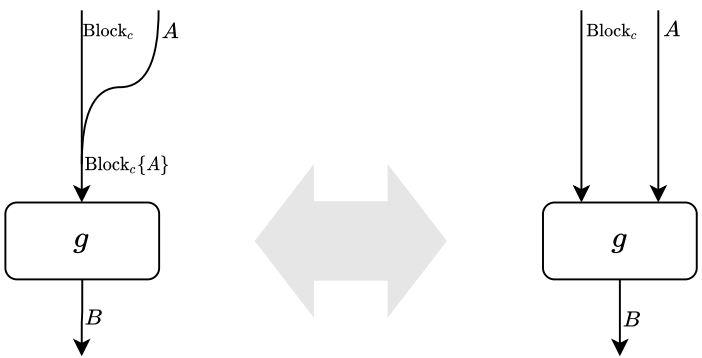
14. Object Transformation



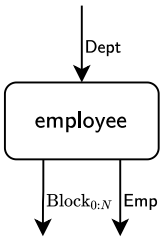
Then any compatible transformation can be applied to the object wire, which indicates that the transformation is applied to every element of the block

13. Multiwired transformations

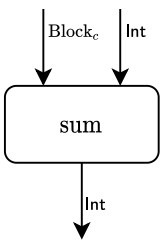




14. Example: Multiwired Transformations

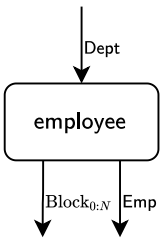


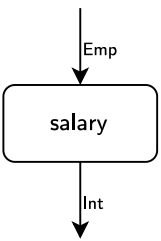
Maps a department to the collection of associated employees

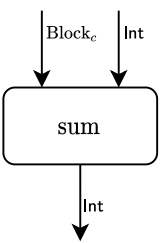


Produces the sum of a collection of integers

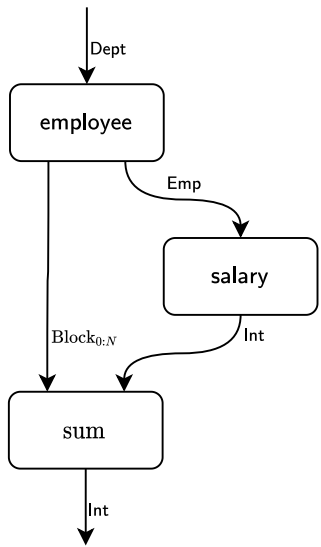
14. Example: Multiwired Composition





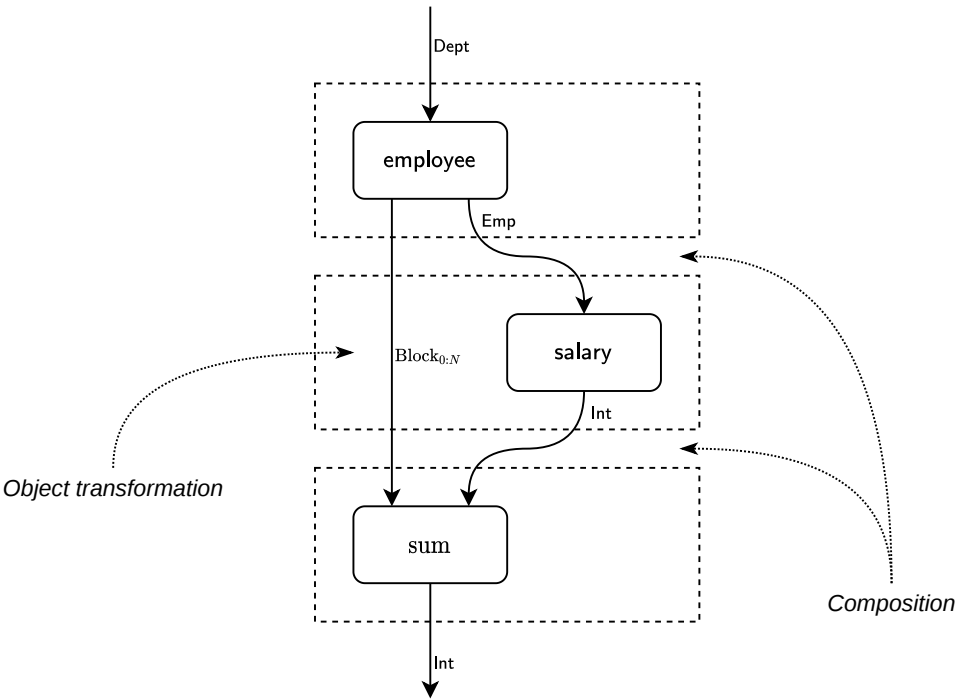


Total sum of salaries in a given department



$\mathrm{chain\_of}(\mathsf{employee}, \mathrm{with\_elements}(\mathsf{salary}), \mathrm{sum})$

15. Example: Details



$\text{chain\_of}(\textsf{employee}, \text{with\_elements}(\textsf{salary}), \text{sum})$