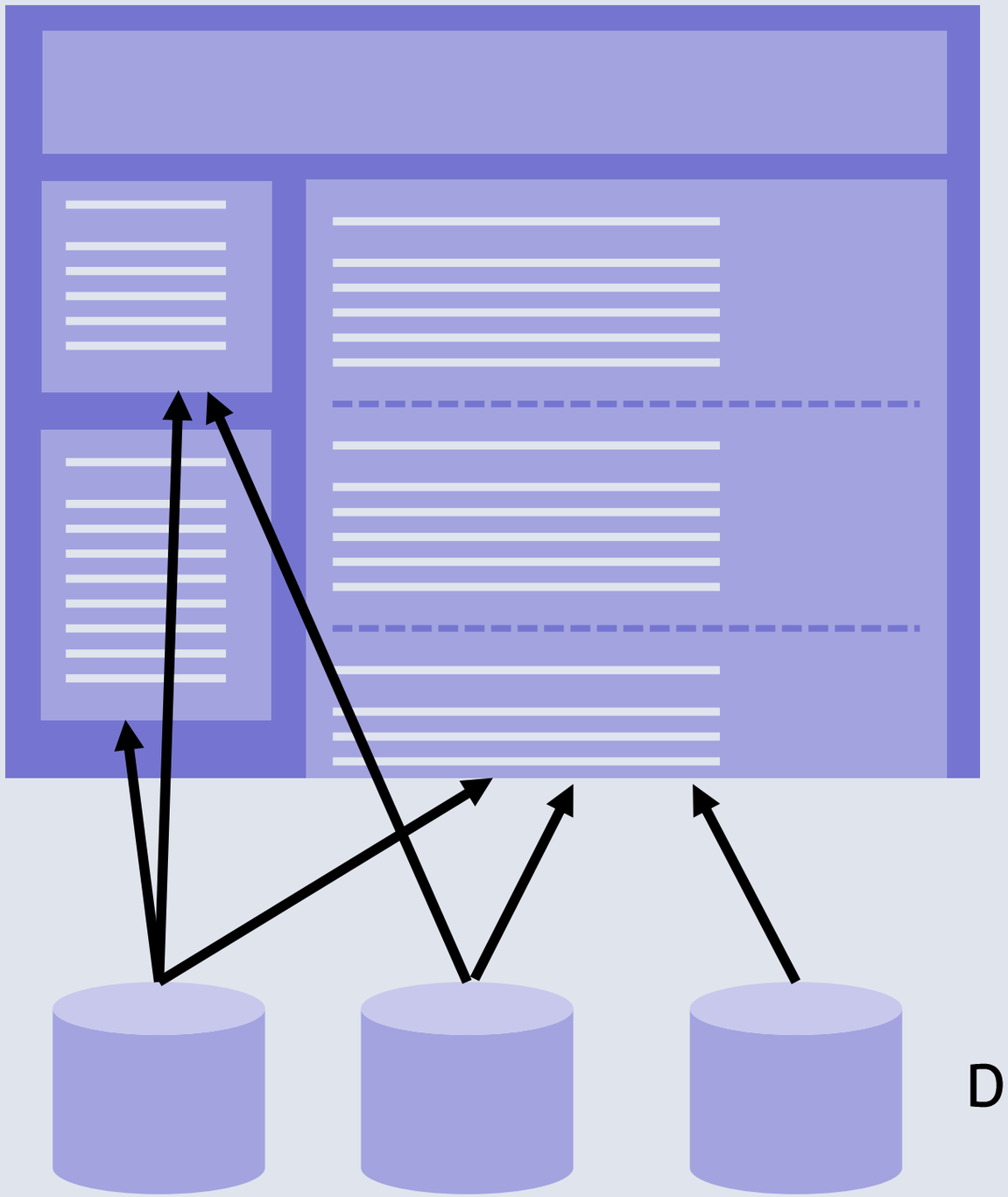
facebook

Remote data access made easy and fast with Haskell

Simon Marlow
20 November 2014

Agenda

1. Motivation: efficient data fetching
2. Example: a blog
3. How to define a data source
4. Example data sources



Data sources

For efficiency, we would like:

For efficiency, we would like:

