

## Getting with Getters

Any function  $(s \rightarrow a)$  can be flipped into continuation passing style,  $(a \rightarrow r) \rightarrow s \rightarrow r$  and decorated with **Const** to obtain:

```
type Getting r s a =  
  (a -> Const r a) -> s -> Const r s
```

A **Getter** describes how to retrieve a single value in a way that can be composed with other **LensLike** constructions.

When you see this in a type signature it indicates that you can pass the function a **Lens**, **Getter**, **Traversal**, **Fold**, **Prism**, **Iso**, or one of the indexed variants, and it will just “do the right thing”.

## Safe head

Perform a safe head of a **Fold** or **Traversal** or retrieve **Just** the result from a **Getter** or **Lens**.

$(^?) \equiv \text{flip preview}$

```
(^?) :: s -> Getting (First a) s a -> Maybe a
```

```
> Right 4 ^? _Left  
Nothing  
> "world" ^? ix 3  
Just 'l'
```

## Viewing lenses

View the value pointed to by a **Getter** or **Lens** or the result of folding over all the results of a **Fold** or **Traversal** that points at a monoidal values.

This is the same operation as **view** with the arguments flipped.

```
(^.) :: s -> Getting a s a -> a
```

```
> (0, -5) ^. _2 . to abs  
5  
> ["a", "b", "c"] ^. traversed  
"abc"
```

## Using MonadState

Use the target of a **Lens**, **Iso**, or **Getter** in the current state, or use a summary of a **Fold** or **Traversal** that points to a monoidal value.

```
use :: MonadState s m => Getting a s a -> m a
```

```
> evalState (use _1) (1,2)  
1  
> evalState (uses _1 length) ("hello", "")  
5
```

## Folding Foldables

```
type Fold s a =  
  forall m. Monoid m => Getting m s a
```

A **Fold s a** is a generalization of something **Foldable**. It allows you to extract multiple results from a container. Every **Getter** is a valid **Fold** that simply doesn't use the **Monoid** it is passed.

If there exists a **foo** method that expects a **Foldable** (**f a**), then there should be a **fooOf** method that takes a **Fold s a** and a value of type **s**.

## Extracting lists from Folds

Extract a list of the targets of a **Fold**, an infix version of **toListOf**.

$\text{toList } xs \equiv xs \hat{.} \text{folded}$

```
(^..) :: s -> Getting (Endo [a]) s a -> [a]
```

```
> [[1,2],[3]] ^.. traverse . traverse  
[1,2,3]  
> (1,2) ^.. both  
[1,2]
```

## Checking for matches

Check to see if this **Fold** or **Traversal** matches 1 or more entries. For the opposite, use **hasn't**.

```
has :: Getting Any s a -> s -> Bool
```

```
> has (element 0) []  
False  
> has _Right (Left 12)  
False  
> hasn't _Right (Left 12)  
True
```

## Indexed Getters

For most operations, there is an indexed variant which will work as expected if the underlying target supports a notion of **Indexing**.

```
> ["ab", "c"] ^@.. itraversed <.> itraversed  
[((0,0),'a'),((0,1),'b'),((1,0),'c')]  
> "hello" ^@.. itraversed . indices even  
[(0,'h'),(2,'l'),(4,'o')]  
  
> ifind (\i k -> i > k) [1,2,2,2]  
Just (3,2)
```

## Modifying records with Setters

A **Setter** `s t a b` is a generalization of `fmap` from **Functor**. It allows you to map into a structure and change out the contents, but it isn't strong enough to allow you to enumerate those contents. Starting with `fmap :: Functor f => (a -> b) -> fa -> fb` we monomorphize the type to obtain `(a -> b) -> s -> t` and then decorate it with `Identity` to obtain:

```
type Setter s t a b =  
  (a -> Identity b) -> s -> Identity t
```

Every **Traversal** is a valid **Setter**, since **Identity** is **Applicative**.

## Modifying with a function

Modifies the target of a **Lens** or all of the targets of a **Setter** or **Traversal** with a user supplied function.

This is an infix version of **over**.

```
(%~) :: Profunctor p  
      => Setting p s t a b -> p a b -> s -> t
```

```
> traverse %~ even $ [1,2,3]  
[False,True,False]
```

## Modifying with a constant value

Replace the target of a **Lens** or all of the targets of a **Setter** or **Traversal** with a constant value.

```
(.) :: ASetter s t a b -> b -> s -> t
```

```
> [1,2,3] & element 0 .~ 3  
[3,2,3]  
> 0 & bitAt 8 .~ True  
256  
> [1,2,3] & traversed . filtered odd .~ 0  
[0,2,0]
```

## Prisms and Isos

An **Iso** is a pair of inverse functions. You can invert an **Iso** with **from**.

**Prisms** can be thought of as **Isos** that can fail in one direction. You can invert a **Prism** with **re**.

```
type Prism s t a b  
  forall p f. (Choice p, Applicative f) =>  
    p a (f b) -> p s (f t)  
type Prism' s a = Prism s s a a
```

```
prism :: (b -> t)  
       -> (s -> Either t a)  
       -> Prism s t a b  
prism' :: (a -> s)  
        -> (s -> Maybe a)  
        -> Prism' s a
```

```
> 5^.re _Left ^?! _Left  
5  
> _Left # 1  
Left 1
```

```
type Iso s t a b =  
  forall p f. (Profunctor p, Functor f) =>  
    p a (f b) -> p s (f t)  
type Iso' s a = Iso s s a a
```

```
iso :: (s -> a) -> (b -> t) -> Iso s t a b  
from :: AnIso s t a b -> Iso b a t s
```

```
> 'a' ^. from enum  
97  
> 97 ^. enum :: Char  
'a'  
  
> Map.empty & at "hi"  
>      . non Map.empty  
>      . at "world" ?~ "!"  
fromList [("hi",fromList [("world","!")])]
```

## Some setting operators

Operator	W/result	W/state	W/both	Action
+~	<+~	+=	<+=	Add to target(s)
-~	<-~	-=	<-=	Subtract from target(s)
*~	<*~	*=	<*=	Multiply target(s)
//~	<//~	//=	<//=	Divide target(s)
^^~	<^^~	^^=	<^^=	Raise target(s) to a non-negative Integral power
^^~	<^^~	^^=	<^^=	Raise target(s) to an Integral power
**~	<**~	**=	<**=	Raise target(s) to an arbitrary power
~	<  ~	=	<  =	Logically or target(s)
&&~	<&&~	&&=	<&&=	Logically and target(s)
<>~	<<>~	<>=	<<>=	mapend to the target monoidal value(s)