


*Beyond REST:*  
Coursera's Journey to GraphQL

Bryan Kane

 @bryanskane

 bryan-coursera



**Nishanth Creamer**  
@nishanthgandhi

Follow

@coursera My coursera account is dead slow. My courses si not even loading completely. Bitter experience

9:19 PM - 11 Apr 2017



**Jürg Ritter**  
@juergritter

Follow

@coursera Do you currently experience some #performance issues on your platform? Seems to be very slow, both app and website.

7:16 AM - 18 Sep 2016

**Jan Heese**  
@janheese

Follow

@coursera I'm having trouble accessing my course... Site and mobile very slow, unable to download lectures. Is it just me?

1:52 PM - 28 Feb 2017



**SoumyaSoni**  
@soumya77

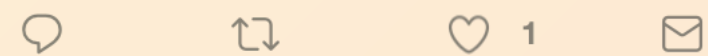
Follow

#Coursera you're depressingly slow nowadays.

Like  
1



6:25 AM - 26 Sep 2016



**Félix Sanz**  
@felixsanzm

Follow

@coursera is the perfect example of a bad react application. Slow as h\*, buggy, and using react for static content. Totally over engineered

5:28 PM - 6 Aug 2016



**Joe Sessa**  
@joesessa

Follow

@coursera why is your site extremely slow to load up? It's absolutely ridiculous. It takes > 5 minutes to load up a page for my class

9:24 PM - 22 Nov 2016



**Alexis Chan**  
@alexisylchan

Follow

current status: watching coursera load on a slow network (0.96Mbps dl). Time spent attempting to login & access quiz: 56 minutes :'(

Name	Status	Type	Initiator	Size	Time	Timeline - Start Time
home	200	document	Other	188 KB	52.24 s	
index.css	200	stylesheet	home:202	28.5 KB	15.97 s	
preloader.r.js	200	script	home:653	14.1 KB	3.85 s	
loader.r.js	200	script	home:653	157 KB	29.69 s	
startApp.sub.js	200	script	home:653	618 KB	1.4 min	
info.v2?key=web-preload-loaded&value=78%7D&	200	script	pploader.r.js	471 B	1.02 s	
userAgent.js	200	script	pploader.r.js	(from cache)	6 ms	
parseurl.v1-2.js	200	script	pploader.r.js	(from cache)	5 ms	
icon-blue-32x32.png	200	png	Other	1.3 KB	599 ms	
userAgent.js	200	script	pploader.r.js	(from cache)	15 ms	

9:03 AM - 30 Sep 2016

**Meng.Yuan**  
@loveflora1229

Follow

@coursera It's very very unbelievably slow to browse ur courses in China. I will miss my DDL

10:00 AM - 24 Feb 2016



**G Athanasakopoulos**  
@gathanasak

Follow

@coursera Loving my course but the website is slow slow slow. Please fix. Also, video resolution is not good when viewed full screen. Thanks

12:48 PM - 1 Dec 2016



## Chapter One

Site speed  
issues

## Chapter Two

Intro to GraphQL

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## Chapter Four

Learnings and  
retrospective

Name	S...	Waterfall	6.50 s	7.00 s	7.50 s	8.00 s
<input type="checkbox"/> onDemandCourseForums.v1?q=co...	200					
<input type="checkbox"/> onDemandMentorForums.v1?q=co...	200					
<input type="checkbox"/> groupForums.v1?q=course&cours...	200					
<input type="checkbox"/> 10466539	200					
<input type="checkbox"/> ?q=findByUser&userId=3539566	200					
<input type="checkbox"/> 3539566~SessionStartedModal.8O...	200					
<input type="checkbox"/> infoBatch.v2	200					
<input type="checkbox"/> ?q=allByCourse&courseId=Gtv4Xb...	200					
<input type="checkbox"/> ?q=course&courseId=Gtv4Xb1-Ee...	200					
<input type="checkbox"/> ?userId=3539566&shouldAggregat...	200					
<input type="checkbox"/> 3539566~Gtv4Xb1-EeS-ViACwYK...	404					
<input type="checkbox"/> 3539566~Gtv4Xb1-EeS-ViACwYK...	404					
<input type="checkbox"/> infoBatch.v2	200					
<input type="checkbox"/> onDemandCourseForumStatistics....	200					
<input type="checkbox"/> ?userId=3539566&shouldAggregat...	200					
<input type="checkbox"/> infoBatch.v2	200					