- Concurrency

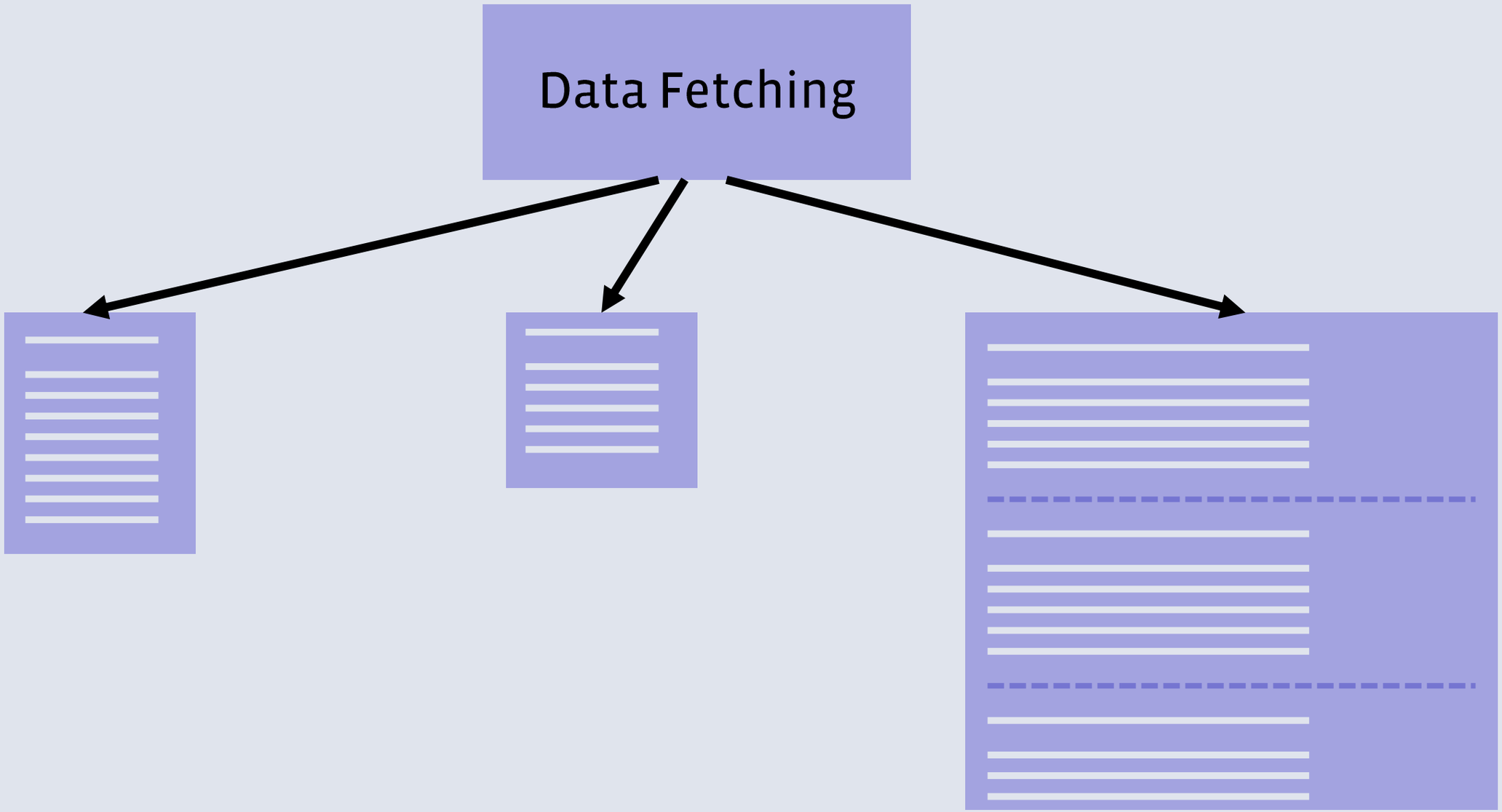
For efficiency, we would like:

- Concurrency
- Batching

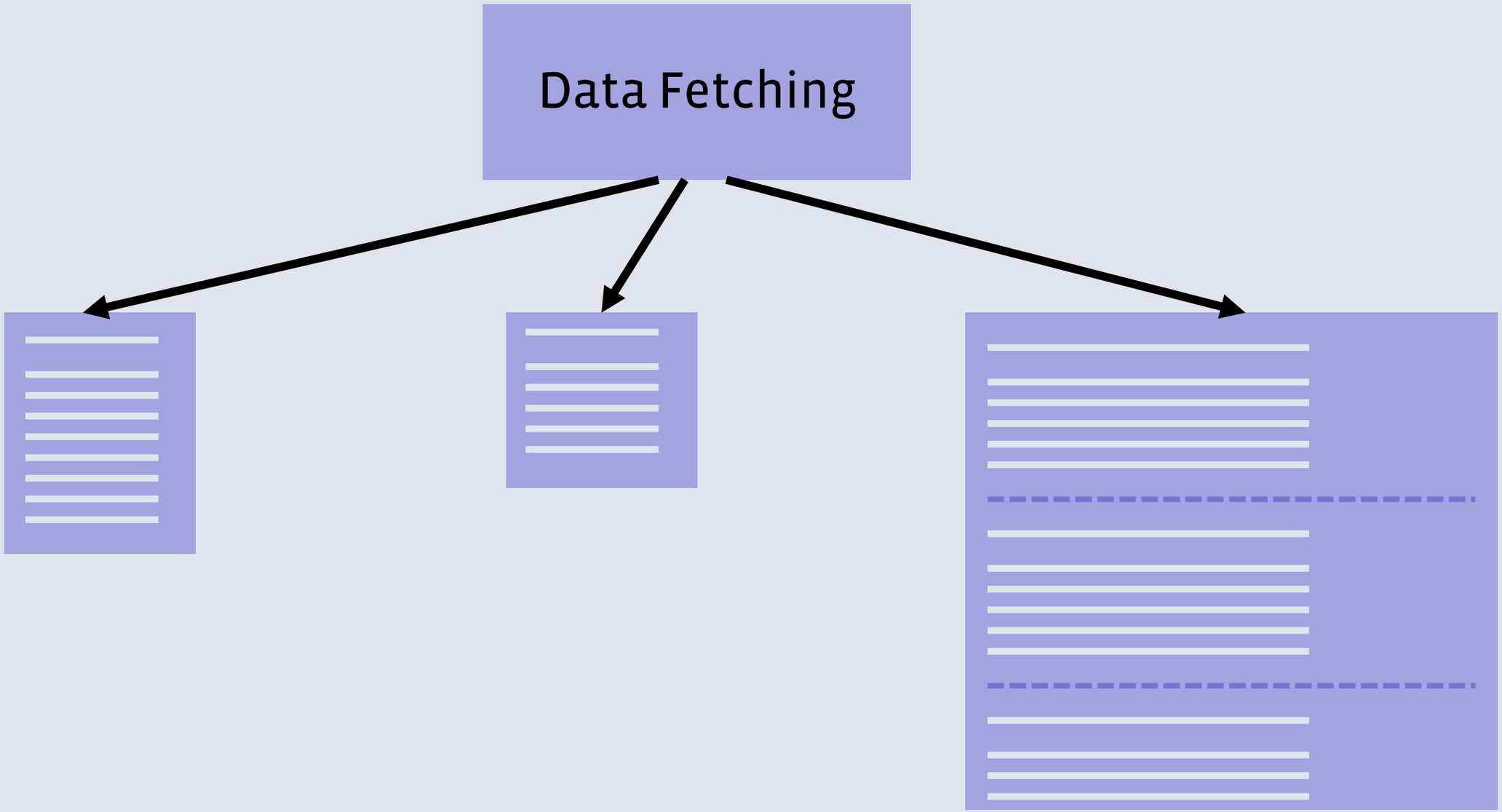
For efficiency, we would like:

