

Aakash Sabharwal

@aakashsabharwal



Stefanie Schirmer

@linse

Your Search Service as a Composable Function

Etsy

- online marketplace
- 1.5 million active sellers
- handmade + vintage items

The screenshot shows the Etsy homepage with the following elements:

- Header:** The Etsy logo on the left, a search bar with the text "Search for items or shops" and a "Search" button, and links for "Sell on Etsy", "Register", "Sign in", and a shopping cart icon.
- Navigation:** A horizontal menu with categories: Jewelry & Accessories, Clothing & Shoes, Home & Living, Wedding & Party, Toys & Entertainment, Art & Collectibles, Craft Supplies & Tools, and Vintage.
- Featured Banners:**
 - A yellow banner for "GARDENING Hand-crafted by green thumbs." with a "Shop now >" link.
 - A banner for "Unique accents for the big 'I do'." featuring a dog and shoes, with a "Shop now >" link.
 - A yellow banner for "Fantastic finds that ship for free >".
- Value Propositions:** Three columns with checkmarks and text:
 - "Unique everything: We have millions of one-of-a-kind items, so you can find whatever you need (or really, really want)."
 - "Independent sellers: Buy directly from someone who put their heart and soul into making something special."
 - "Secure shopping: We use best-in-class technology to protect your transactions."
- Discover lists by creative people:** A section titled "A new way to explore" featuring a grid of product lists:
 - "Patches" by Ginger, showing various patches.
 - "back to black" by Sheila, showing black-themed items.
 - "marry me" by Jody and Kari, showing wedding-related items.
 - "Cats" by Valerie, showing cat-themed items.
- Popular right now:** A row of product listings with images, titles, seller names, ratings, and prices:
 - "About to Leave - Graphic No..." by framedd, 4.5 stars (2,293 reviews), €20.18, Best Seller.
 - "Rarest of Them All Father's D..." by gctamago, 5 stars (755 reviews), €4.38.
 - "Amigurumi crochet doll part..." by BubblesAndBongo, 4.5 stars (1,143 reviews), €3.80, Best Seller.
 - "Pink Guatemalan Itat + Brass ..." by AnimalsInCharge, 4.5 stars (745 reviews), €26.23.
 - "Nursery Wall Art, Girl X O Pri..." by LILxLOLA, 4.5 stars (3,901 reviews), €5.77.
 - "Mid Century Modern Plant St..." by HookAndStemCo, 4.5 stars (923 reviews), €31.10 (€34.55 10% off).

Etsy

- online marketplace
- 1.5 million active sellers
- handmade + vintage items
- **unique** search problem!

The screenshot shows the Etsy search results for 'sun microsystems'. The top navigation bar includes the Etsy logo, a search bar with 'sun microsystems' entered, and links for 'Sell on Etsy', 'Register', 'Sign In', and 'Cart'. Below the navigation bar are category tabs: Jewelry & Accessories, Clothing & Shoes, Home & Living, Wedding & Party, Toys & Entertainment, Art & Collectibles, Craft Supplies & Tools, and Vintage. The search results are displayed in a grid of four items, each with a thumbnail image, title, seller name, star rating, and price. The items are: 1. Custom LSC keycap for Cherry MX s... (Decendkeyboards, 5 stars, 123 reviews, €4.39). 2. Vintage 90s JAVA Shirt Size M Free S... (maxvintageshop, 5 stars, 190 reviews, €28.07 Free shipping). 3. Rare!! True Vintage 90s Nike Sweats... (Negoc1990, 5 stars, 89 reviews, €21.04). 4. Vintage JAVA Sun Microsystems Pro... (hainesstreet, 5 stars, 11 reviews, €24.56). On the left side of the search results, there are several filter sections: 'All categories' (Clothing, Electronics & Accessories, Accessories), 'Shipping' (Free shipping, Ready to ship in 1 business day, Ready to ship within 3 business days), 'Special offers' (On sale), 'Shop location' (Anywhere, Germany, Custom), 'Item type' (All items, Handmade, Vintage), 'Price (€)' (Any price, Under €20, €20 to €50, €50 to €100, Over €100, Custom), and 'Ordering options' (Accepts Etsy gift cards, Customizable, Can be gift-wrapped). At the bottom of the filters, there is a 'Ship to' dropdown menu set to 'Germany'. Below the search results, there is a pagination bar showing '< 1 >'. At the bottom of the page, there is a promotional banner for 'Get fresh Etsy trends and unique gift ideas delivered right to your inbox.' with an email input field and a 'Subscribe' button. The footer contains links for 'Shop' (Gift cards, Etsy blog), 'Sell' (Sell on Etsy, Teams), 'About' (Etsy, Inc., Policies), and 'Follow Etsy' (Facebook, Instagram).

The screenshot shows the footer of the Etsy website. It features a promotional banner at the top with the text 'Get fresh Etsy trends and unique gift ideas delivered right to your inbox.' and a 'Subscribe' button. Below the banner, there are four columns of links: 'Shop' (Gift cards, Etsy blog), 'Sell' (Sell on Etsy, Teams), 'About' (Etsy, Inc., Policies), and 'Follow Etsy' (Facebook, Instagram).

Infrastructure Challenge



Etsyweb

Etsy

Search for items or shops

Search

Sell on Etsy

Register

Sign in

Cart

Jewelry & Accessories

Clothing & Shoes

Home & Living

Wedding & Party

Toys & Entertainment

Art & Collectibles

Craft Supplies & Tools

Vintage

GARDENING

Hand-crafted by green thumbs.

Shop now >



Unique accents for the big "I do".

Shop now >

Fantastic finds that ship for free >

✓ Unique everything
We have millions of one-of-a-kind items, so you can find whatever you need (or really, really want).

✓ Independent sellers
Buy directly from someone who put their heart and soul into making something special.

✓ Secure shopping
We use best-in-class technology to protect your transactions.

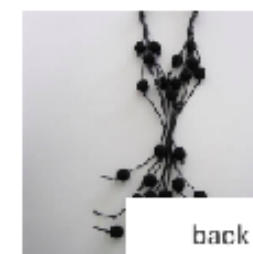
Discover lists by creative people

A new way to explore



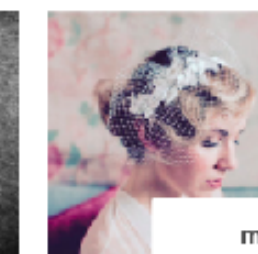
Patches

by Ginger



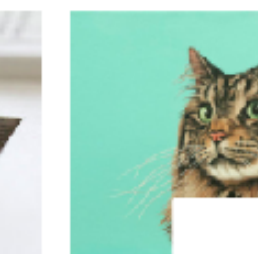
back to black

by Stella



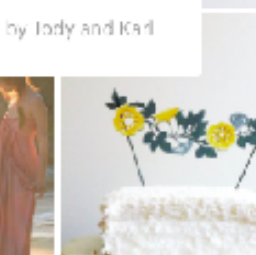
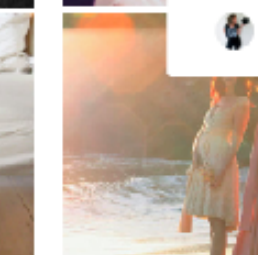
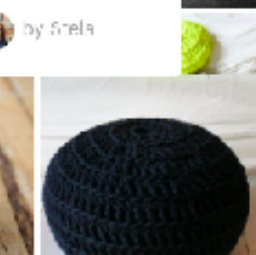
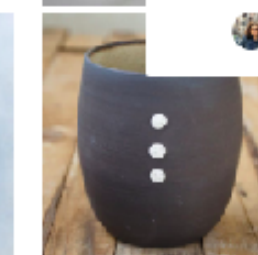
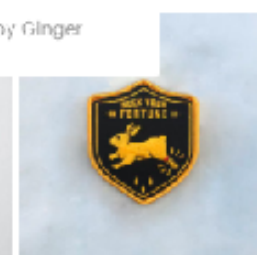
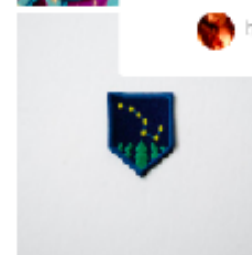
marry me

by Jody and Kyd

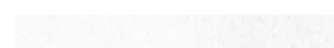
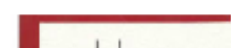


Cats

by Valerie



Popular right now





Etsyweb

Etsy [Sell on Etsy](#) [Register](#) [Sign in](#)

[Jewelry & Accessories](#) [Clothing & Shoes](#) [Home & Living](#) [Wedding & Party](#) [Toys & Entertainment](#) [Art & Collectibles](#) [Craft Supplies & Tools](#) [Vintage](#)

GARDENING
Hand-crafted by green thumbs.
[Shop now >](#)

Unique accents for the big "I do".
[Shop now >](#)

Fantastic finds that ship for free >

- ✓ **Unique everything**
We have millions of one-of-a-kind items, so you can find whatever you need (or really, really want).
- ✓ **Independent sellers**
Buy directly from someone who put their heart and soul into making something special.
- ✓ **Secure shopping**
We use best-in-class technology to protect your transactions.

Discover lists by creative people

A new way to explore

Patches
by Ginger

back to black
by Drew

marry me
by Body and Soul

Cats
by Sallie

Popular right now

About a Boy - Geoff Kin...
framed
★★★★★ (2,292)
€20.18

Rarest of Them All: Father's D...
geterago
★★★★★ (758)
€4.38

Amigurami crochet doll pat...
BulovaIndBongo
★★★★★ (1,145)
€3.80

Pink Guatemalan Hat + Bress...
AnimalsnCharge
★★★★★ (453)
€26.23

Nursery Wall Art, Girl X O Pri...
LILALOLA
★★★★★ (3,901)
€9.77

Mid-Century Modern Plant St...
HookAndStemCo
★★★★★ (623)
€31.00 ~~€34.88~~ (12% off)

Shop by category





Etsyweb

The screenshot shows the Etsy website homepage. At the top, there is a search bar with the text "Search for items or shops" and a "Search" button. To the right of the search bar are links for "Sell on Etsy", "Register", "Sign in", and a shopping cart icon. Below the search bar is a navigation menu with categories: "Jewelry & Accessories", "Clothing & Shoes", "Home & Living", "Wedding & Party", "Toys & Entertainment", "Art & Collectibles", "Craft Supplies & Tools", and "Vintage".

The main content area features several promotional banners. The first banner is for "GARDENING" with the text "Hand-crafted by green thumbs." and a "Shop now" link. The second banner is for "Unique accents for the big 'I do'." featuring a dog and shoes, with a "Shop now" link. Below these banners are three key features:

- Unique everything:** We have millions of one-of-a-kind items, so you can find whatever you need (or really, really want).
- Independent sellers:** Buy directly from someone who put their heart and soul into making something special.
- Secure shopping:** We use best-in-class technology to protect your transactions.

Below the features is a section titled "Discover lists by creative people" with the subtitle "A new way to explore". This section displays several curated lists with images and titles: "Patches" by Ginger, "back to black" by Drew, "marry me" by body and knit, and "Cats" by Solstice.

The next section is "Popular right now", which displays a grid of product listings. Each listing includes a product image, title, seller name, star rating, and price. For example, one listing is "About to Leave - Graphic No. 1" by framed, priced at €20.18. Another is "Pink Guatemalan Hat + Brass..." by AnimalCharger, priced at €26.23.

At the bottom, there is a section titled "Shop by category" with a grid of category images.



Search Backend





Etsyweb

The screenshot shows the Etsy website interface. At the top, there is a search bar with the text "Search for items or shops" and a "Search" button. To the right of the search bar are links for "Sell on Etsy", "Register", "Sign in", and a shopping cart icon. Below the search bar is a horizontal navigation menu with categories: "Jewelry & Accessories", "Clothing & Shoes", "Home & Living", "Wedding & Party", "Toys & Entertainment", "Art & Collectibles", "Craft Supplies & Tools", and "Vintage".

The main content area features several promotional banners:

- A yellow banner on the left with the text "GARDENING Hand-crafted by green thumbs. Shop now >" and an image of a potted plant.
- A white banner on the right with the text "Unique accents for the big 'I do'." and "Shop now >" featuring an image of a dog and a pair of shoes.
- A yellow banner below the white one with the text "Fantastic finds that ship for free >".

Below the banners are three columns of text:

- "Unique everything: We have millions of one-of-a-kind items, so you can find whatever you need (or really, really want)."
- "Independent sellers: Buy directly from someone who put their heart and soul into making something special."
- "Secure shopping: We use best-in-class technology to protect your transactions."

The next section is titled "Discover lists by creative people" with the subtitle "A new way to explore". It displays a grid of list thumbnails:

- "Patches" by Ginger
- "back to black" by Drew
- "marry me" by body and knit
- "Cats" by Solstice

Below this is a "Popular right now" section showing a grid of product listings with images, titles, ratings, and prices.

- "About to Leave - Graphic No..." by framed
- "Rarest of Them All Father's D..." by geterago
- "Amigurumi crochet doll pat..." by BulovaPridBongo
- "Pink Guatemalan Hat + Bress..." by AnimalCharger
- "Nursery Wall Art, Girl X O Pri..." by LILALOLA
- "Mid-Century Modern Plant St..." by HookAndStemCo

The bottom section is titled "Shop by category" and shows a row of category thumbnails.



Search Backend





Etsyweb

The screenshot shows the Etsy homepage with a search bar at the top, navigation links for various categories, and several promotional banners. The main banner features a potted plant with the text 'Hand-crafted by green thumbs.' Below this are three key features: 'Unique everything', 'Independent sellers', and 'Secure shopping'. A section titled 'Discover lists by creative people' displays a grid of product lists like 'Patches', 'back to black', 'marry me', and 'Cats'. At the bottom, there is a 'Popular right now' section with product cards and a 'Shop by category' section.



