

Master's Thesis

Incremental Cata Computation for Generic Data Types

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1 Experiments

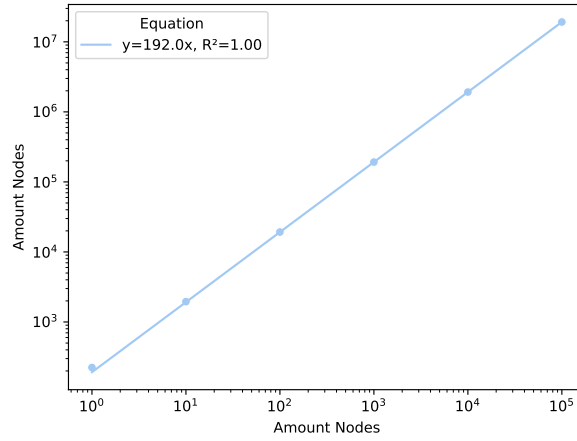


Figure 1: Bytes allocated for Cata Sum

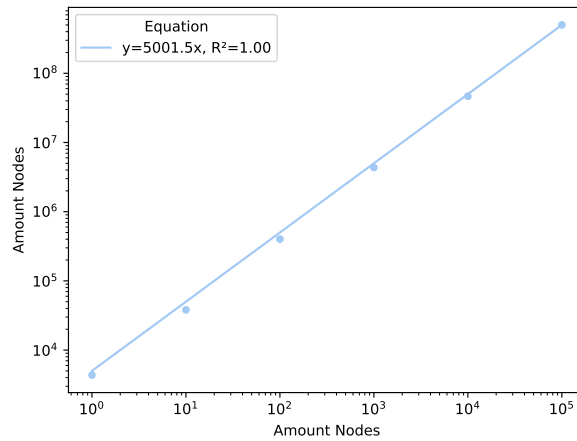


Figure 2: Bytes allocated for Generic Cata Sum

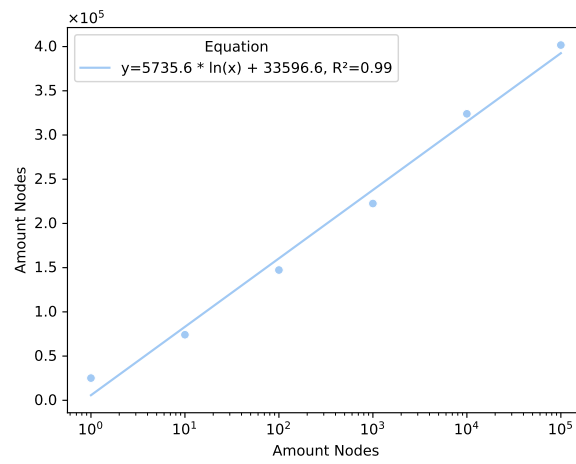


Figure 3: Bytes allocated for Incremental Cata Sum

2 Appendix

A Definition Generic Datatypes

```
data U r      = U
data I r      = I r
data K a r    = K a
data (+:) f g r = L (f r) | R (g r)
data (:*) f g r = (f r) :* (g r)
data C c f r  = C (f r)

newtype Fix f = In { out :: f (Fix f) }
```

B Implementation Hashable

```
class Hashable f where
  hash :: f (Fix (g :* K Digest)) -> Digest

instance Hashable U where
  hash _ = digest "U"

instance (Show a) => Hashable (K a) where
  hash (K x) = digestConcat [digest "K", digest x]

instance Hashable I where
  hash (I x) = digestConcat [digest "I", getDigest x]
  where
    getDigest :: Fix (f :* K Digest) -> Digest
    getDigest (In (_ :* K h)) = h

instance (Hashable f, Hashable g) => Hashable (f :+: g) where
  hash (L x) = digestConcat [digest "L", hash x]
  hash (R x) = digestConcat [digest "R", hash x]

instance (Hashable f, Hashable g) => Hashable (f :* g) where
  hash (x :* y) = digestConcat [digest "P", hash x, hash y]

instance (Hashable f) => Hashable (C c f) where
```

```
hash (C x) = digestConcat [digest "C", hash x]
```

C Implementation Merkle

```
type Merkle f = Fix (f :: K Digest)

merkleG :: Hashable f
  => f (Fix (g :: K Digest))
  -> (f :: K Digest) (Fix (g :: K Digest))
merkleG f = f :: K (hash f)

merkle :: (Regular a, Hashable (PF a), Functor (PF a))
  => a -> Merkle (PF a)
merkle = In . merkleG . fmap merkle . from
```

D Implementation Cata Merkle

```
cataMerkleState :: (Functor f, Traversable f)
  => (f a -> a) -> Fix (f :: K Digest)
  -> State (M.Map Digest a) a
cataMerkleState alg (In (x :: K h)) = do m <- get
  case M.lookup h m of
    Just a -> return a
    Nothing -> do y <- mapM (cataMerkleState alg) x
      let r = alg y
      modify (M.insert h r) >> return r

cataMerkle :: (Functor f, Traversable f)
  => (f a -> a) -> Fix (f :: K Digest) -> (a, M.Map Digest a)
cataMerkle alg t = runState (cataMerkleState alg t) M.empty
```

E Implementation Zipper Merkle

```
data Loc :: * -> * where
  Loc :: (Zipper a) => Merkle a
      -> [Ctx (a :: K Digest) (Merkle a)]
      -> Loc (Merkle a)
```

```
modify :: (a -> a) -> Loc a -> Loc a
modify f (Loc x cs) = Loc (f x) cs

updateDigest :: Hashable a => Merkle a -> Merkle a
updateDigest (In (x :*: _)) = In (merkleG x)

updateParents :: Hashable a => Loc (Merkle a) -> Loc (Merkle a)
updateParents (Loc x []) = Loc (updateDigest x) []
updateParents (Loc x cs) = updateParents
    $ expectJust "Exception: Cannot go up"
    $ up (Loc (updateDigest x) cs)

updateLoc :: Hashable a => (Merkle a -> Merkle a)
    -> Loc (Merkle a) -> Loc (Merkle a)
updateLoc f loc = if top loc'
    then loc'
    else updateParents
        $ expectJust "Exception: Cannot go up" (up loc')

where
    loc' = modify f loc
```