- Concurrency
- Batching
- Caching

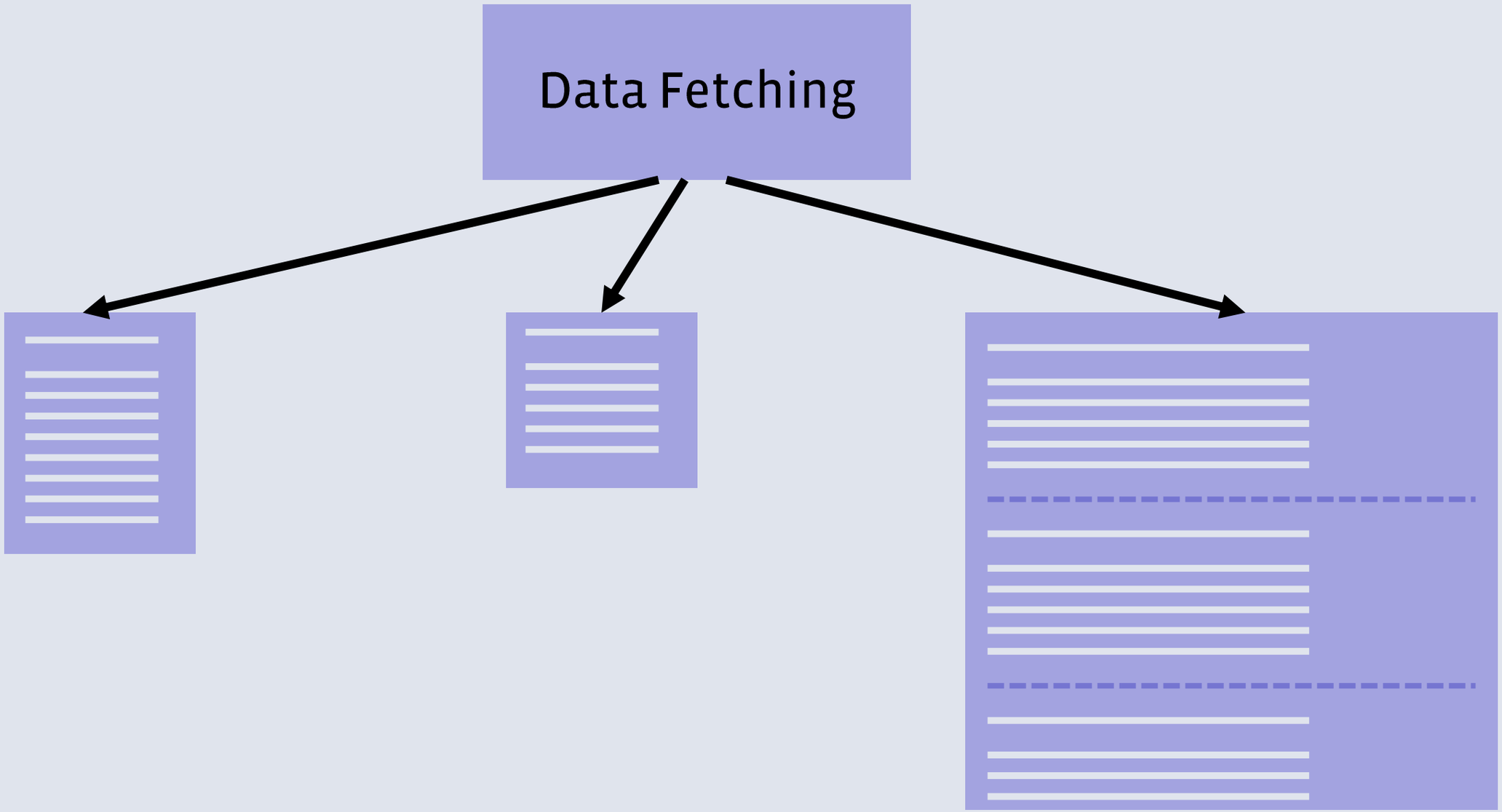
We could do all our data fetching up front...