# Load Courses

## Chapter One

Site speed issues

## Chapter Two

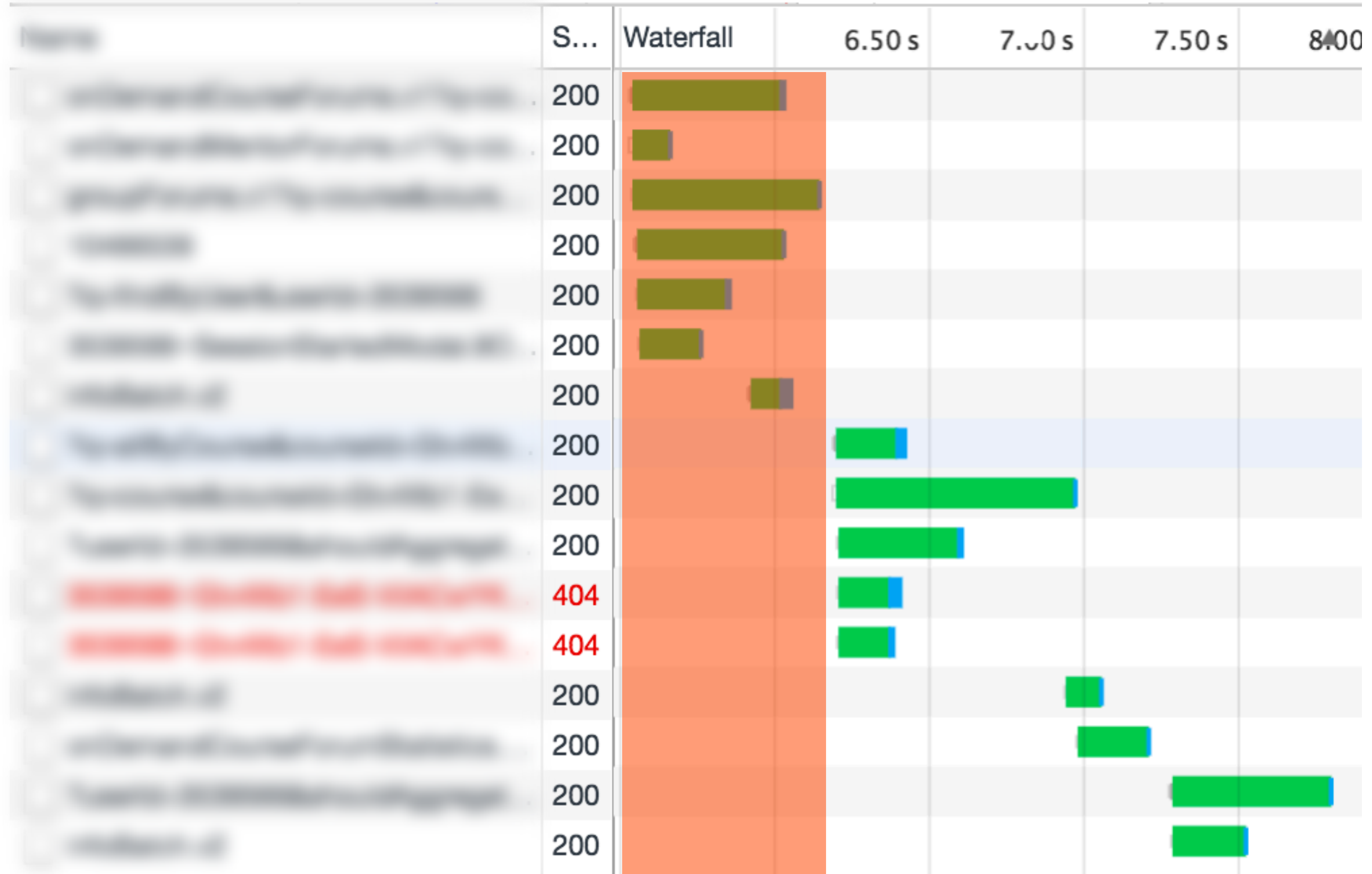
Intro to GraphQL

