

Monoid

Monoid

Definition:

A monoid is an algebraic structure with an **associative** binary operation that has an **identity** element.

Data.Monoid

```
class Monoid a where
```

```
  -- an identity element
```

```
  mempty :: a
```

```
  - an associative operation
```

```
  mappend :: a -> a -> a
```

Rules of monoid

Rule 1: identity element

$$\text{mempty} \text{ `mappend` } n == n$$

$$n \text{ `mappend` } \text{mempty} == n$$

Rule 2: associative operation

$$(a \text{ `mappend` } b) \text{ `mappend` } c$$

$$== a \text{ `mappend` } (b \text{ `mappend` } c)$$

Examples of monoid

Plus (+)

Product (*)

Examples of monoide

binary operator : $(++)$

identity element : $[]$

$$[] ++ n == n$$

$$n ++ [] == n$$

associative : $(a ++ b) ++ c$

$$== a ++ (b ++ c)$$

Question

We already have individual functions like (`++`), why do we use `mappend` instead?

Monoid

```
newtype Sum a = Sum { getSum :: a }  
    deriving (Eq, Ord, Read, Show, Bounded)
```

```
instance Num a => Monoid (Sum a) where  
    mempty = Sum 0  
    Sum x `mappend` Sum y = Sum (x + y)
```


Monoid

```
newtype Product a = Product { getProduct :: a }  
    deriving (Eq, Ord, Read, Show, Bounded)
```

```
instance Num a => Monoid (Product a) where
```

```
    mempty = Product 1
```

```
    Product x `mappend` Product y = Product (x * y)
```

Foldable

- Type class : `Data.Foldable`
- abstract `foldl` and `foldr` from list
- applicable to arbitrary structures

Composition

- Tuples are already instances of monoids.
- Tuples of monoids

Extend monoid

define type class Aggregation:

```
class (Monoid a) => Aggregation a where  
  type AggResult a :: *  
  aggResult :: a -> AggResult a
```

Summary

- Definition
- Rules
- Usage

Questions?