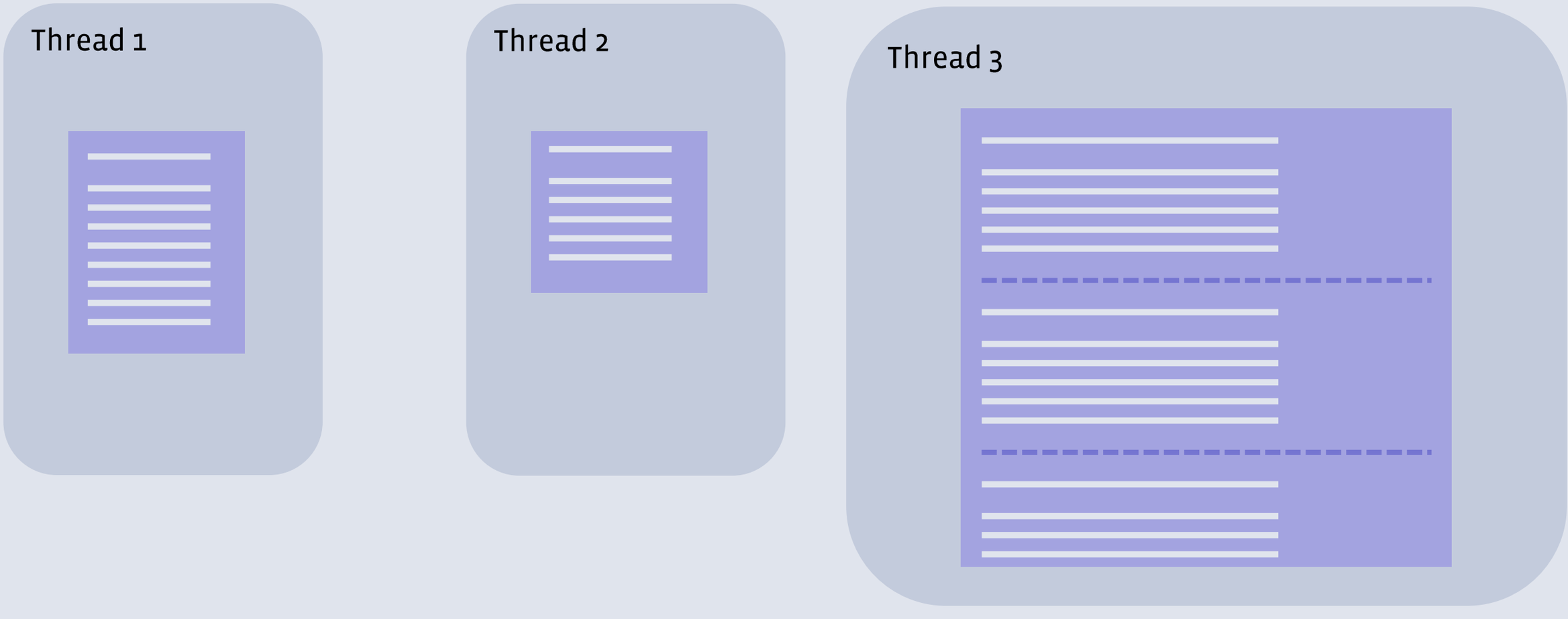
But that destroys modularity.



And we cannot always extract the data fetching from the business logic.



What about explicit concurrency?



Explicit concurrency relies too much on the programmer.

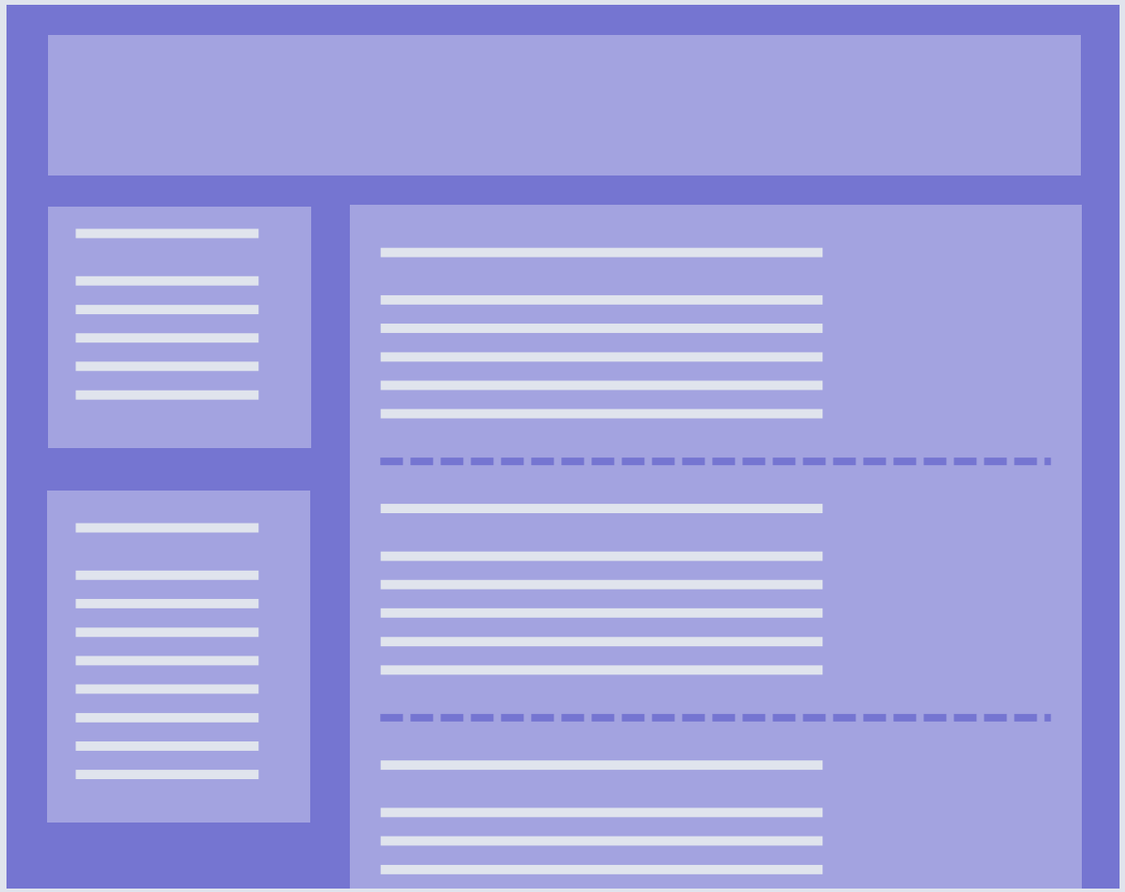
- Must remember to fork (or async)
- Must not demand results too early
- Don’t fork unnecessary work

Explicit concurrency is too explicit for this application.