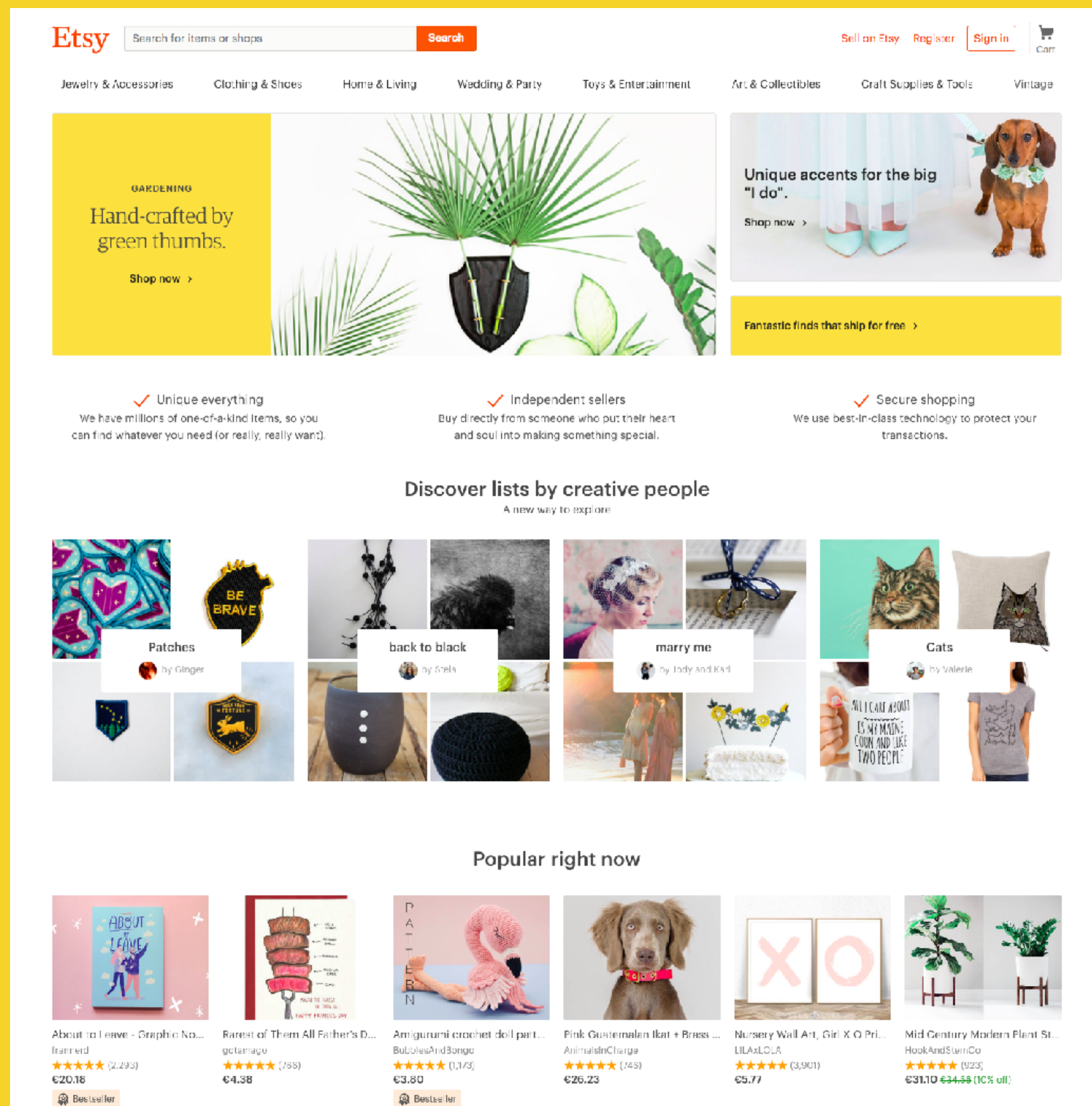
Search Backends



Machine Learning Models



Etsyweb



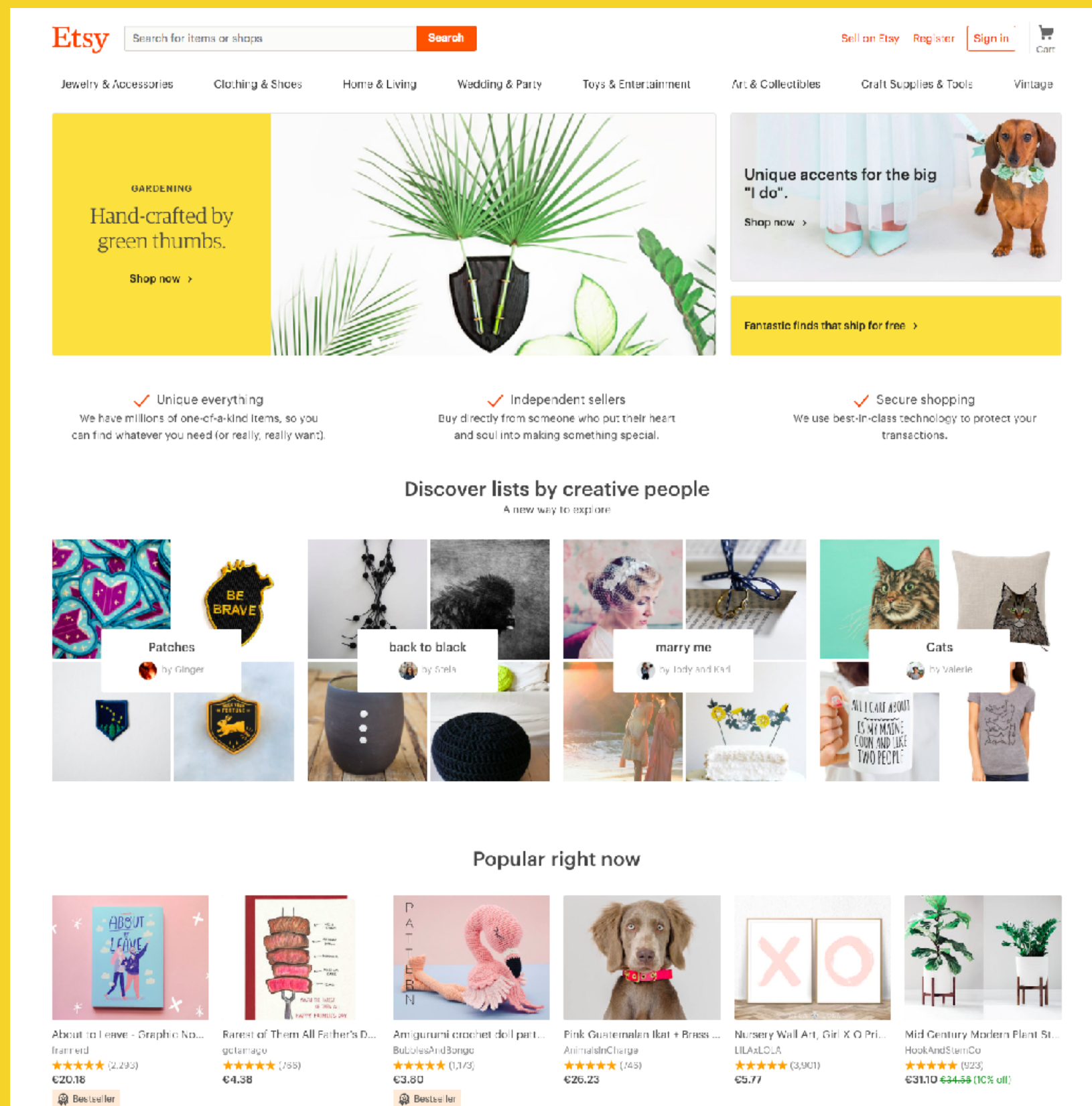
Search Backends



Machine Learning Models



Etsyweb



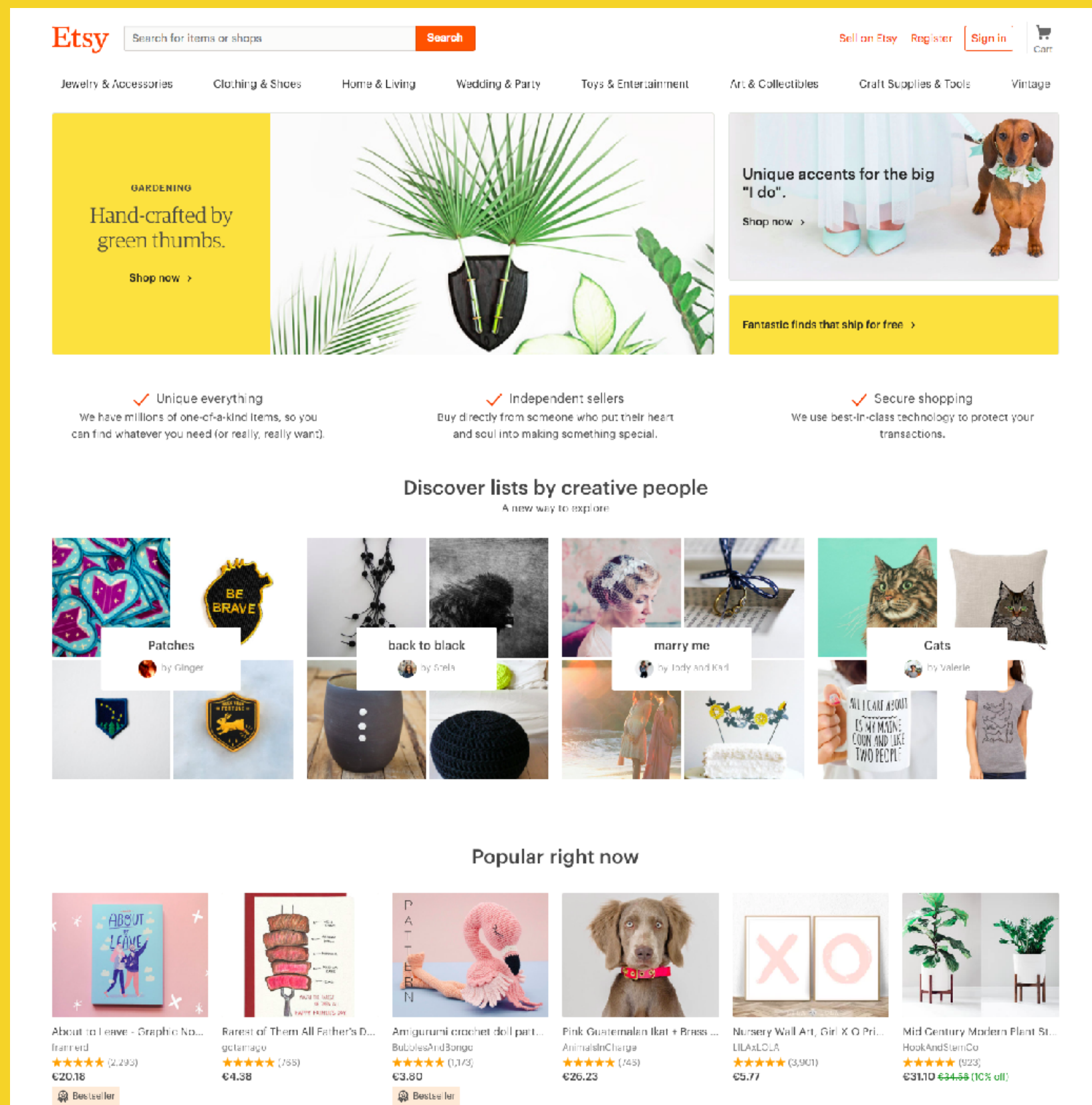
Search Backends



Machine Learning Models



Etsyweb



Search Backends



Acquiring a New Approach

Etsy buys Blackbird Technologies to bring AI to its search

Ingrid Lunden @hgridlunden / Sep 20, 2016

Comment



It's not just gigantic search engines that are looking to [acquire tech and talent](#) around emerging areas like speech recognition. Even design and craft marketplaces can use a little machine learning and artificial intelligence to make their wheels turn a little better.

Today, the popular handmade-goods site [Etsy](#) announced it has [acquired](#) a startup called [Blackbird Technologies](#), which developed algorithms for natural language processing, image recognition and analytics — similar to those used by Amazon and Google for product and other searches — and then “democratized” them to be used by any company of any size. At Etsy, the tech will be used to improve its own search features.

Financial terms of the deal have not been disclosed, but we're asking and will update if we learn more. The company's employees — it appears [there were around 10](#) — will all be joining Etsy. “The team possesses a deep expertise in Artificial Intelligence, search, and distributed systems and has direct experience working in these areas for some of the largest technology companies in the world,” [Etsy](#) @ said in a statement.

Little is known about Blackbird — no listings on Crunchbase or AngelList, a fairly unspecific website for Blackbird itself — and even Etsy's announcement of the deal is light on company details. According to LinkedIn, though, the two co-founders are [Nikhil Raghavan](#) (CEO) and [Manju Rajashekhar](#) (CTO), who collectively had worked on similar technologies across places like Google, Twitter, Microsoft, Oracle and Yahoo.

Because Etsy is going to be using Blackbird's tech for its own platform, it seems that Blackbird's [current business plans](#), which deployed its tech by way of an API, will shut down. Customers had [included](#) Nasty Gal, Thrall ID and Teabutter.

Functional Programming in

Scala



Paul Chiusano
Rúnar Bjarnason



Your Server as a Function

Marius Eriksen

Twitter Inc.
marius@twitter.com

Abstract

Building server software in a large-scale setting, where systems exhibit a high degree of concurrency and environmental variability, is a challenging task to even the most experienced programmer. Efficiency, safety, and robustness are paramount—goals which have traditionally conflicted with modularity, reusability, and flexibility.

We describe three abstractions which combine to present a powerful programming model for building safe, modular, and efficient server software: Composable *futures* are used to relate concurrent, asynchronous actions; *services* and *filters* are specialized functions used for the modular composition of our complex server software.

Finally, we discuss our experiences using these abstractions and techniques throughout Twitter’s serving infrastructure.

Categories and Subject Descriptors D.1.1 [Programming techniques]: Applicative (Functional) Programming; D.1.3 [Program-

Services Systems boundaries are represented by asynchronous functions called *services*. They provide a symmetric and uniform API: the same abstraction represents both clients and servers.

Filters Application-agnostic concerns (e.g. timeouts, retries, authentication) are encapsulated by *filters* which compose to build services from multiple independent modules.

Server operations (e.g. acting on an incoming RPC or a timeout) are defined in a declarative fashion, relating the results of the (possibly many) subsequent sub-operations through the use of future combinators. Operations are phrased as *value transformations*, encouraging the use of immutable data structures and, we believe, enhancing correctness through simplicity of reasoning.

Operations describe *what* is computed; execution is handled separately. This frees the programmer from attending to the minu-



Your Server as a ^{Set of Composable} Functions

Marius Eriksen

Twitter Inc.
marius@twitter.com

Req => Future [Rep]

Abstract

Building server software in a large-scale setting, where systems exhibit a high degree of concurrency and environmental variability, is a challenging task to even the most experienced programmer. Efficiency, safety, and robustness are paramount—goals which have traditionally conflicted with modularity, reusability, and flexibility.

We describe three abstractions which combine to present a powerful programming model for building safe, modular, and efficient server software: Composable *futures* are used to relate concurrent, asynchronous actions; *services* and *filters* are specialized functions used for the modular composition of our complex server software.

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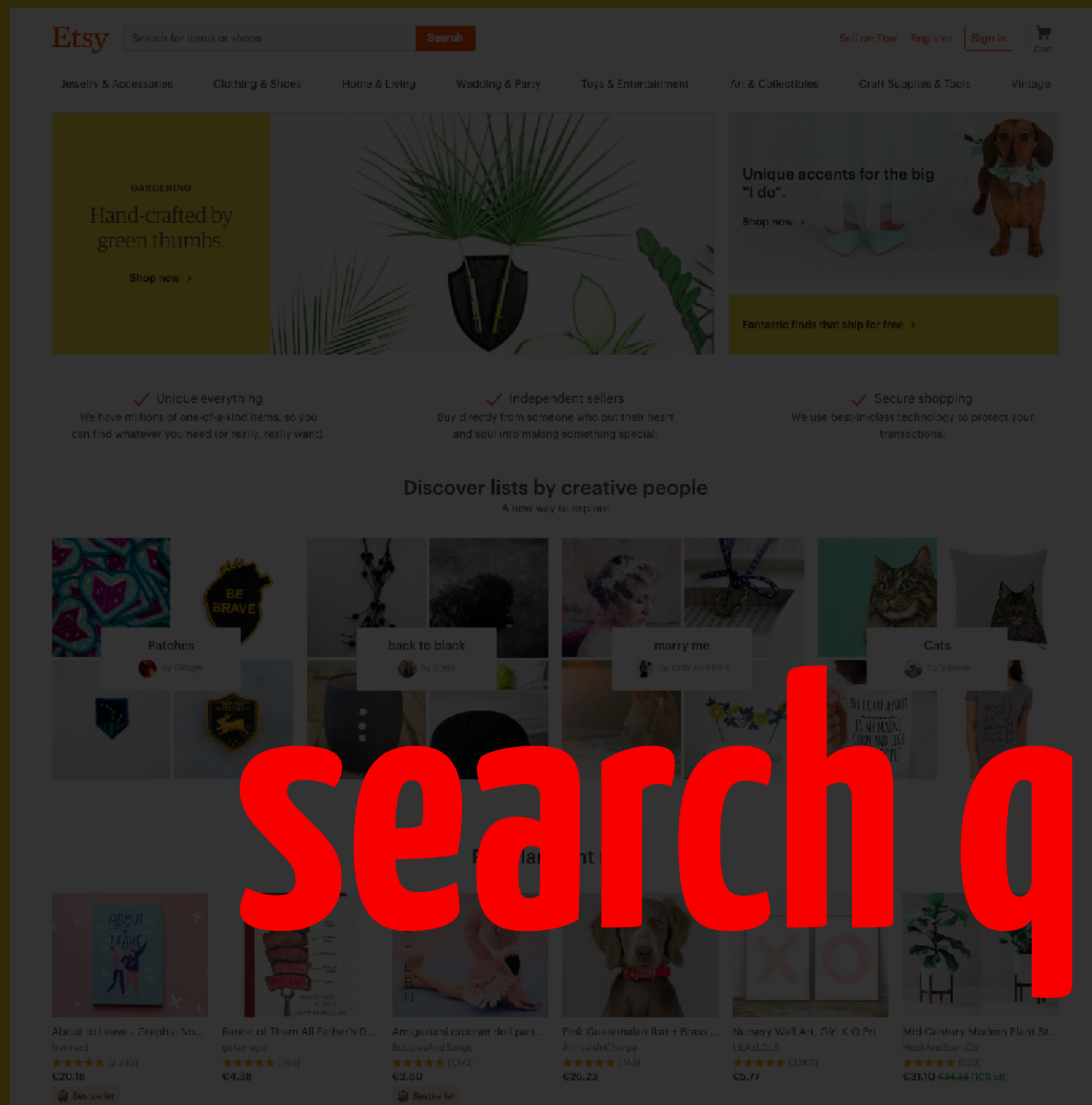
Operations describe *what* is computed; execution is handled separately. This frees the programmer from attending to the minu-