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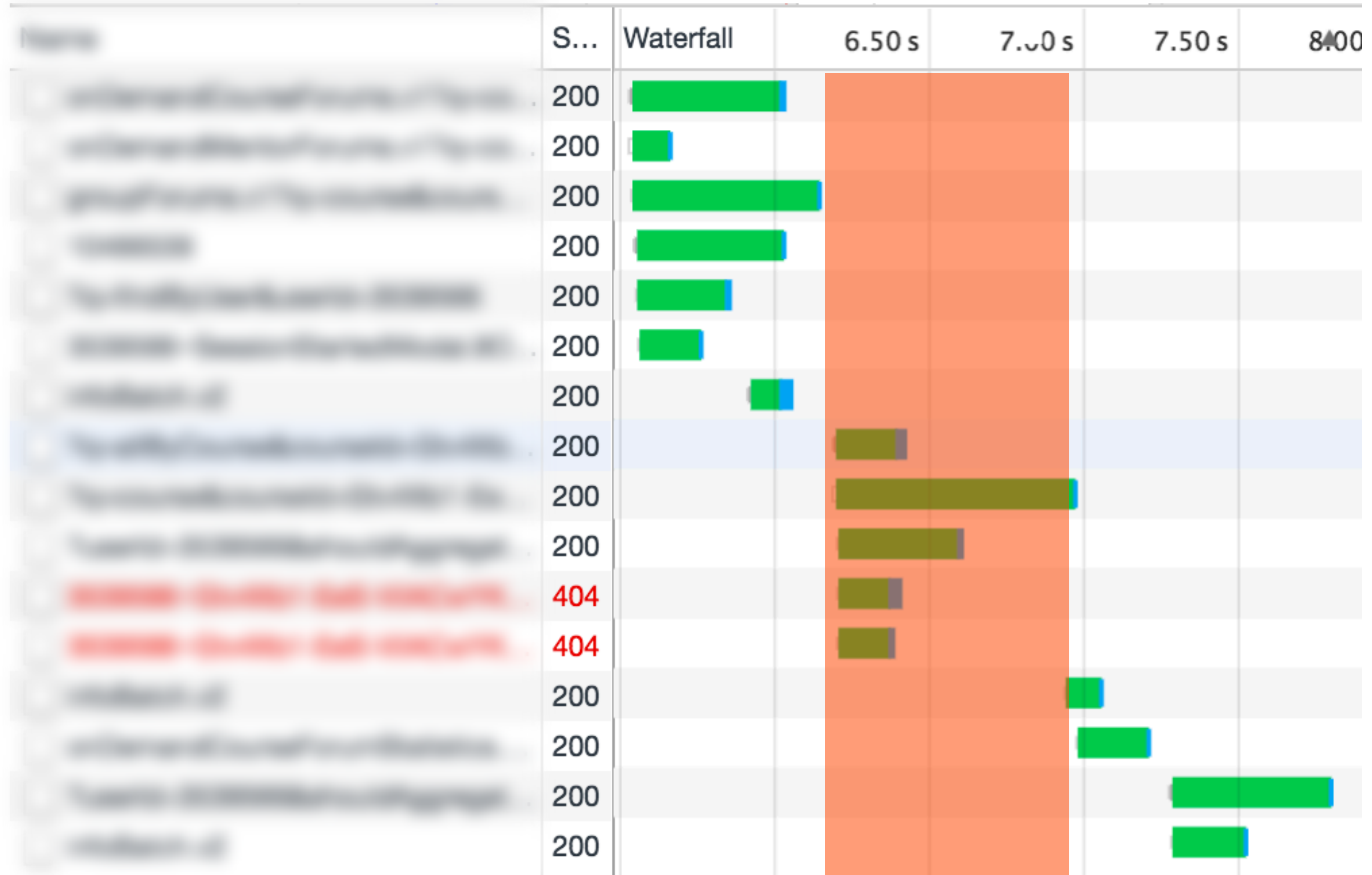
# Load Instructors