- Explicit concurrency is good when the programmer needs to ask for non-determinism
- We're only fetching data – no side effects
- Programmer doesn't care about ordering

Concrete example: a blog

- Main pane: posts
- Left pane:
  - Top-10 most popular posts
  - Post topics, with post counts



```
blog :: Haxl Html
blog = renderPage <$> leftPane <*> mainPane
```

```
blog :: Haxl Html
blog = renderPage <$> leftPane <*> mainPane
```

Haxl is our Monad that provides data-fetching.

```
blog :: Haxl Html
blog = renderPage <$> leftPane <*> mainPane
```

```
leftPane :: Haxl Html
leftPane = renderSidePane <$> popularPosts <*> topics

renderPage     :: Html -> Html -> Html
renderSidePane :: Html -> Html -> Html
```

```
data PostId      -- identifies a post
data PostContent -- the content of a post

-- metadata about a post
data PostInfo = PostInfo
  { postId    :: PostId
  , postDate  :: Date
  , ...
  }

-- data-fetching operations
getPostIds     :: Haxl [PostId]
getPostInfo    :: PostId -> Haxl PostInfo
getPostContent :: PostId -> Haxl PostContent
```

```
getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

```haskell
data PostId      -- identifies a post
data PostContent -- the content of a post

-- metadata about a post
data PostInfo = PostInfo
  { postId    :: PostId
  , postDate  :: Date
  , ...
  }

-- data-fetching operations
getPostIds     :: Haxl [PostId]
getPostInfo    :: PostId -> Haxl PostInfo
getPostContent :: PostId -> Haxl PostContent
```

```haskell
getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

```haskell
data PostId      -- identifies a post
data PostContent -- the content of a post

-- metadata about a post
data PostInfo = PostInfo
  { postId    :: PostId
  , postDate  :: Date
  , ...
  }

-- data-fetching operations
getPostIds     :: Haxl [PostId]
getPostInfo    :: PostId -> Haxl PostInfo
getPostContent :: PostId -> Haxl PostContent

getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

```haskell
data PostId      -- identifies a post
data PostContent -- the content of a post

-- metadata about a post
data PostInfo = PostInfo
  { postId    :: PostId
  , postDate  :: Date
  , ...
  }
```

```haskell
-- data-fetching operations
getPostIds     :: Haxl [PostId]
getPostInfo    :: PostId -> Haxl PostInfo
getPostContent :: PostId -> Haxl PostContent
```

```haskell
getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

```
data PostId      -- identifies a post
data PostContent -- the content of a post

-- metadata about a post
data PostInfo = PostInfo
  { postId    :: PostId
  , postDate  :: Date
  , ...
  }

-- data-fetching operations
getPostIds     :: Haxl [PostId]
getPostInfo    :: PostId -> Haxl PostInfo
getPostContent :: PostId -> Haxl PostContent
```

```
getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

```haskell
mainPane :: Haxl Html
mainPane = do
  posts <- getAllPostsInfo
  let ordered = take 5 $ sortBy (flip (comparing postDate)) posts
  content <- mapM (getPostContent . postId) ordered
  return $ renderPosts (zip ordered content)
```

```
mainPane :: Haxl Html
mainPane = do
  posts <- getAllPostsInfo
  let ordered = take 5 $ sortBy (flip (comparing postDate)) posts
  content <- mapM (getPostContent . postId) ordered
  return $ renderPosts (zip ordered content)
```

First we fetch all the metadata

```
mainPane :: Haxl Html
mainPane = do
  posts <- getAllPostsInfo
  let ordered = take 5 $ sortBy (flip (comparing postDate)) posts
  content <- mapM (getPostContent . postId) ordered
  return $ renderPosts (zip ordered content)
```

Sort it by date, and take the latest 5

```haskell
mainPane :: Haxl Html
mainPane = do
  posts <- getAllPostsInfo
  let ordered = take 5 $ sortBy (flip (comparing postDate)) posts
  content <- mapM (getPostContent . postId) ordered
  return $ renderPosts (zip ordered content)
```

Fetch the content for those 5

```haskell
mainPane :: Haxl Html
mainPane = do
  posts <- getAllPostsInfo
  let ordered = take 5 $ sortBy (flip (comparing postDate)) posts
  content <- mapM (getPostContent . postId) ordered
  return $ renderPosts (zip ordered content)
```

And finally render the output

Things to note

```
mainPane :: Haxl Html
mainPane = do
  posts <- getAllPostsInfo
  let ordered = take 5 $ sortBy (flip (comparing postDate)) posts
  content <- mapM (getPostContent . postId) ordered
  return $ renderPosts (zip ordered content)
```

- No explicit concurrency constructs
  - Just standard structuring tools: do-notation, <*>, mapM
  - No concurrency bugs

No manual batching

```
getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

No manual batching

```
getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

This line performs many data fetches

No manual batching

```
getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

This line performs many data fetches

Unbatched

```
SELECT postinfo FROM posts
  WHERE postid = id1

SELECT postinfo FROM posts
  WHERE postid = id2

...
```

No manual batching

```
getAllPostsInfo :: Haxl [PostInfo]
getAllPostsInfo = do
  ids <- getPostIds
  mapM getPostInfo ids
```