Machine Learning Models

Search Backends



Etsyweb



Goal:

rewrite

search query + response

Machine Learning Models

Search Backends



Etsyweb



Format:

proxy, “no state”

async + protocol agnostic

WARRIOR
TO THE EDGE™

Future + slow call

```
scala> |
```

Service + slow service

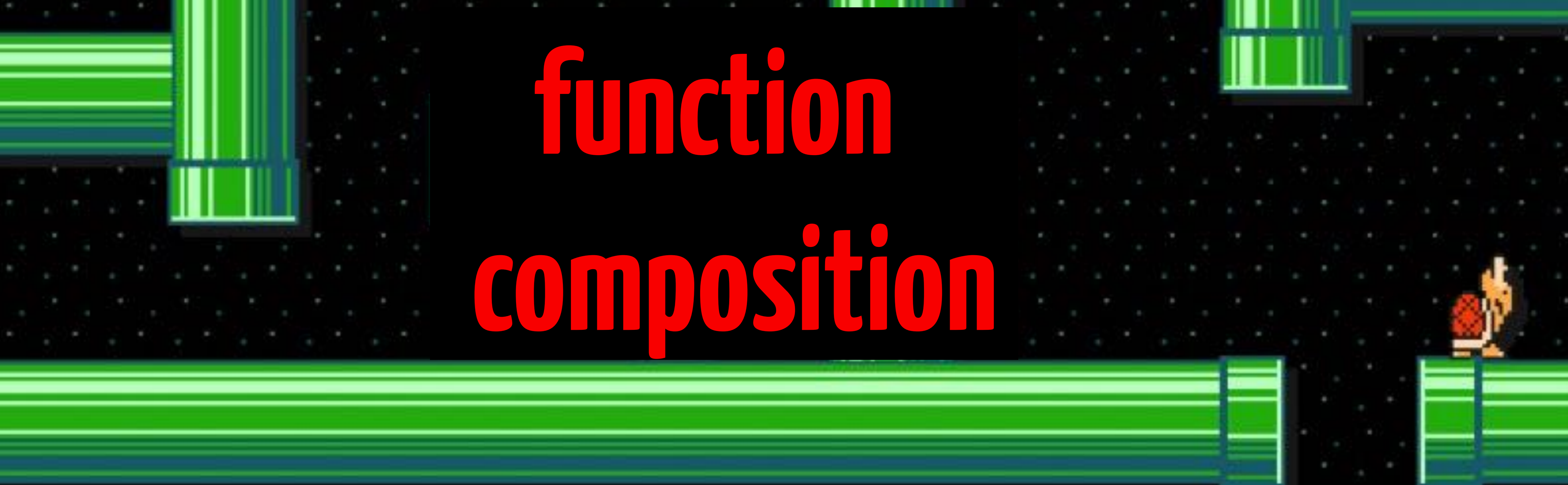
```
scala> 
```



$$g(f(x)) = g \circ f(x)$$



**function
composition**



Service with filter

```
import com.twitter.finagle.Service
import com.twitter.finagle.http

val service: Service[http.Request, http.Response] = ...
val timeoutFilter = new TimeoutFilter[http.Request, http.Response](...)

val serviceWithTimeout: Service[http.Request, http.Response] =
  timeoutFilter.andThen(service)
~
~
~
~
~
~
~
~
~
~
~
~
-- VISUAL --
```


A Finagle Service

```
trait Service[Req, Rep]  
extends (Req => Future[Rep])
```

```
import com.twitter.util.Future
import org.jboss.netty.handler.codec.http._
import com.twitter.logging.Logger
import com.twitter.finagle.http.{Method, Request, Response, Version}
import play.filters.joob.{Null, Joob}
import scala.concurrent.duration._
```

```
import scalaz.{V, V-}
import java.util.zip.CRC32
```

```
object ArizonaService {
```

```
  // Usually we read this map from production.php. This is for testing convenience only.
  val shard2hostForTestingOnly = Map(1 -> "az-shard-1-vip.ny2.etsy.com:80", 2 -> "az-shard-2-vip.ny2.etsy.com:80")
}
```

```
case class ArizonaService(name: String, shard2host: Map[Int, String], sro: Option[StatsReceiver], timeout: Int = 100)
  extends Service[ArizonaRequest, ArizonaResponse] {
```

```
  private val log = Logger(getClass)
  private val sr = sro.getOrElse(DefaultStatsReceiver)
  private val retryFilter = RetryTimeoutsFilter[Request, Response](sr, log, 1)
```

```
  if (shard2host.isEmpty) {
    throw new Exception("shard2host map was empty.");
  }
```

```
  private[this] val shard2client = shard2host.map { case (s, h) => (s, shardedClient(s, h)) }.toMap
```

```
  private[this] val threadLocalShardHasher = new ThreadLocal[CRC32] {
    protected override def initialValue(): CRC32 =
      new CRC32
  }
```

```
  def shardedClient(shard: Int, host: String): Service[Request, Response] = {
```

apply: ArizonaReq => Future[ArizonaRsp]

```
def apply(req: ArizonaRequest): Future[ArizonaResponse] =  
  req match {  
    case MultiGet(_, keys) if keys.size > MultiGet.maximumRequestSize =>  
      Future.exception(  
        new RuntimeException(  
          s"MultiGet supports up to $MultiGet.maximumRequestSize request; got ${keys.size}"  
        )  
      )  
    case _ => {  
      val datasetName = req.dataset_name  
      val shardHasher = threadLocalShardHasher.get()  
      shardHasher.reset()  
      shardHasher.update(datasetName.getBytes(StandardCharsets.UTF_8))  
      val shardNum = (shardHasher.getValue() % shard2client.keys.size).toInt + 1  
      val client = shard2client.getOrElse(shardNum, throw new Exception(s"Client for shard $shardNum missing."))  
  
      val r = Request(Version.Http11, Method.Get, makeUrl(req))  
      r.headerMap.set(HttpHeaders.Names.CONNECTION, HttpHeaders.Values.KEEP_ALIVE)  
      r.headerMap.set(  
        HttpHeaders.Names.HOST,   
        shard2host.getOrElse(shardNum, throw new Exception(s"Host for shard $shardNum missing."))  
      );  
  
      client(r).map { resp =>  
        makeResponse(req, resp)  
      }  
    }  
  }
```

fail if multiget #keys exceeded

find client for shard

set request headers

```
Service: Req => Future[Rep]
```

```
def Future[A].flatMap[B](f: A =>  
    Future[B]): Future[B]
```

Future: can flatMap over it!

```
val f = for {  
  user    <- authenticate(request)  
  banned <- isBanned(user)  
} yield (user, banned)
```

reader monad



Readers

**/ListingSearchThriftController.scala:

```
def handle(Search) { args: Search.Args =>
  val req = constructReq(args)
  val rsp = for {
    config    <- cdb.read[Config](req)
    index     <- req.read("index") \> "url path is missing index component"
    ctx       <- config.read[SearchCSRctx](index -> req)
  } yield {
    searchWithBackoff(args)(ctx.listingsCtx)
  }
  rsp.fold(e => Future.exception(new RuntimeException(e)), resFuture => resFuture)
}
```

A Merlin Mixer Service

Req => ReaderToFuture[Ctx, Rep]

Type: Reader to Future

ReaderMonad + FutureMonad

```
type ReaderToFuture[Req, Rep] = ReaderT[Future, Req, Rep]
```

```
object ReaderToFuture extends KleisliInstances {  
  def apply[Req, Rep](f: Req => Future[Rep]): ReaderToFuture[Req, Rep] = Kleisli.kleisli(f)  
}
```

```
implicit object FutureMonad extends Monad[Future] {  
  def point[A](a: => A): Future[A] = Future.value(a)  
  
  def bind[A, B](fa: Future[A])(f: A => Future[B]): Future[B] = fa.flatMap(f)  
}
```



It's a proxy!

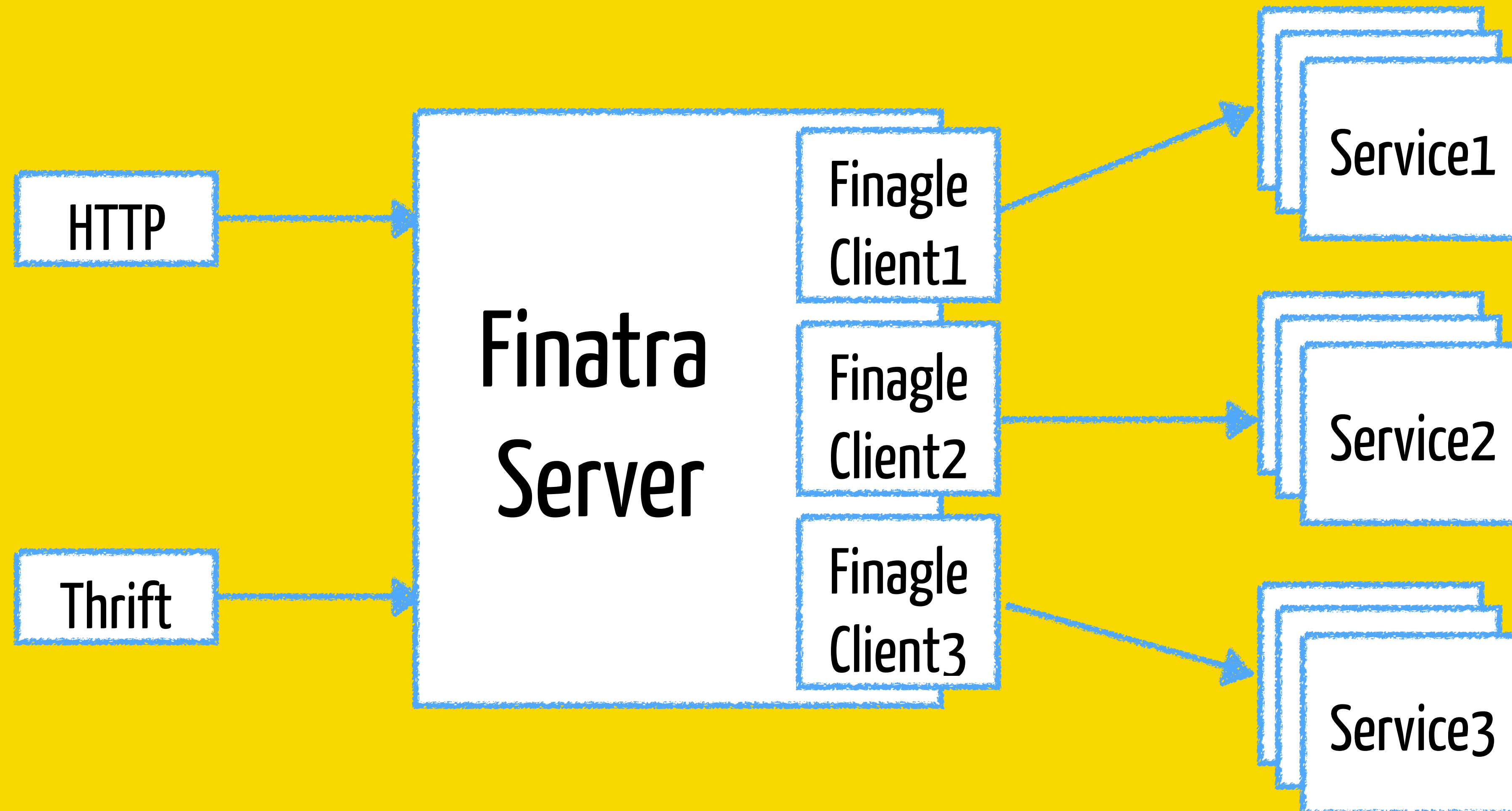
ThriftReq =>

ReaderToFuture[Ctx, ThriftRep]

Example Query Pipeline



MMX: Built with Finatra & Finagle

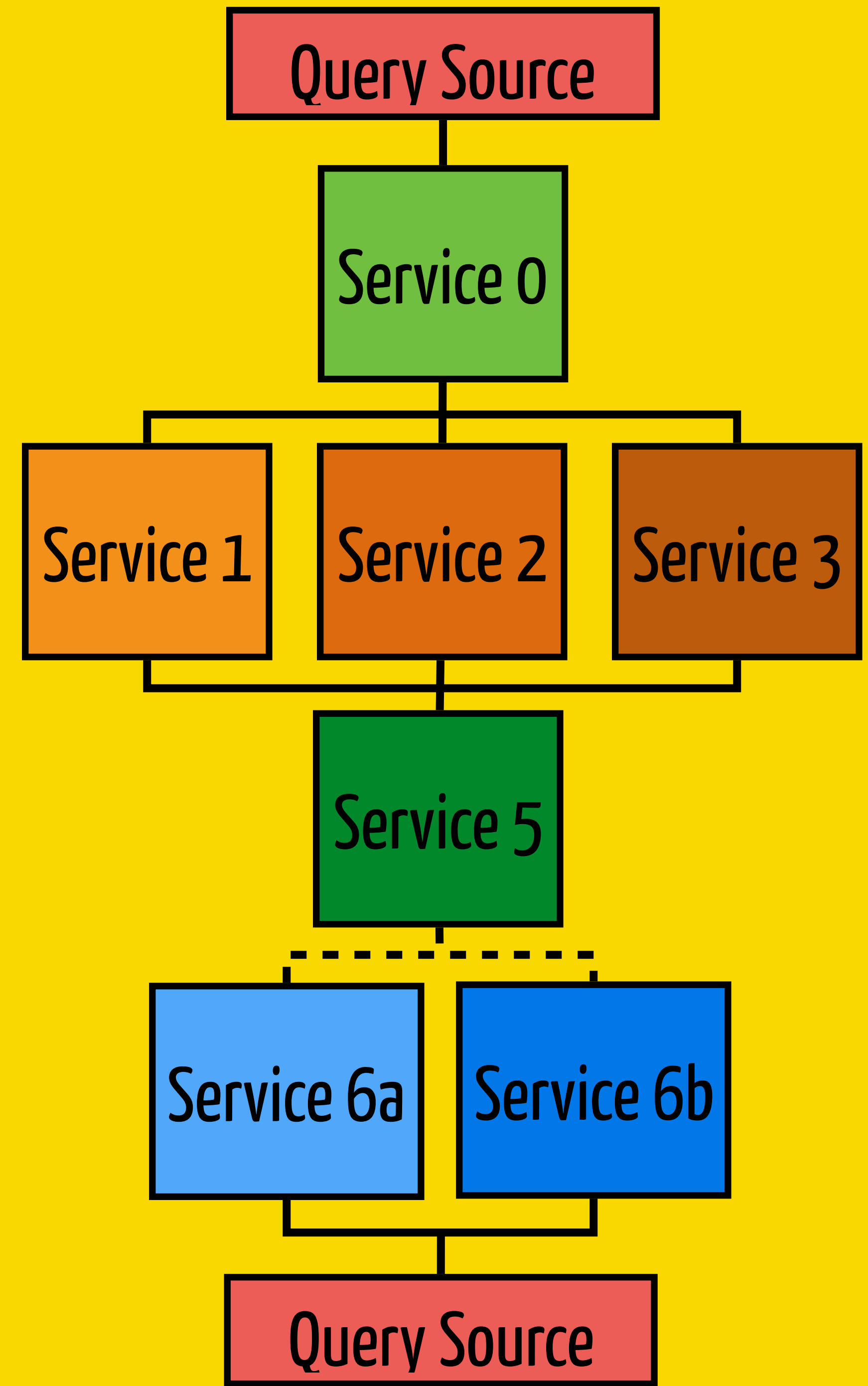


What is a Service?