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# Load University Profile

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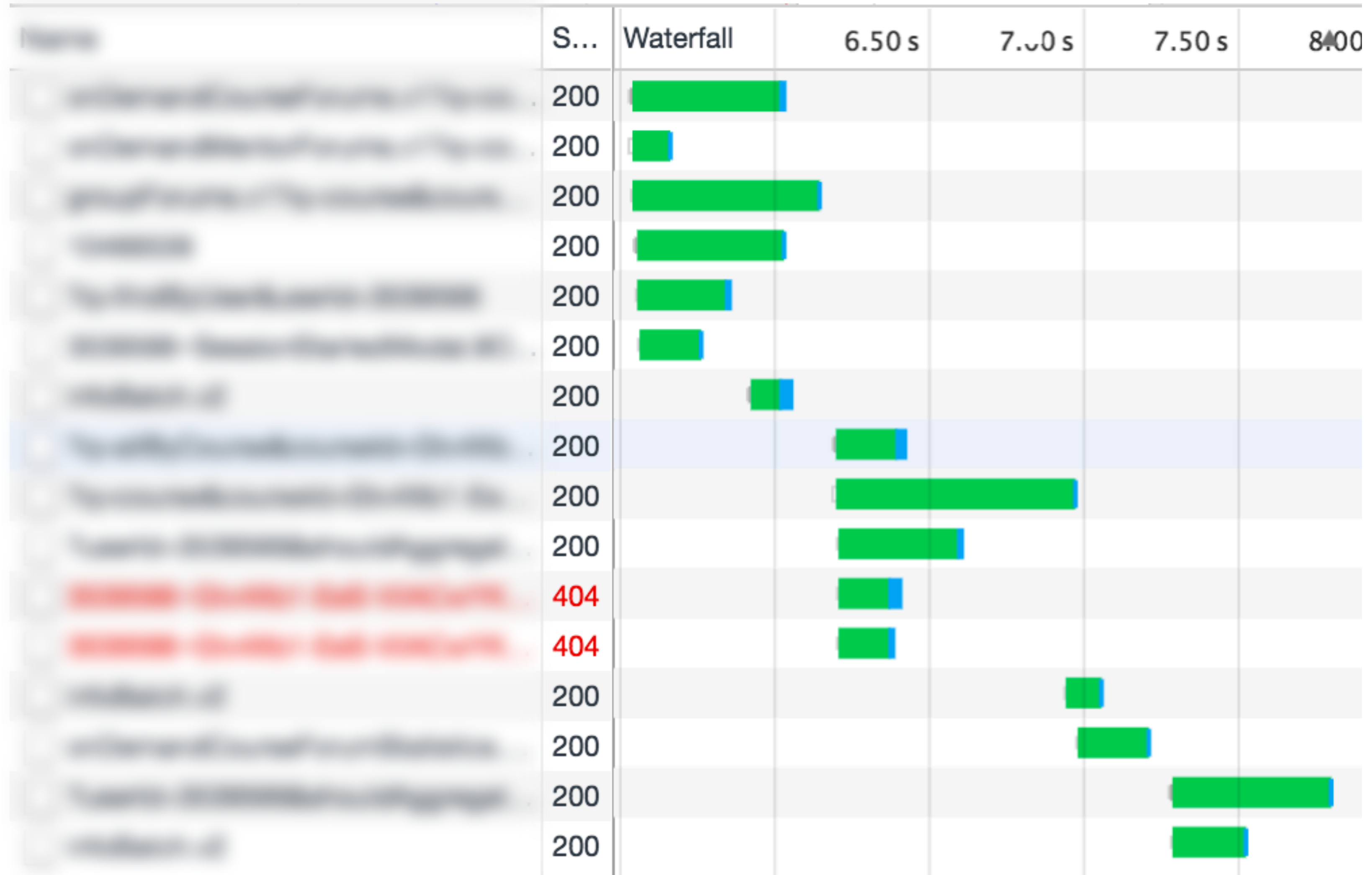
Intro to GraphQL