This line performs many data fetches

Unbatched

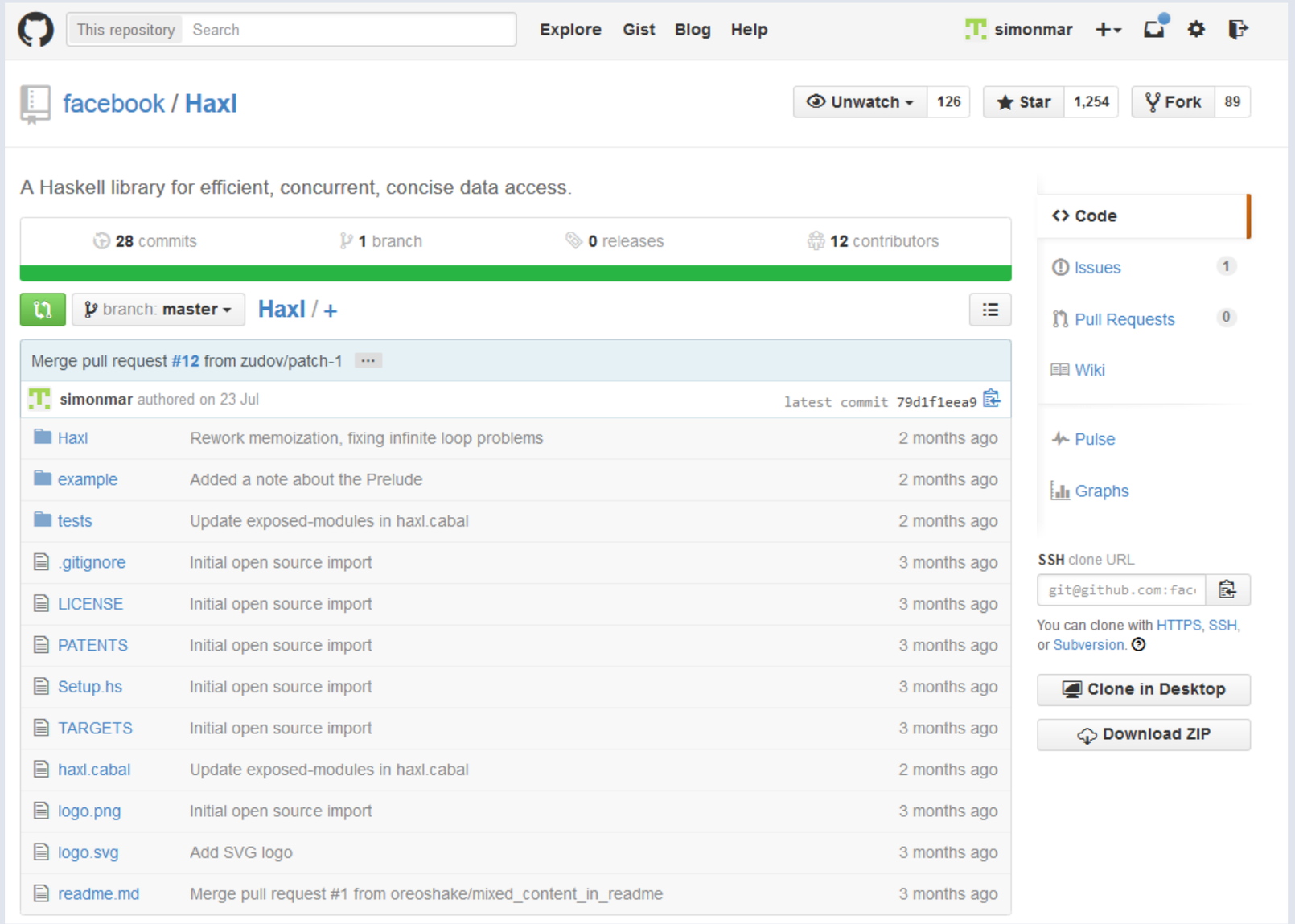
```
SELECT postinfo FROM posts
  WHERE postid = id1

SELECT postinfo FROM posts
  WHERE postid = id2

...
```