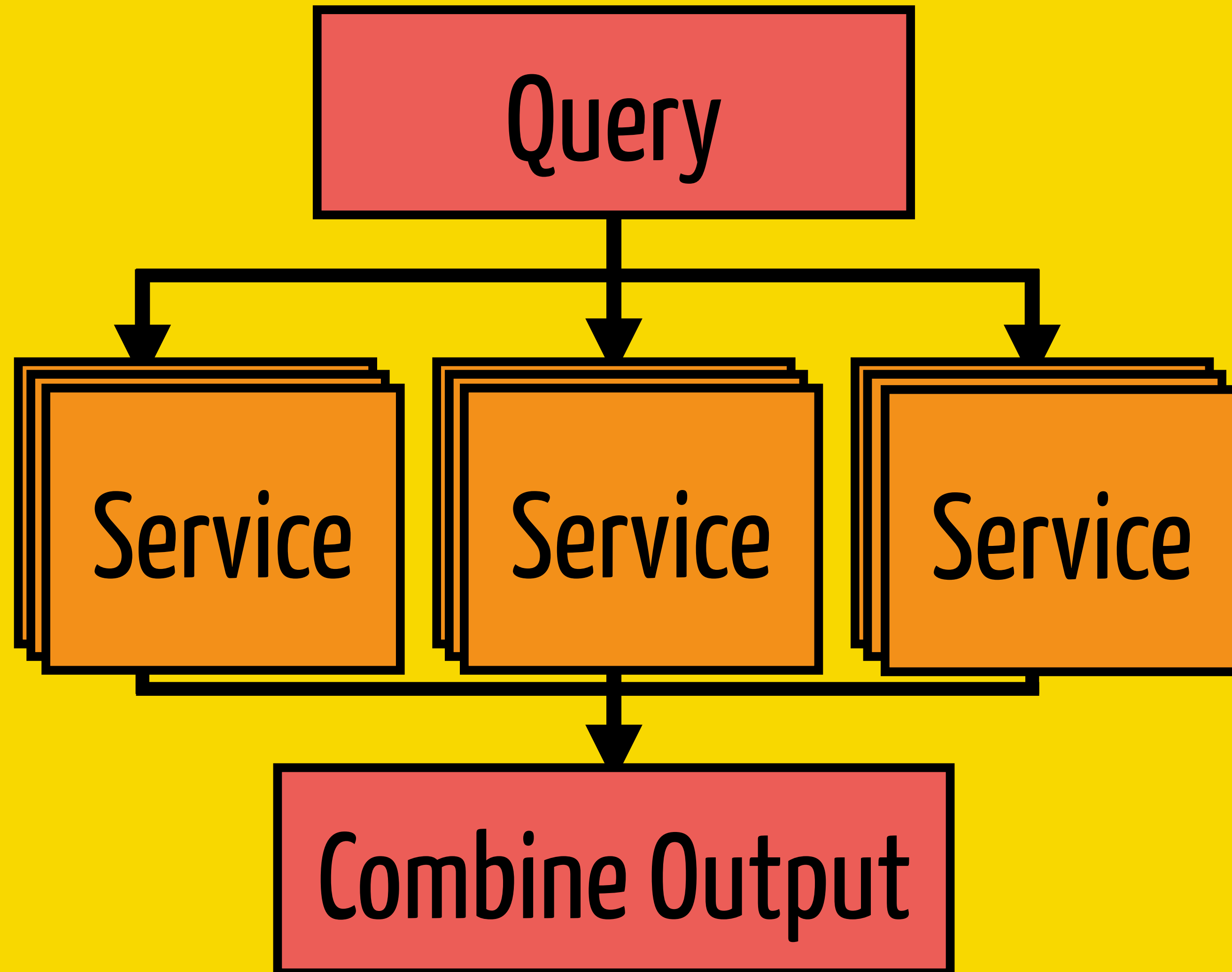
**A Query Pipeline:
Sequential +
Concurrent Calls**

call all!



call one!

Horizontally Scalable



Service building blocks



- **Search Indexes**
 - Solr
 - ElasticSearch

- **Feature & Candidate stores**

- Arizona —> Key-Value Store
- BigTable / DynamoDb
- Mysql



- **Cached model output**
 - Memcache / Redis





VOWPAL WABBIT

The Incredible
PYTORCH



TensorFlow

Service building blocks

- **Models** → Hosted on a separate service.
 - Engine agnostic: **Vowpal Wabbit** or **tensorflow** or **pytorch**?
 - **Json Input** → **Output over HTTP**
 - **Send batch calls with features** → **get back scores.**
 - **Finagle** : send parallel batches!
- **External APIs**
 - **Any cloud provider ML APIs.**



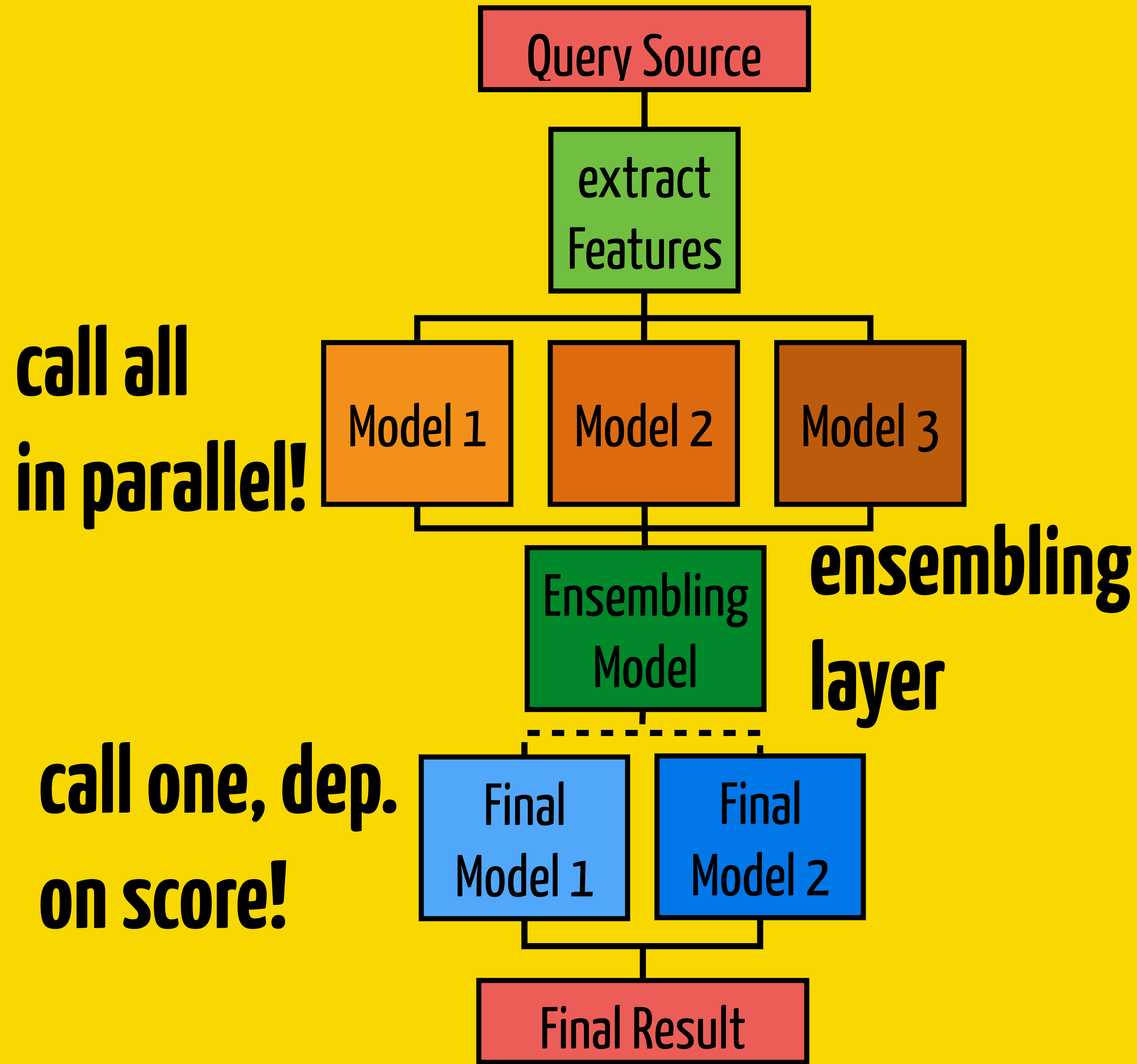
Models as a service!

- **Inference in real time**
 - No precomputed values → **No fixed domain**
 - Separate update schedules for model & feature stores
- **Each model scales independently.**
 - Allows sub-models to be more expensive.

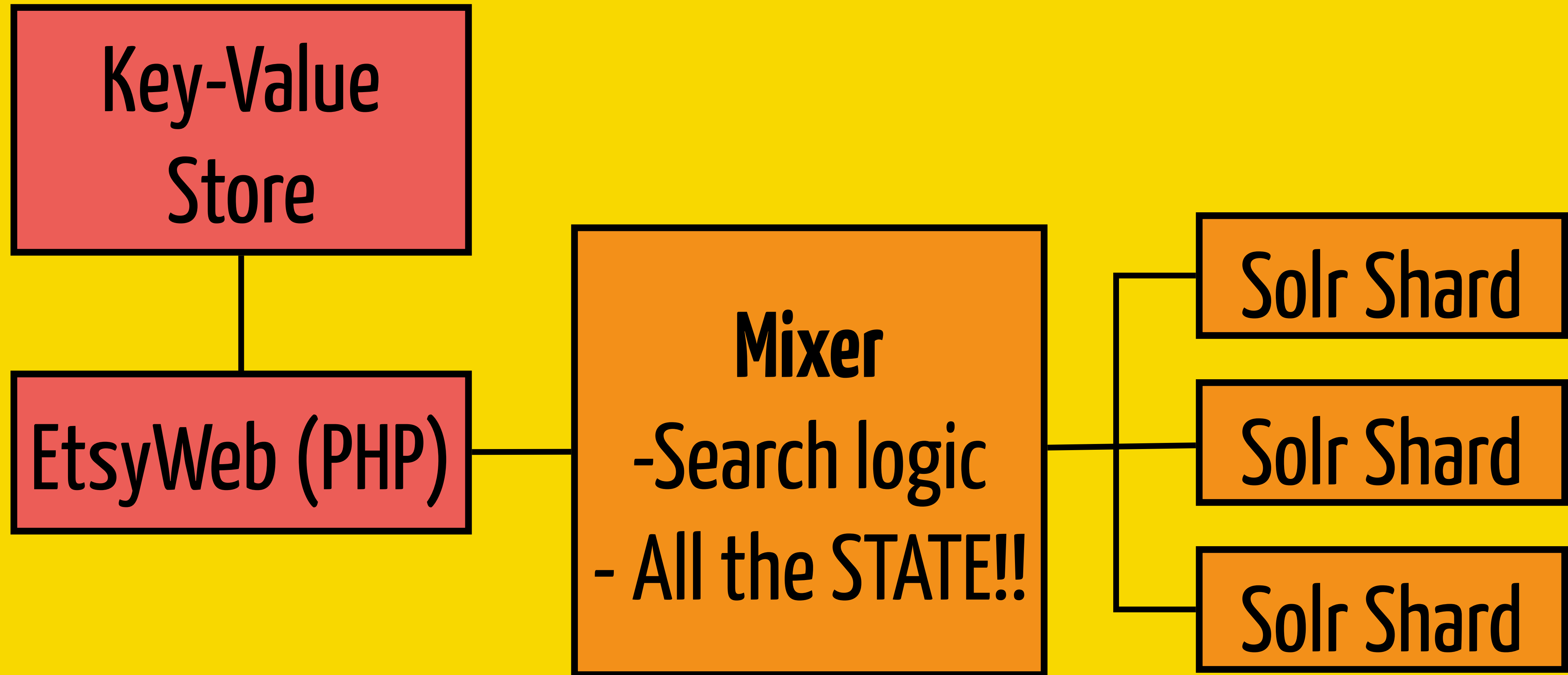
ENSEMBLE OVER MODELS IN REAL TIME!

- Each model gets updated independently.
- The combining function can be a model itself.
- Can define failure scenarios for partial failure.

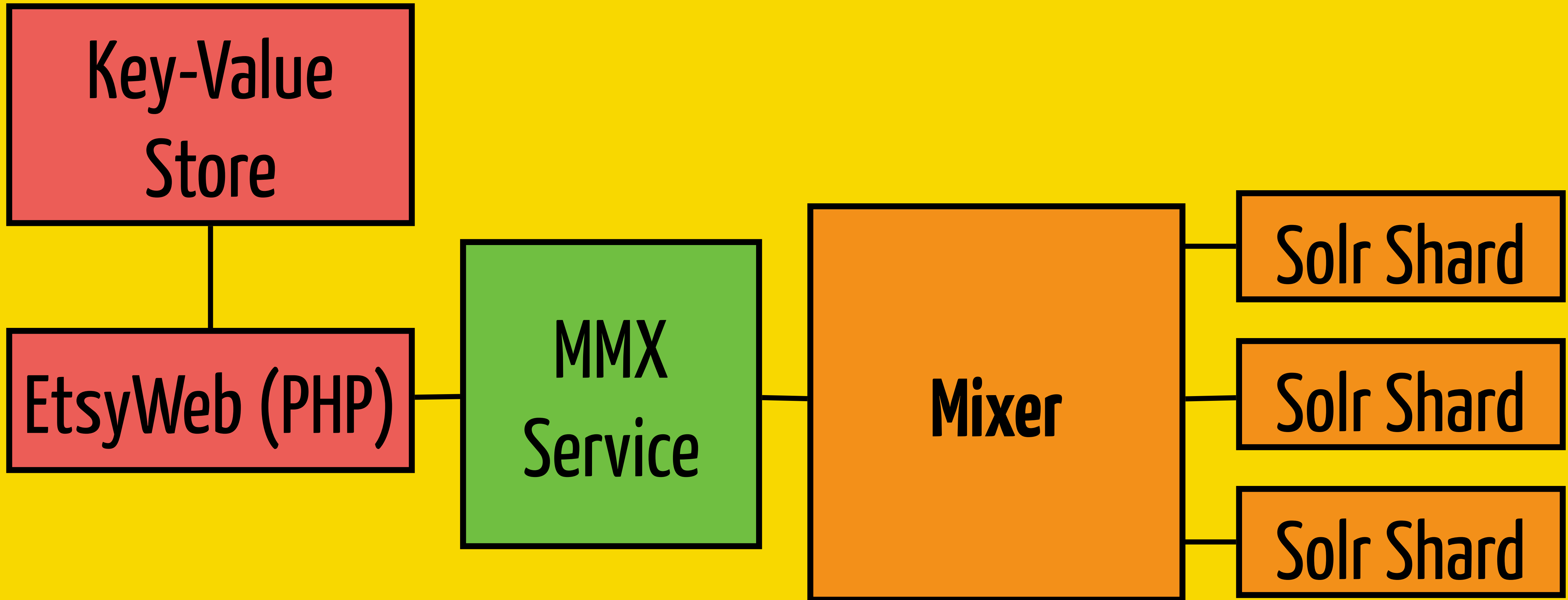
Example of Model Ensembling at Runtime.



Search Stack before MMX



Search Stack with MMX



Before

- Java / PHP
- Models tightly coupled to search code
- Query being mutated and then “executed”
- Cost of change is high

After

- Scala / Finagle / Finatra.
- Models as a service, scale independently.
- **Real time inference pipelines.**
- Build a query plan with ReaderToFuture.
- Async communication with sub-services.

State woven into one service => Service DAG from config.

no pencils for “pencils” ₹_₹

Etsy pencils Search Home Favorites Your shop You Cart

Jewelry & Accessories Clothing & Shoes Home & Living Wedding & Party Toys & Entertainment Art & Collectibles Craft Supplies & Tools Vintage

personalized pencils pencils with quotes funny pencils grammar pencils cute pencils engraved pencils mechanical pencils pens pencil case

All categories > “pencils” (244,159 Results) Sort by: Relevancy

All categories
Art & Collectibles
Craft Supplies & Tools
Bags & Purses
Paper & Party Supplies
[+ Show more](#)

Shipping
 Free shipping
 Ready to ship in 1 business day
 Ready to ship within 3 business days

Special offers
 On sale

Color
 Black
 White
 Blue
 Pink
 Green
[+ Show more](#)

Shop location
 Anywhere
 United States
 Custom

Item type
 All items
 Handmade
 Vintage

Price (\$)
 Any price
 Under \$25
 \$25 to \$50
 \$50 to \$100
 Over \$100

**Julius Caesar Pencil Holder (with Cust...
ElevatedInnovations**
★★★★★ (2)
\$15.00

**Teacher SVG, DXF File, Beaching Not T...
TheSmudgeFactoryLLC**
★★★★★ (3,850)
\$3.99

**Original Colored Pencil Drawing, Red ...
ArtCornerShop**
★★★★★ (239)
\$100.00

**Rise Up Pencil Set
ThePoshShopCo**
★★★★★ (176)
\$10.00

**Small African Print Pouch, Ankara Smal...
LollyKiks**
★★★★★ (48)
\$20.78

**A5 storage tin with hinged lid | Simple...
WhirlingWorld**
★★★★★ (84)
\$5.54

**Miss Doughmestic Thank You with Pen...
BobbisCookiesCutters**
★★★★★ (9,539)
\$6.00

**Elephant wall art print / Pencil / digital ...
BringGoodMood**
(9)
\$3.90

**Framed Art: original 8x10 inch pencil d...
ARTuro1984**
\$59.99 Free shipping

**Thanos Portrait - Colored Pencil Drawi...
JimmiePetrasouART**
\$19.99

**vtg 50s flannel pencil skirt high waist ...
mad4modvintage**
★★★★★ (375)

**Color Pencil Rose
StitchMadnessMarket**
\$8.00 Free shipping

MMX + Query Ranking Model

All categories
Art & Collectibles
Craft Supplies & Tools
Bags & Purses
Paper & Party Supplies

+ Show more

Shipping

- Free shipping
- Ready to ship in 1 business day
- Ready to ship within 3 business days

Special offers

- On sale

Color

- Black
- White
- Blue
- Pink
- Green

+ Show more

Shop location

- Anywhere
- United States
- Custom

Enter location

Item type

- All items
- Handmade
- Vintage

Price (\$)

- Any price
- Under \$25
- \$25 to \$50
- \$50 to \$100
- Over \$100

All categories > "pencils" (244,159 Results)



1, 2, 3, 4, 5, 6 or 12 Personalized Pencil...
TwistedCrafters
★★★★★ (277)
\$1.80



White and Gold Foil Heart Mini Pencils ...
InklingsPaperie
★★★★★ (9,204)
\$8.00
Bestseller



72 Gold Mini short half Hexagon Golf #...
ExpressPencilsLLC
★★★★★ (447)
\$9.95



Koh I Noor Mondeluz aquarell colored ...
FoxberryStore
★★★★★ (94)
\$4.99

Sort by: Relevancy



MATHS PENCIL SET Geek Stationery Gi...
NewtonAndTheApple
★★★★★ (4,391)
\$10.39
Eligible orders ship free



Custom Pencils By The Dozen, Foiled E...
MadeMarketCo
★★★★★ (196)
\$19.00



The Adventure Begins Mini Pencils // B...
NattyMichellePaperie
★★★★★ (2,048)
\$8.00



Earthy Goodies slate chalk pencils (thi...
EarthyGoodies
★★★★★ (585)
\$9.99
Bestseller



More colors



More colors

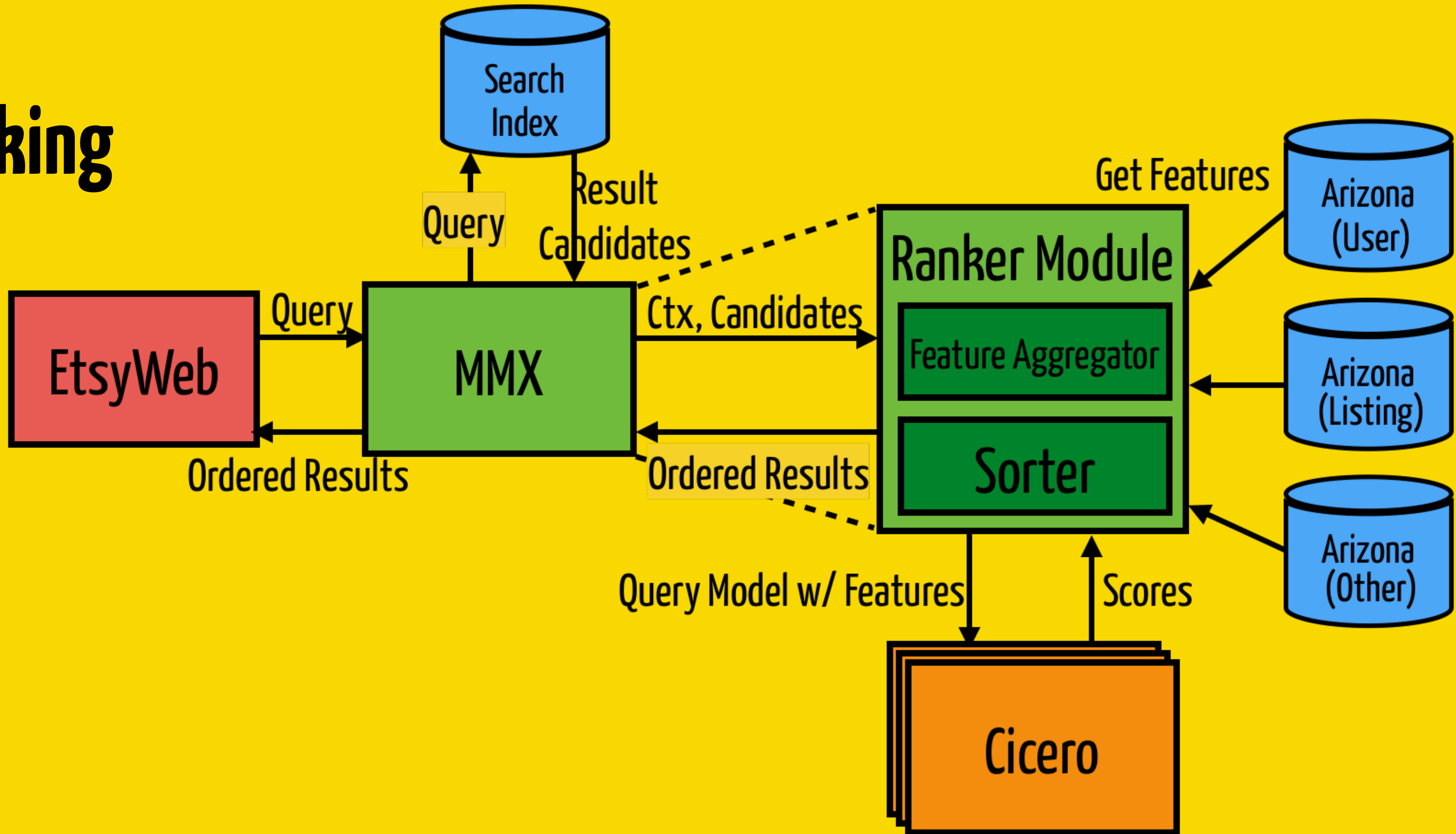


Cute Inspirational Pencil Set - White Pi...