Batched

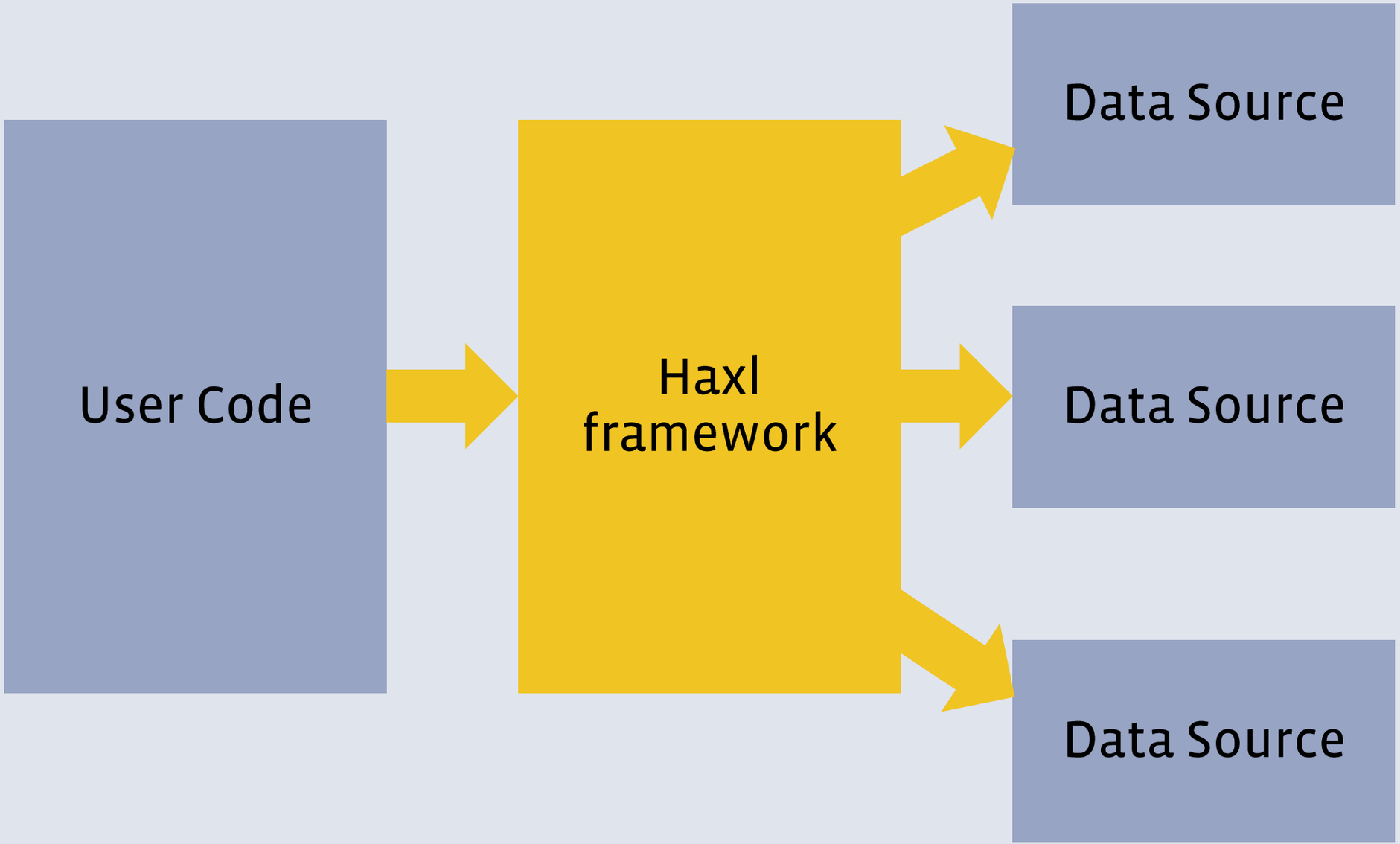
```
SELECT postinfo FROM posts
  WHERE postid IN {id1, id2, ...}
```

How *you* can use Haxl

Open Source: https://github.com/facebook/Haxl



```
cabal install haxl
```


User Code
Haxl framework
Data Source
Data Source
Data Source

DataSource walk-through

- We'll walk through two complete data sources

1. A data source for the Facebook Graph API
   - web API for querying the Facebook Graph
   - using Felipe Lessa's fb package to do the real work
   - Using threads to perform requests concurrently

2. A data source to extract data from an SQL database
   - Batching multiple requests into a single SQL query

```
dataFetch :: (DataSource u req, Request req a)
          => req a
          -> GenHaxl u a
```

```
dataFetch :: (DataSource u req, Request req a)
          => req a
          -> GenHaxl u a
```

DataSource class: every data source implements this

```
dataFetch :: (DataSource u req, Request req a)
          => req a
          -> GenHaxl u a
```

DataSource class: every data source implements this

```
type Request req a =
  ( Eq (req a)
  , Hashable (req a)
  , Typeable (req a)
  , Show (req a)
  , Show a
  )
```

```
dataFetch :: (DataSource u req, Request req a)
          => req a
          -> GenHaxl u a
```

DataSource class: every data source implements this

User state – passed around, can be accessed by data sources

```
type Request req a =
  ( Eq (req a)
  , Hashable (req a)
  , Typeable (req a)
  , Show (req a)
  , Show a
  )
```

- Start with the request type:

```
data FacebookReq a where
   GetObject      :: Id -> FacebookReq Object
   GetUser        :: UserId -> FacebookReq User
   GetUserFriends :: UserId -> FacebookReq [Friend]
  deriving Typeable
```

- We also need some boilerplate:

```
deriving instance Eq (FacebookReq a)
deriving instance Show (FacebookReq a)

instance Show1 FacebookReq where show1 = show

instance Hashable (FacebookReq a) where ...
```

The DataSource class

```
class DataSourceName req where
  dataSourceName :: req a -> Text

class (DataSourceName req, StateKey req, Show1 req)
      => DataSource u req where
  fetch
    :: State req
    -> Flags
    -> u
    -> [BlockedFetch req]
    -> PerformFetch

class Typeable f => StateKey (f :: * -> *) where
  data State f
```

The Haxl monad collects requests from dataFetch calls, and passes them to fetch

The DataSource class

```
class DataSourceName req where
  dataSourceName :: req a -> Text

class (DataSourceName req, StateKey req, Show1 req)
      => DataSource u req where
  fetch
    :: State req
    -> Flags
    -> u
    -> [BlockedFetch req]
    -> PerformFetch

class Typeable f => StateKey (f :: * -> *) where
  data State f
```

The Haxl monad collects requests from dataFetch calls, and passes them to fetch

```
instance DataSourceName FacebookReq where
 dataSourceName _ = "Facebook“
```

A data source has some state:

```
instance StateKey FacebookReq where
  data State FacebookReq =
    FacebookState
       { credentials :: Credentials
       , userAccessToken :: UserAccessToken
       , manager :: Manager
       , numThreads :: Int
       }
```

API keys

HTTP connection manager

Concurrency control

Initialise the state

```
initGlobalState
  :: Int
  -> Credentials
  -> UserAccessToken
  -> IO (State FacebookReq)

initGlobalState threads creds token = do
  manager <- newManager tlsManagerSettings
  return FacebookState
    { credentials = creds
    , manager = manager
    , userAccessToken = token
    , numThreads = threads
    }
```

- nothing surprising there.