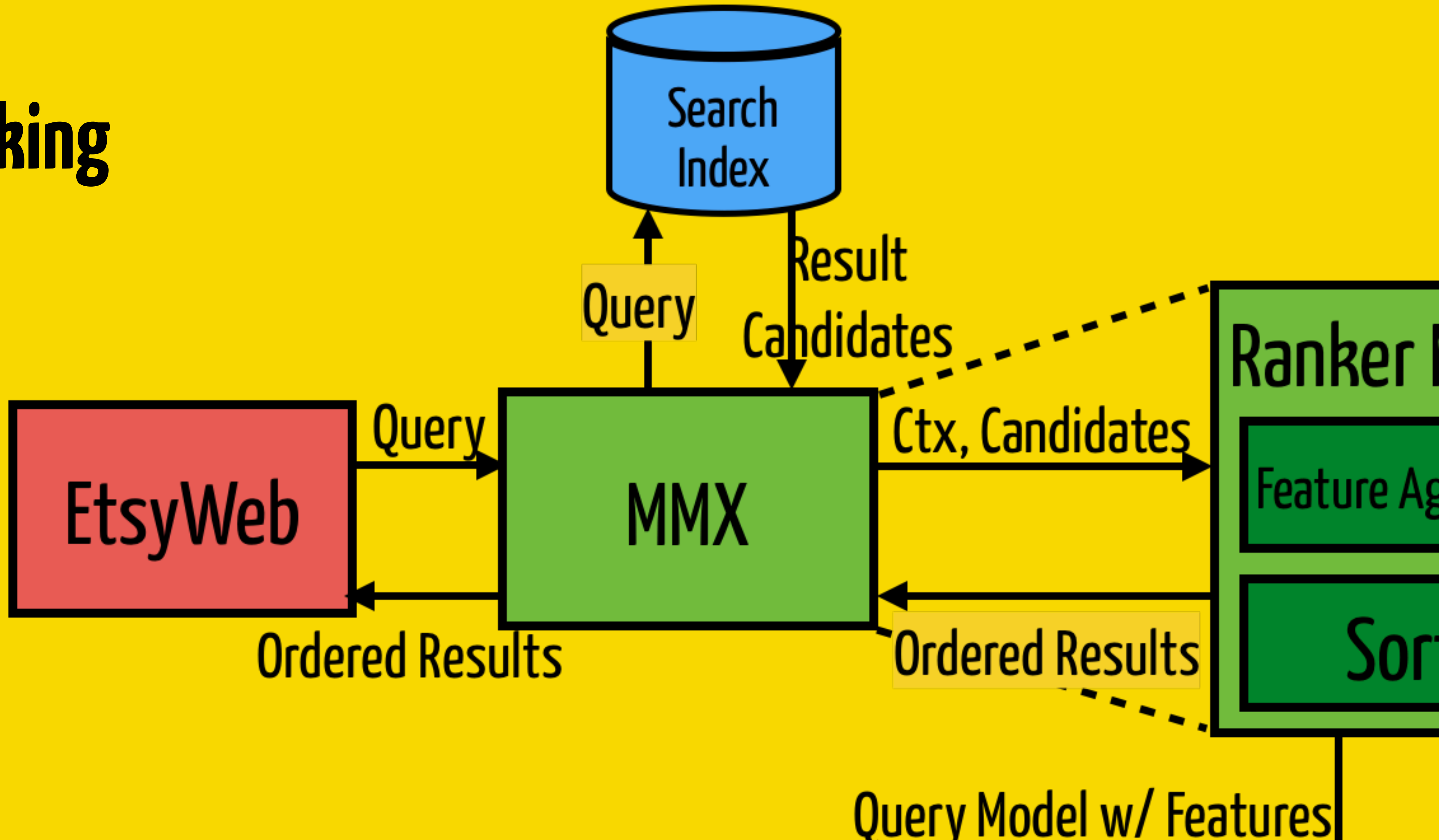


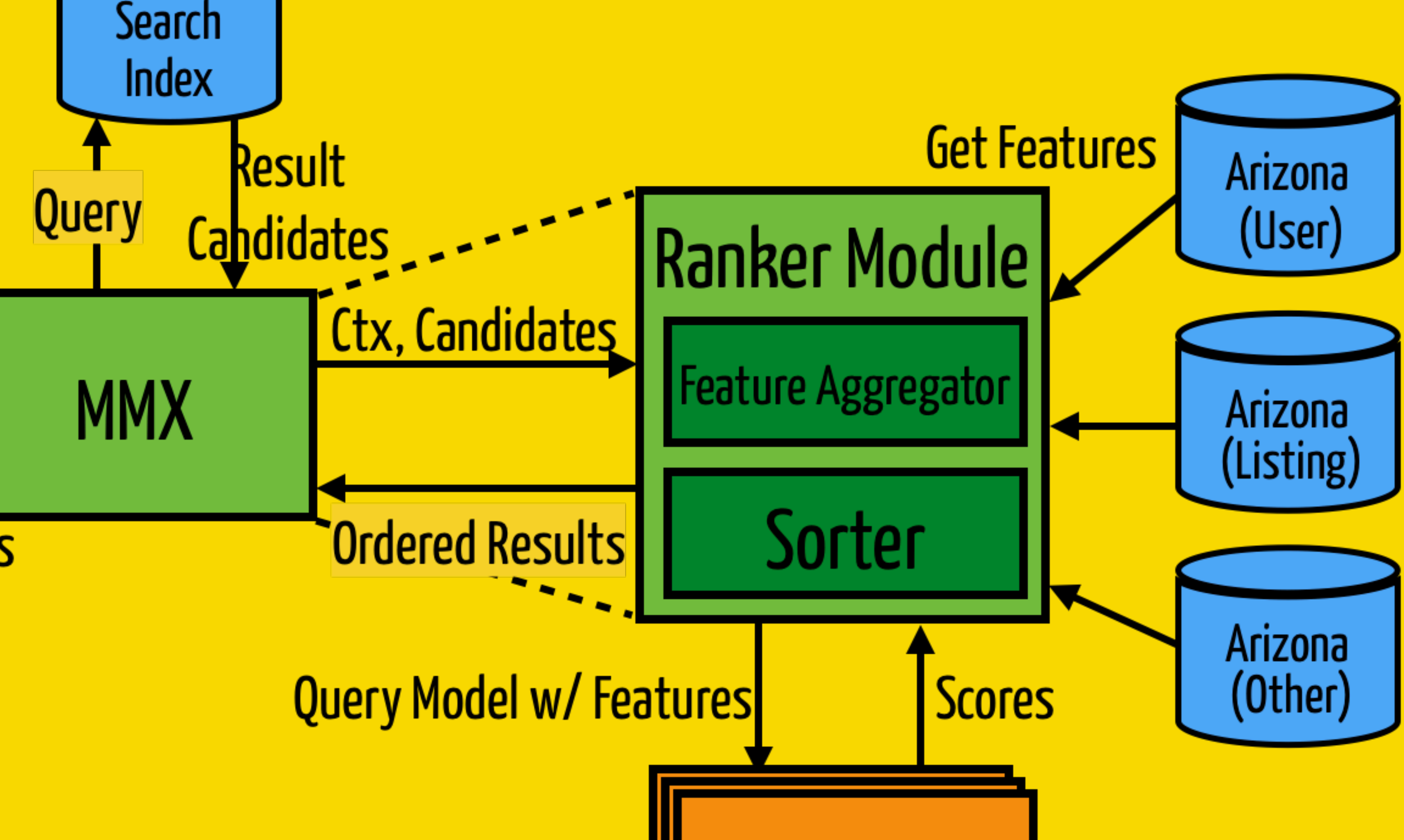
More colors

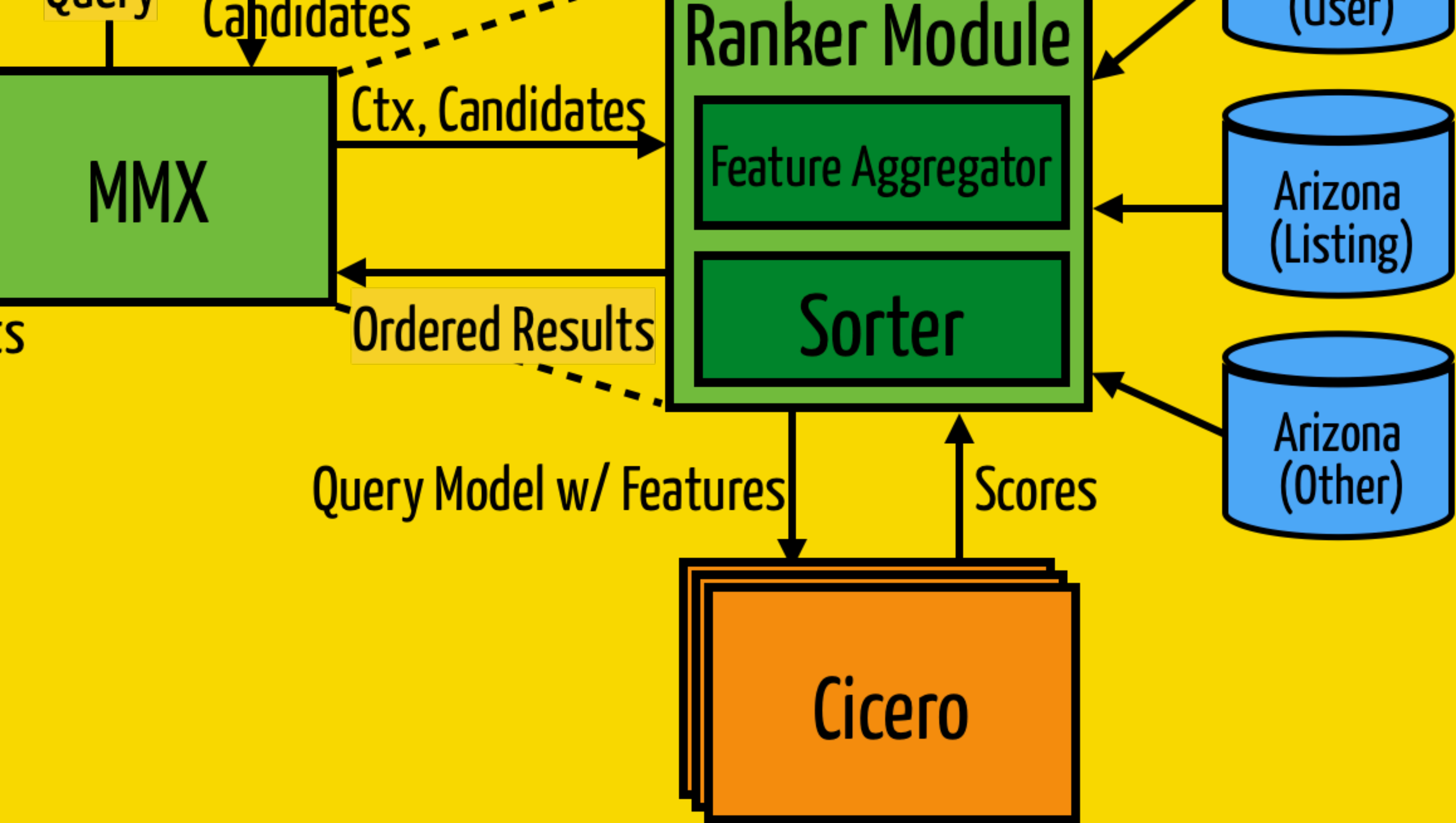
New Ranking Pipeline

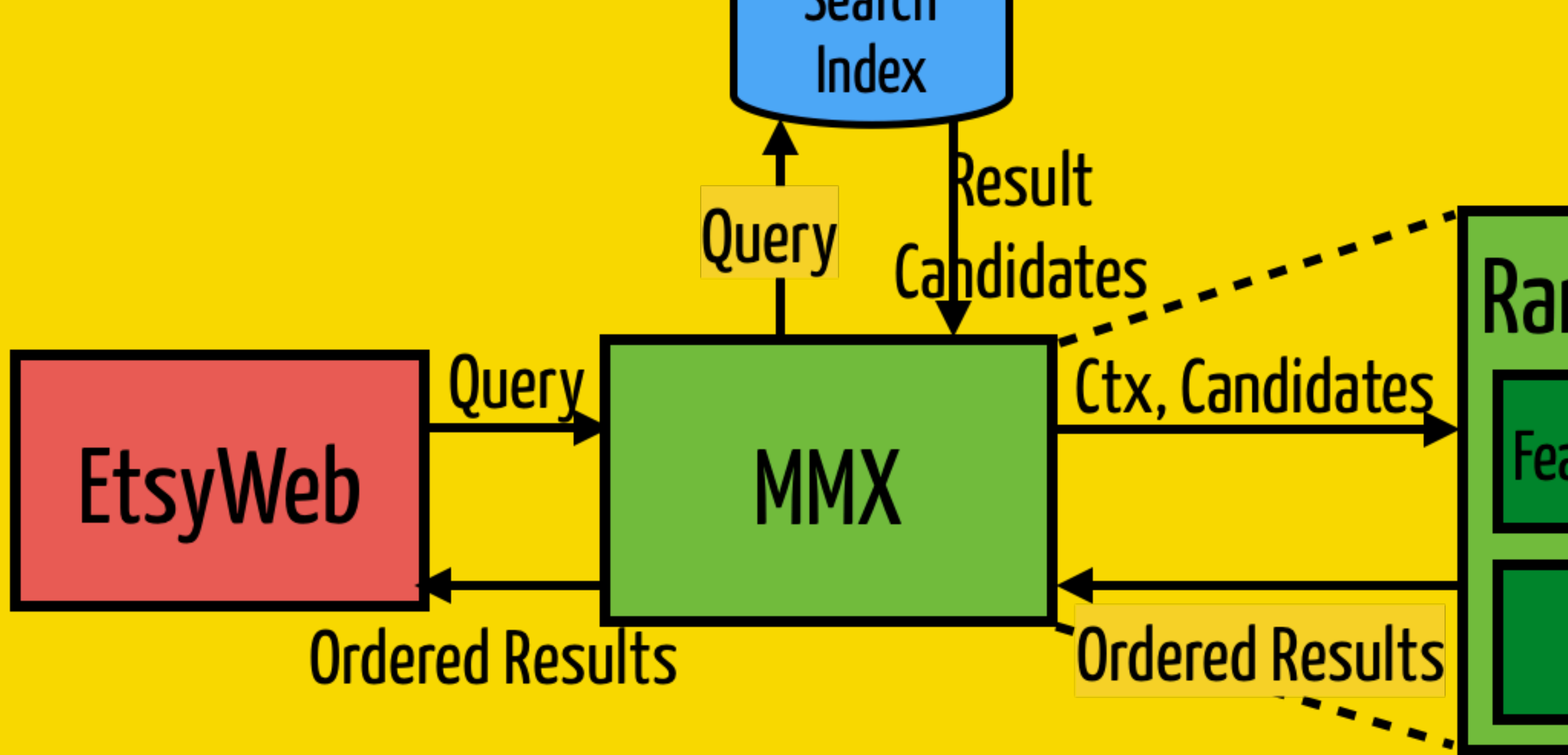


New Ranking Pipeline



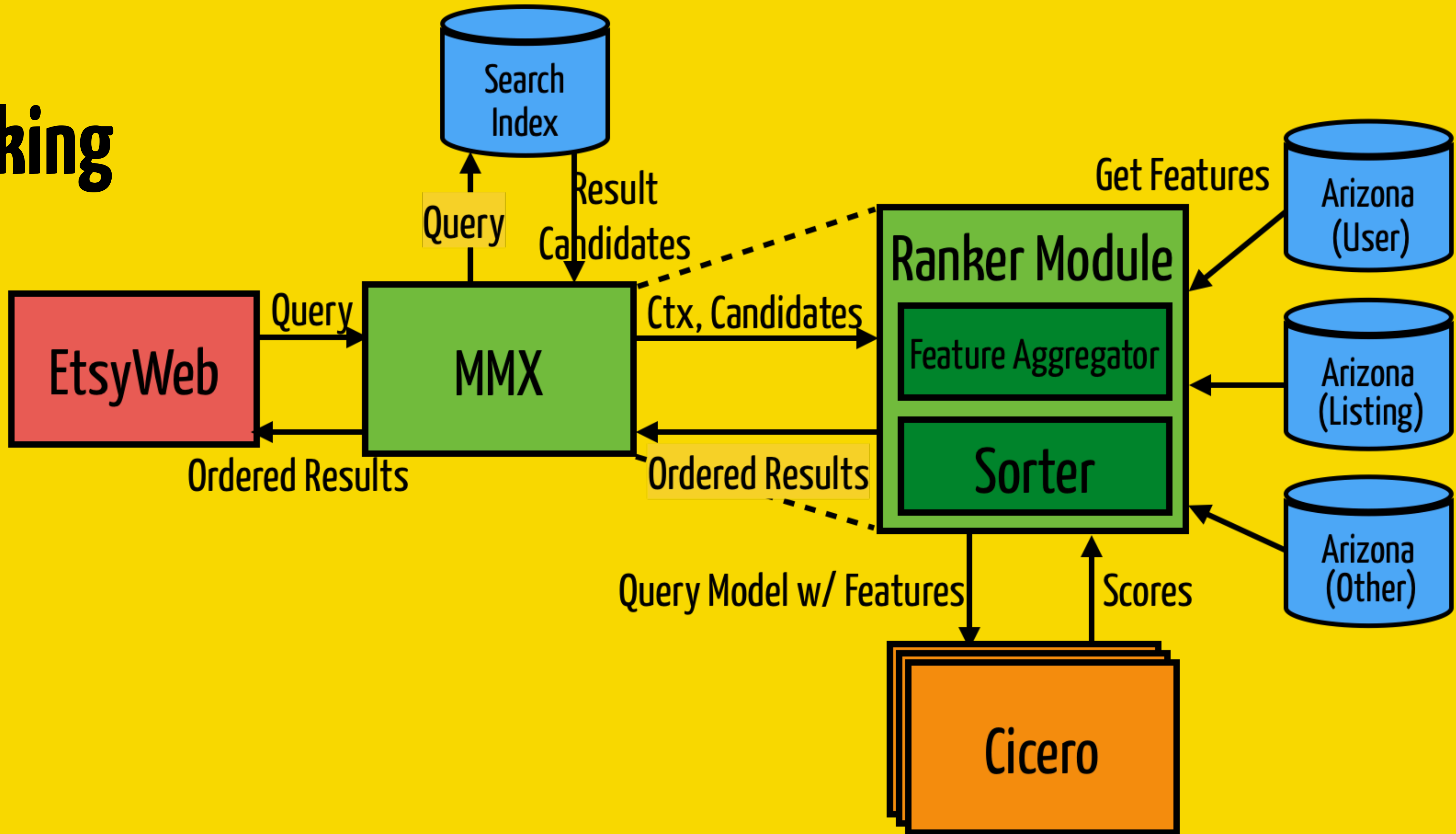






Query Model w/ Feature

New Ranking Pipeline



No Results \Rightarrow

Query Backoff



Query Backoff

TV 1340ms + 211ms + 4676ms = 6227ms

Etsy Search

Home Favorites Your shop You Cart

Jewelry & Accessories Clothing & Shoes Home & Living Wedding & Party Toys & Entertainment Art & Collectibles Craft Supplies & Tools Vintage

Showing results for sneakers for puppies.

kayne west sneakers for puppies had no results.
Search instead: [kayne west sneakers](#) [west sneakers](#) [sneakers](#)

All categories > "sneakers for puppies" (81 Results) Sort by: Relevancy

Special offers

On sale

All categories

- Shoes
- Art & Collectibles
- Pet Supplies
- Toys & Games

+ Show more

Shipping

Free shipping

Ready to ship in 1 business day

Ready to ship within 3 business days

Shop location

Anywhere

United States

Custom

▶

Item type

All items

Handmade

Vintage

Price (\$)

Any price


Under \$25

\$25 to \$50


\$50 to \$100

Over \$100


Custom




Fabric, Dawgs and Sneakers on Brown, Funny ...
BluePacificFabrics
\$10.00
★★★★★ (2,446)




Custom Personalize Design Your Waterproof P...
DGCustomGraphics
\$39.00
★★★★★ (114)




It's A Ruff Life Nike Roshe Run Black Custom P...
NYCustoms
\$135.00 ~~\$150.00~~ (10% off)
★★★★★ (1,211)




Sneakers the Corgi Pillow (Mermaid)
thousandskies
\$35.00
★★★★★ (1,033)




Naughty Dachshund - Women's Sneakers with ...
CustomKIKScom
\$69.95



Sneakers the Corgi Pizza Pillow (Teal collar)
thousandskies
\$30.00

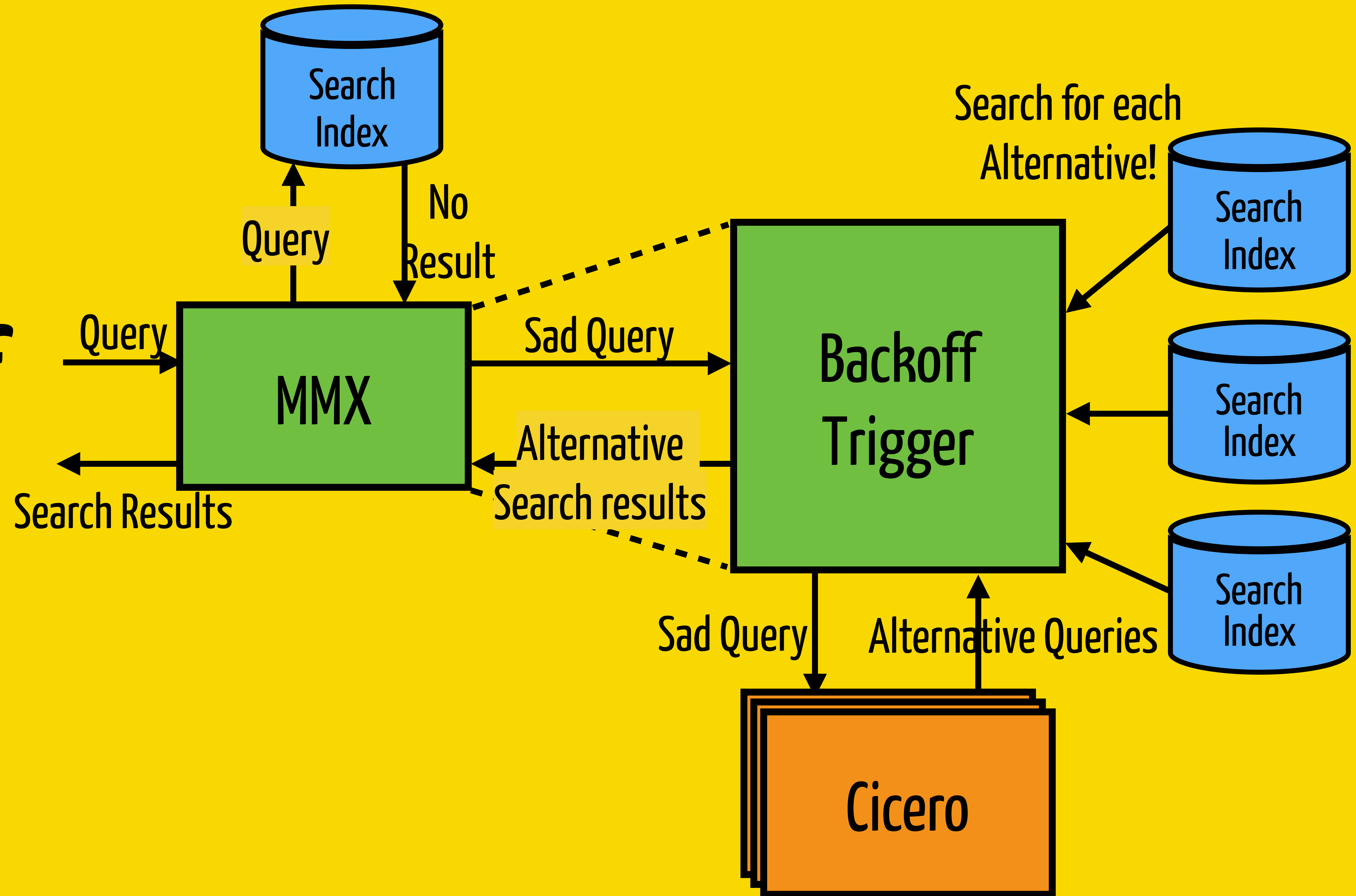


vintage womens Hush Puppies golf shoes - ta...
humblepeacock
\$75.00

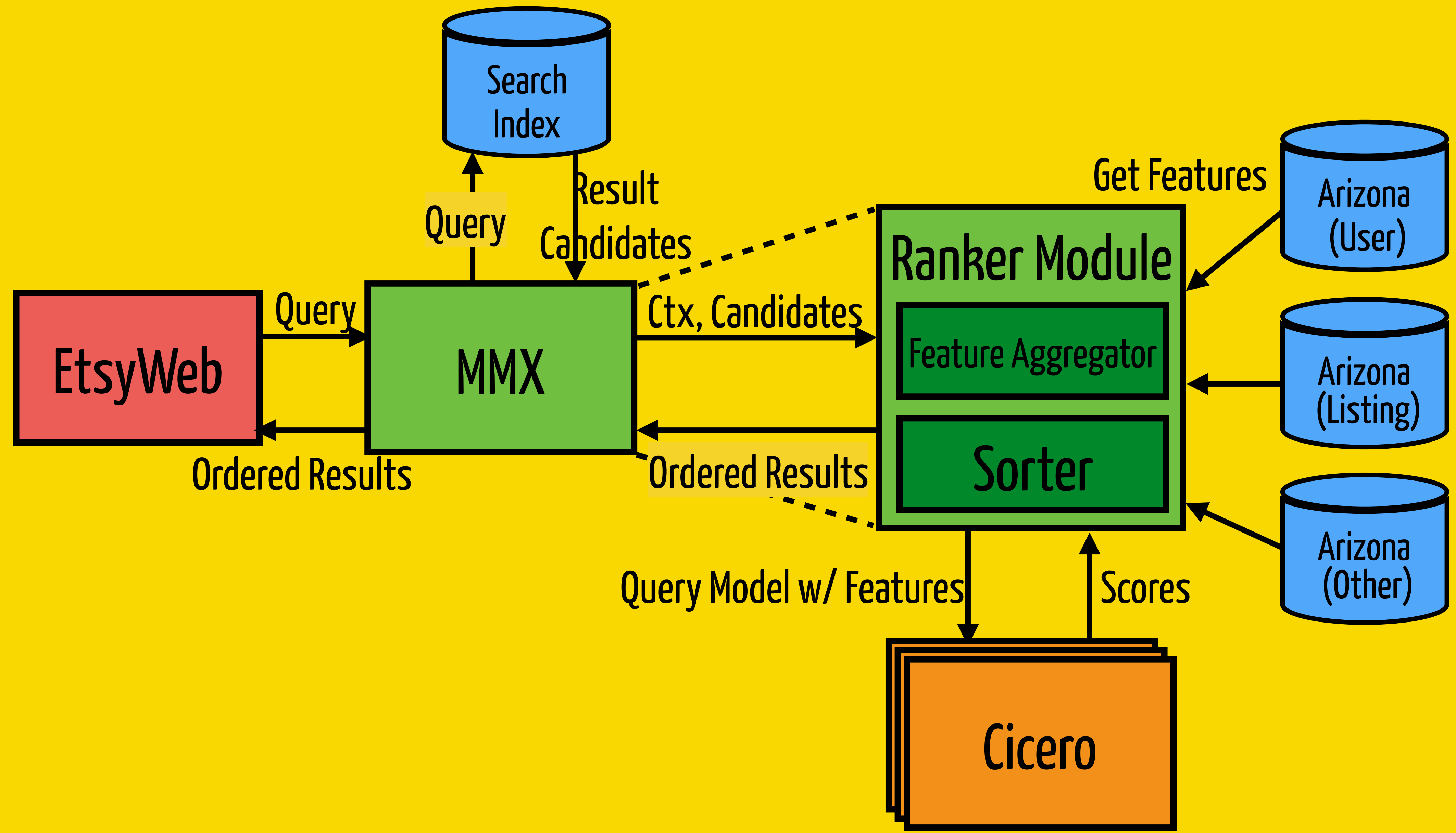


Girls High Top Puppy Shoes Custom High Top...
PricklyPaw
\$78.50

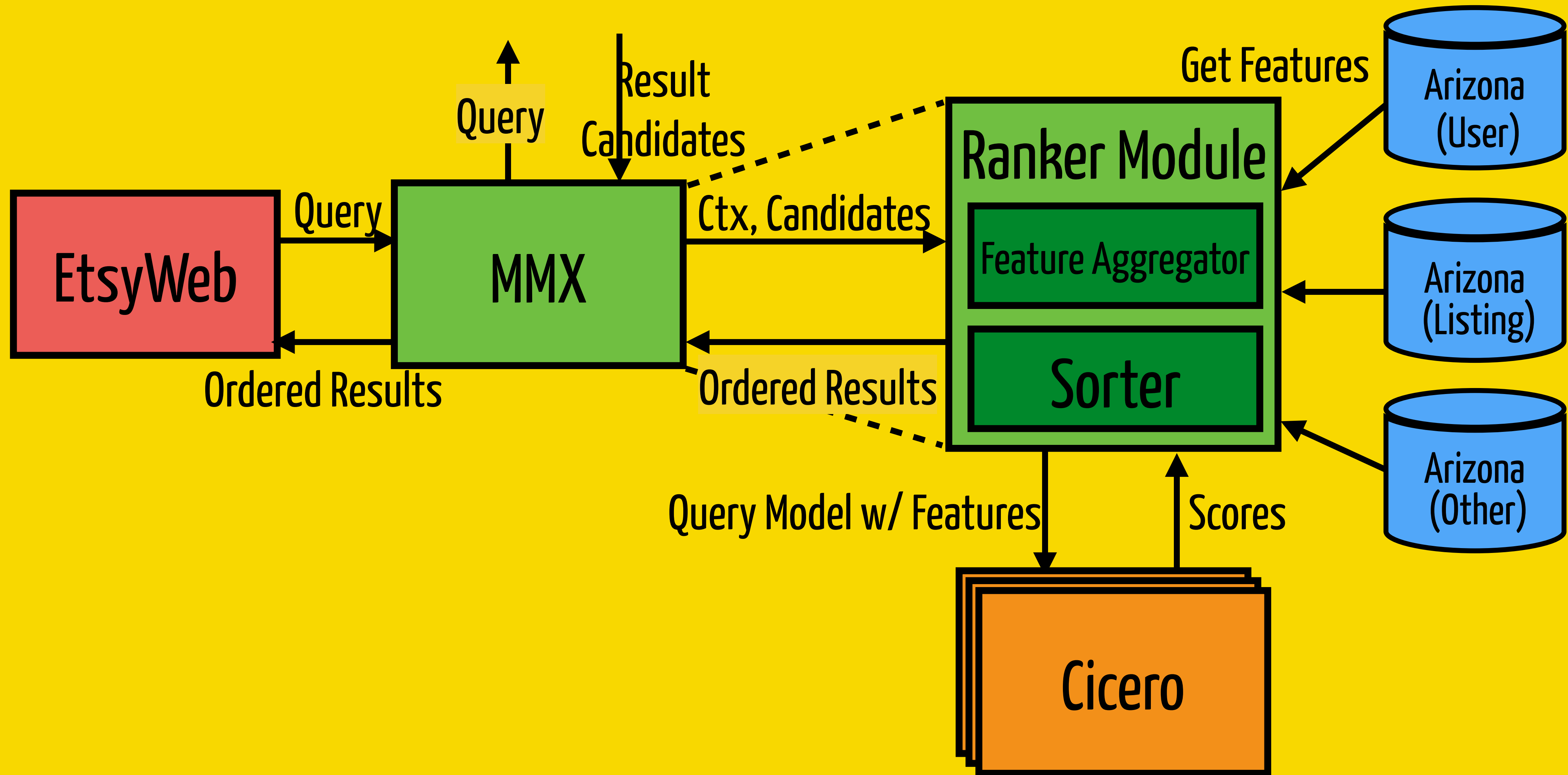
Query Backoff Pipeline



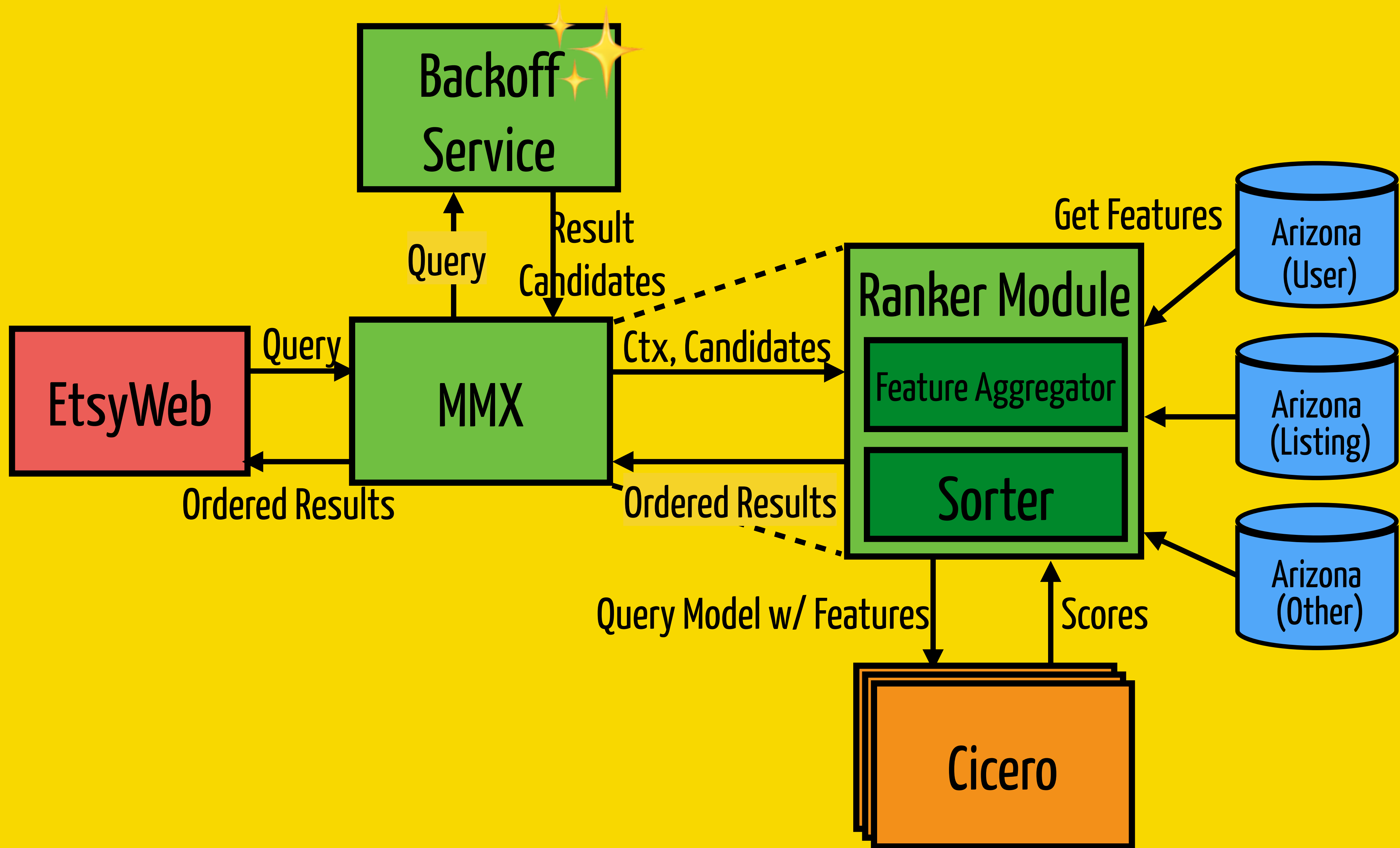
Current Ranking Pipeline



Ranking + Backoff



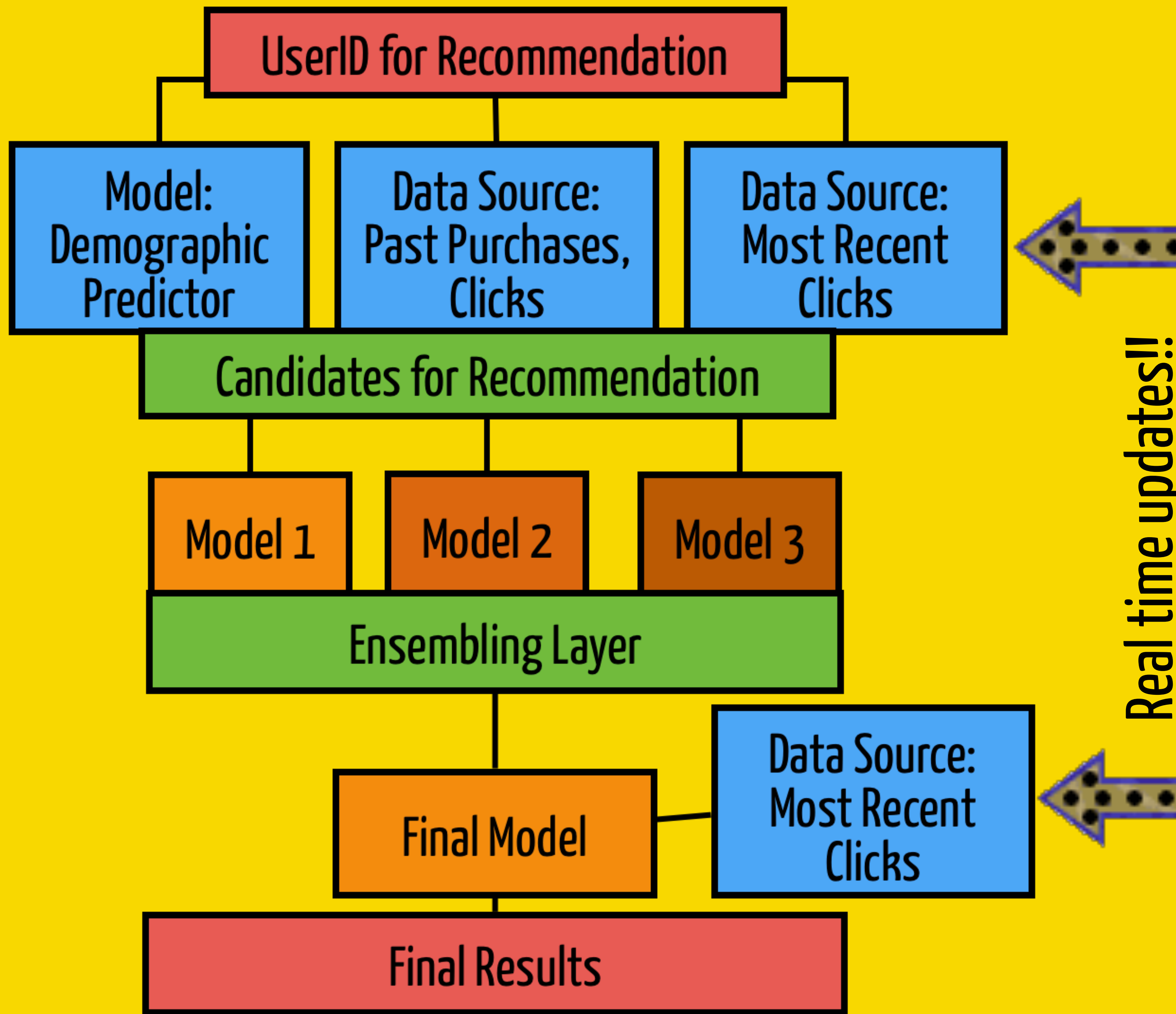
Ranking + Backoff



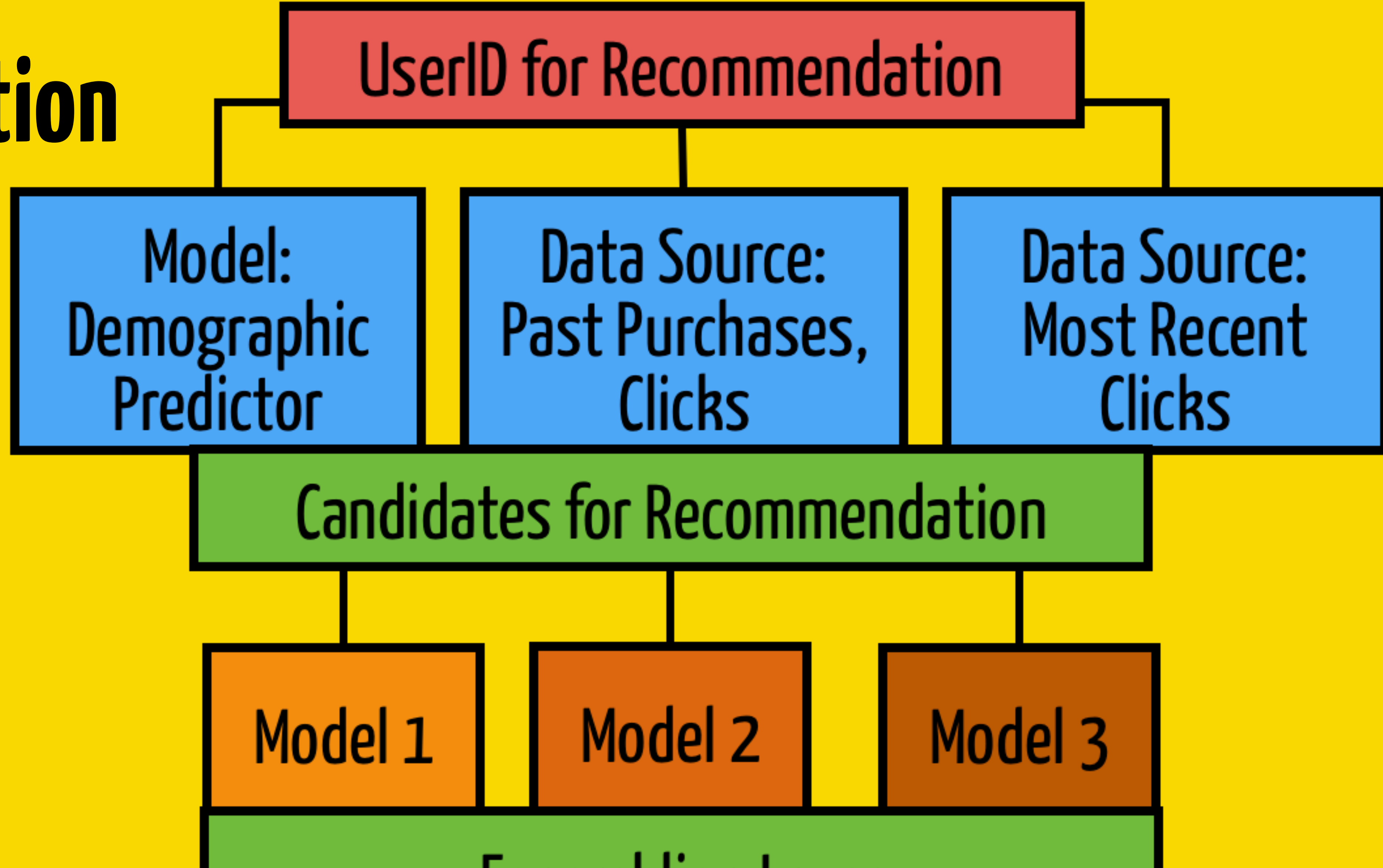
Recommendation Pipeline



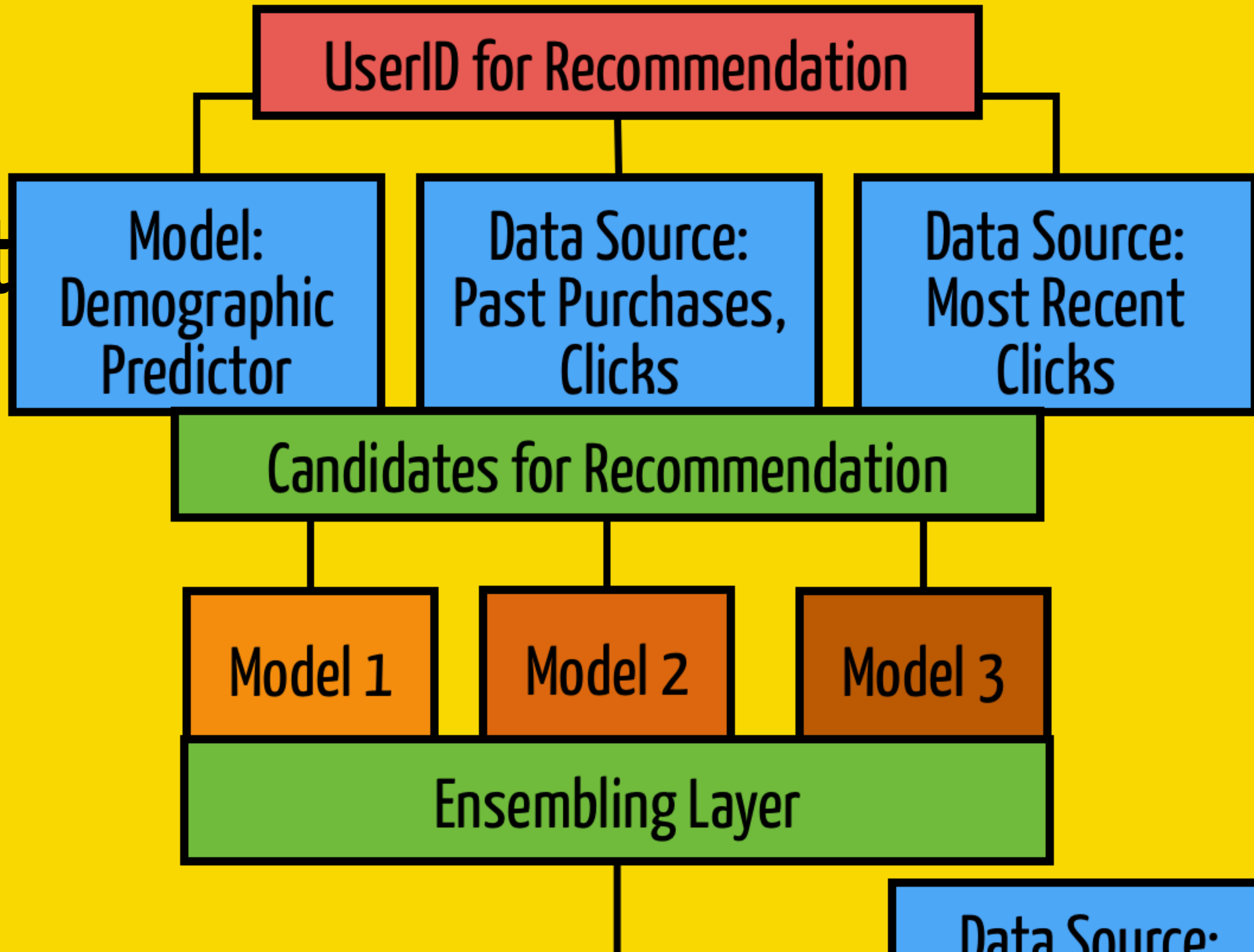
Recommendation Pipeline



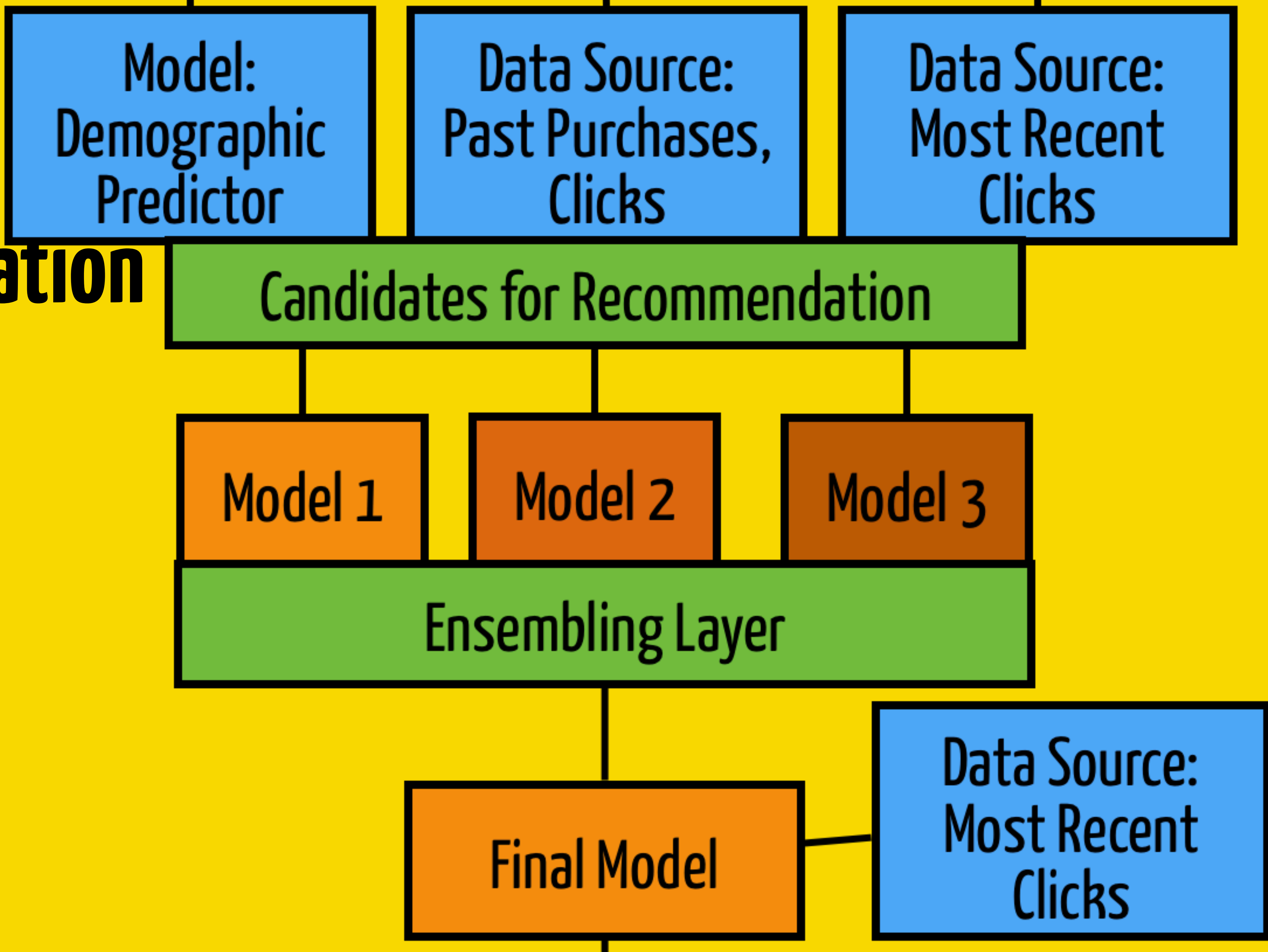
Recommendation Pipeline



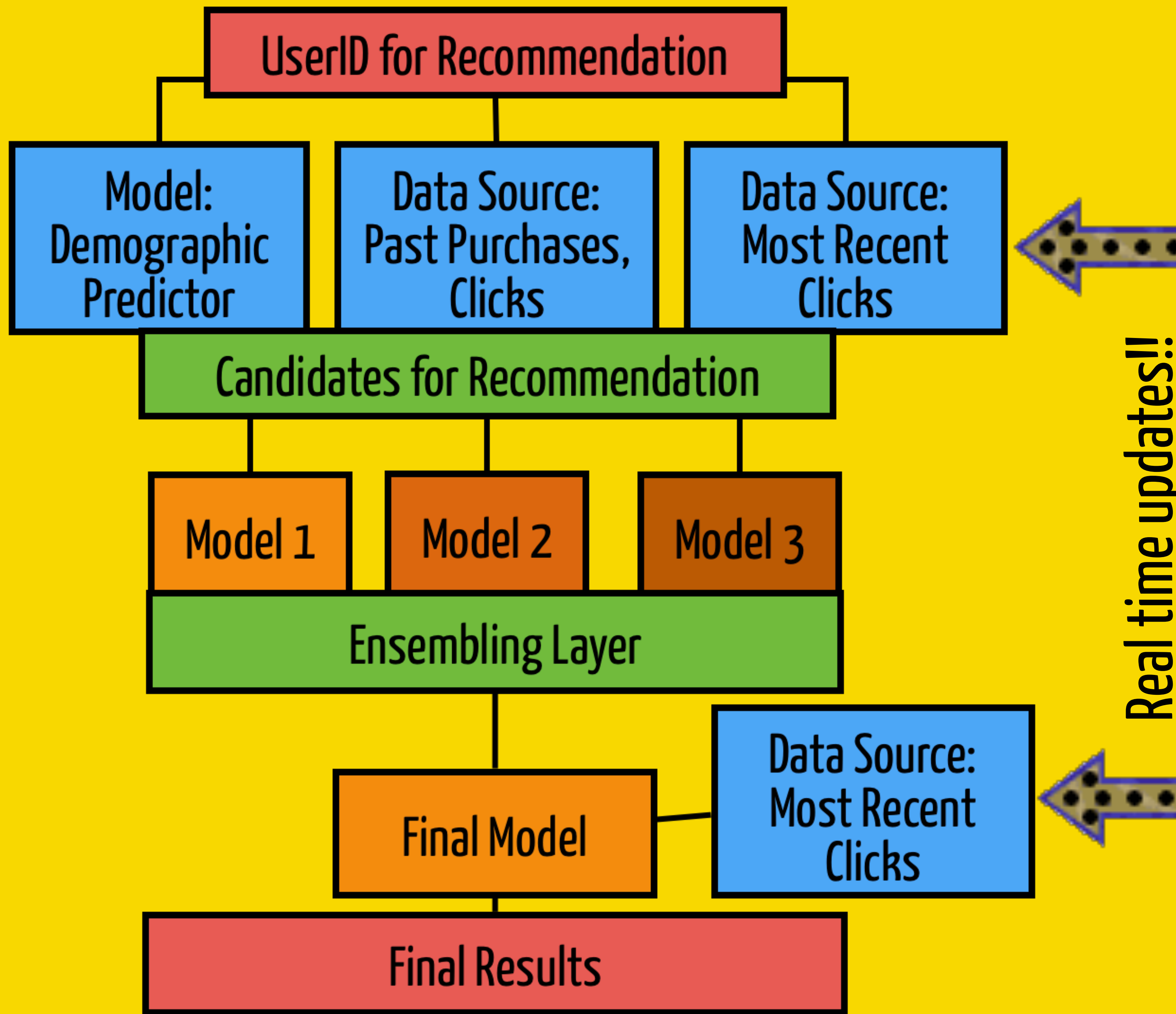
Recommendation Pipeline



Recommendation Pipeline



Recommendation Pipeline



A/B Testing

- Configurable pipelines \Rightarrow Create **versions of a pipeline**.
 - different model versions.
 - different arguments to services.
 - Example: Increasing reranking coverage was only a config knob switch.
 - different data sources \rightarrow **Features, Candidates** etc
 - Pick and choose datasets, versions

A/B Testing: Configuring Variants

```
"variant_200" : ${configs.control} {  
  ranker_options: { "rank_limit": 200}  
},  
"variant_400" : ${configs.control} {  
  ranker_options: { "rank_limit": 400}  
},  
"variant_tuned_boosts" : ${configs.control} {  
  ranker_options: {  
    "rank_limit"      : 400  
    "variant_mean"   : 0.71,  
    "variant_std"    : 0.53,  
    "control_mean"   : 0.20,  
    "control_std"    : 0.95,  
    "relevance"      : false,  
    "missing_val"    : 0.23  
  }  
}
```

Takeaways

- Each service is a **reusable unit** in the query DAG. 

=> **algebra over services.**

- Models as a Service => **Real time inference.**

- Building new ML query pipelines is **fun!!** 

+ we can debug and **experiment.** 

- Towards **query understanding!**

Thank you! Danke!

Questions?

We're Stefanie Schirmer..

sschirme@gmail.com

[@linse](#) on twitter

..and Aakash Sabharwal

asabharwal@etsy.com

[@aakashsabharwal](#) on twitter