Implementing fetch

```
class (DataSourceName req, StateKey req, Show1 req)
      => DataSource u req where
  fetch
    :: State req
    -> Flags
    -> u
    -> [BlockedFetch req]
    -> PerformFetch
```

Implementing fetch

```
class (DataSourceName req, StateKey req, Show1 req)
      => DataSource u req where
  fetch
    :: State req
    -> Flags
    -> u
    -> [BlockedFetch req]
    -> PerformFetch
```

Data source state

Implementing fetch

```
class (DataSourceName req, StateKey req, Show1 req)
      => DataSource u req where
  fetch
    :: State req
    -> Flags
    -> u
    -> [BlockedFetch req]
    -> PerformFetch
```

Data source state

Haxl monad flags (tracing etc.)

Implementing fetch

```
class (DataSourceName req, StateKey req, Show1 req)
      => DataSource u req where
  fetch
    :: State req
    -> Flags
    -> u
    -> [BlockedFetch req]
    -> PerformFetch
```

Data source state

Haxl monad flags (tracing etc.)

User state (we'll use () here)

Implementing fetch

```
class (DataSourceName req, StateKey req, Show1 req)
      => DataSource u req where
  fetch
    :: State req
    -> Flags
    -> u
    -> [BlockedFetch req]
    -> PerformFetch
```

Data source state

Haxl monad flags (tracing etc.)

User state (we'll use () here)

The requests!

```
data BlockedFetch r = forall a. BlockedFetch (r a) (ResultVar a)
```

Implementing fetch

```
class (DataSourceName req, StateKey req, Show1 req)
      => DataSource u req where
  fetch
    :: State req
    -> Flags
    -> u
    -> [BlockedFetch req]
    -> PerformFetch
```

Data source state

Haxl monad flags (tracing etc.)

User state (we'll use () here)

The requests!

sync or async?

```
data BlockedFetch r = forall a. BlockedFetch (r a) (ResultVar a)
```

```
data PerformFetch
  = SyncFetch  (IO ())
  | AsyncFetch (IO () -> IO ())
```

Implement fetch

```
data PerformFetch
  = SyncFetch  (IO ())
  | AsyncFetch (IO () -> IO ())
```

```
instance DataSource u FacebookReq where
  fetch = facebookFetch

facebookFetch
  :: State FacebookReq
  -> Flags
  -> ()
  -> [BlockedFetch FacebookReq]
  -> PerformFetch

facebookFetch FacebookState{..} _flags _user bfs =
  AsyncFetch $ \inner -> do
    sem <- newQSem numThreads
    asyncs <- mapM (async . fetchAsync credentials manager
                                  userAccessToken sem) bfs
    inner
    mapM_ wait asyncs
```

- Implement fetchAsync

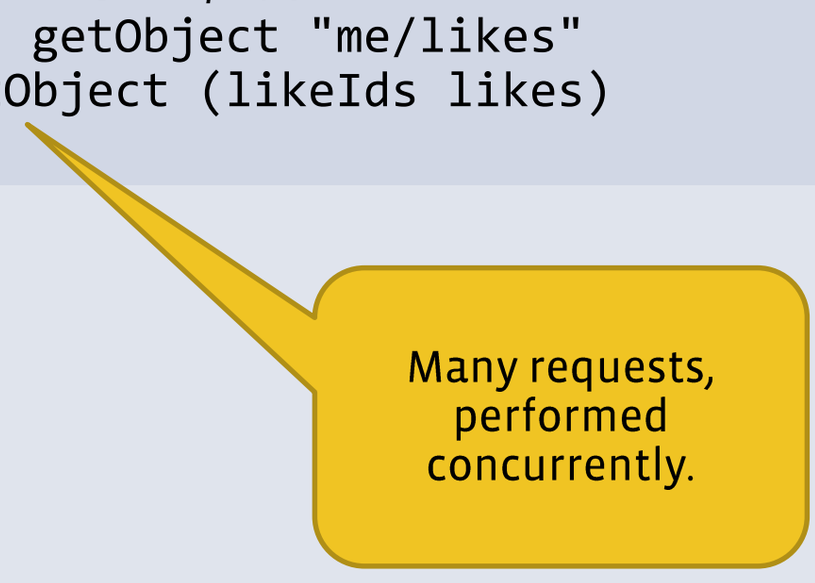
```
fetchAsync
  :: Credentials -> Manager -> UserAccessToken -> QSem
  -> BlockedFetch FacebookReq
  -> IO ()

fetchAsync creds manager tok sem (BlockedFetch req rvar) =
  bracket_ (waitQSem sem) (signalQSem sem) $ do

  e <- Control.Exception.try $
       runResourceT $
       runFacebookT creds manager $
       fetchReq tok req

  case e of
    Left ex -> putFailure rvar (ex :: SomeException)
    Right a -> putSuccess rvar a
```

- fetchReq maps FacebookReq to FacebookT computations

```
fetchReq
  :: UserAccessToken
  -> FacebookReq a
  -> FacebookT Auth (ResourceT IO) a

fetchReq tok (GetObject (Id id)) =
  getObject ("/" <> id) [] (Just tok)

fetchReq _tok (GetUser id) =
  getUser id [] Nothing

fetchReq tok (GetUserFriends id) = do
  f <- getUserFriends id [] tok
  source <- fetchAllNextPages f
  source $$ consume
```

Example

```
main :: IO ()
main = do
  (creds, access_token) <- getCredentials
  facebookState <- initGlobalState 10 creds access_token
  env <- initEnv (stateSet facebookState stateEmpty) ()
  r <- runHaxl env $ do
    likes <- getObject "me/likes"
    mapM getObject (likeIds likes)
  print r
```



SQL example

Questions?

https://github.com/facebook/Haxl

```
cabal install haxl
```