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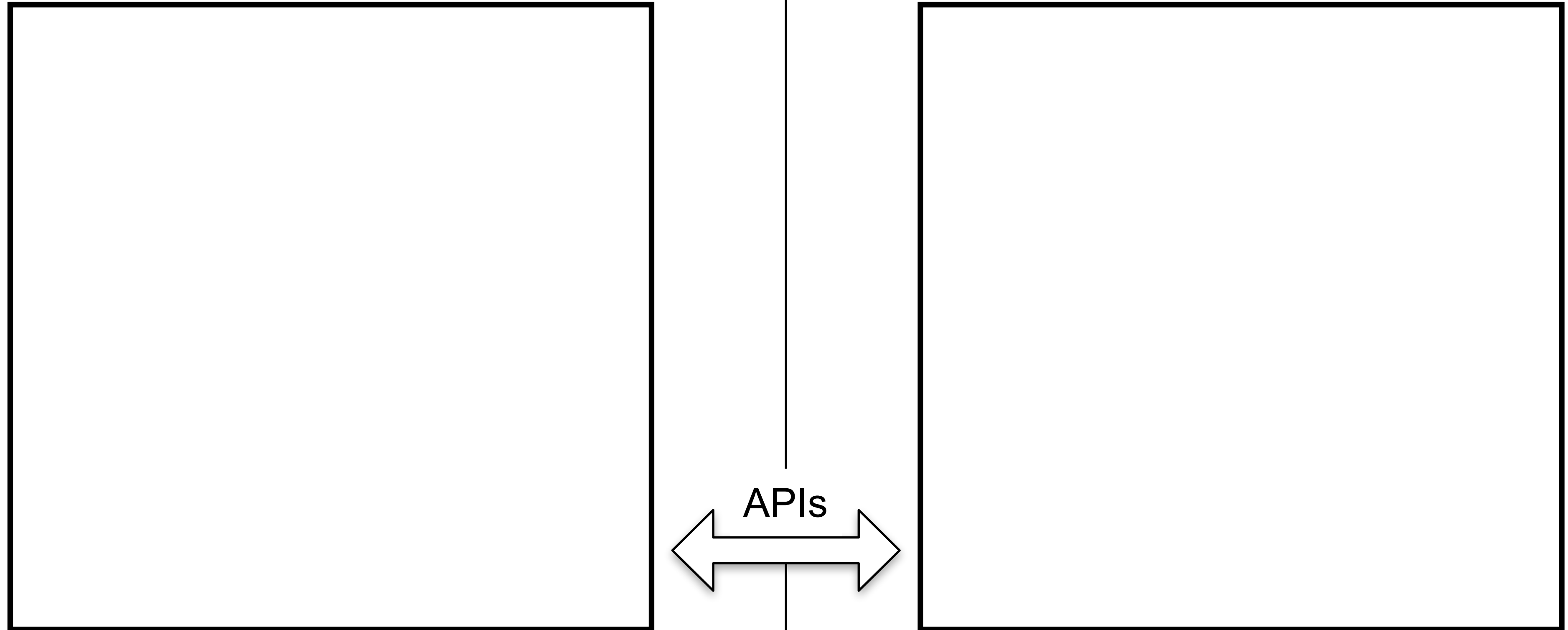
## Chapter Four

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# Backend

# Client



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# Backend

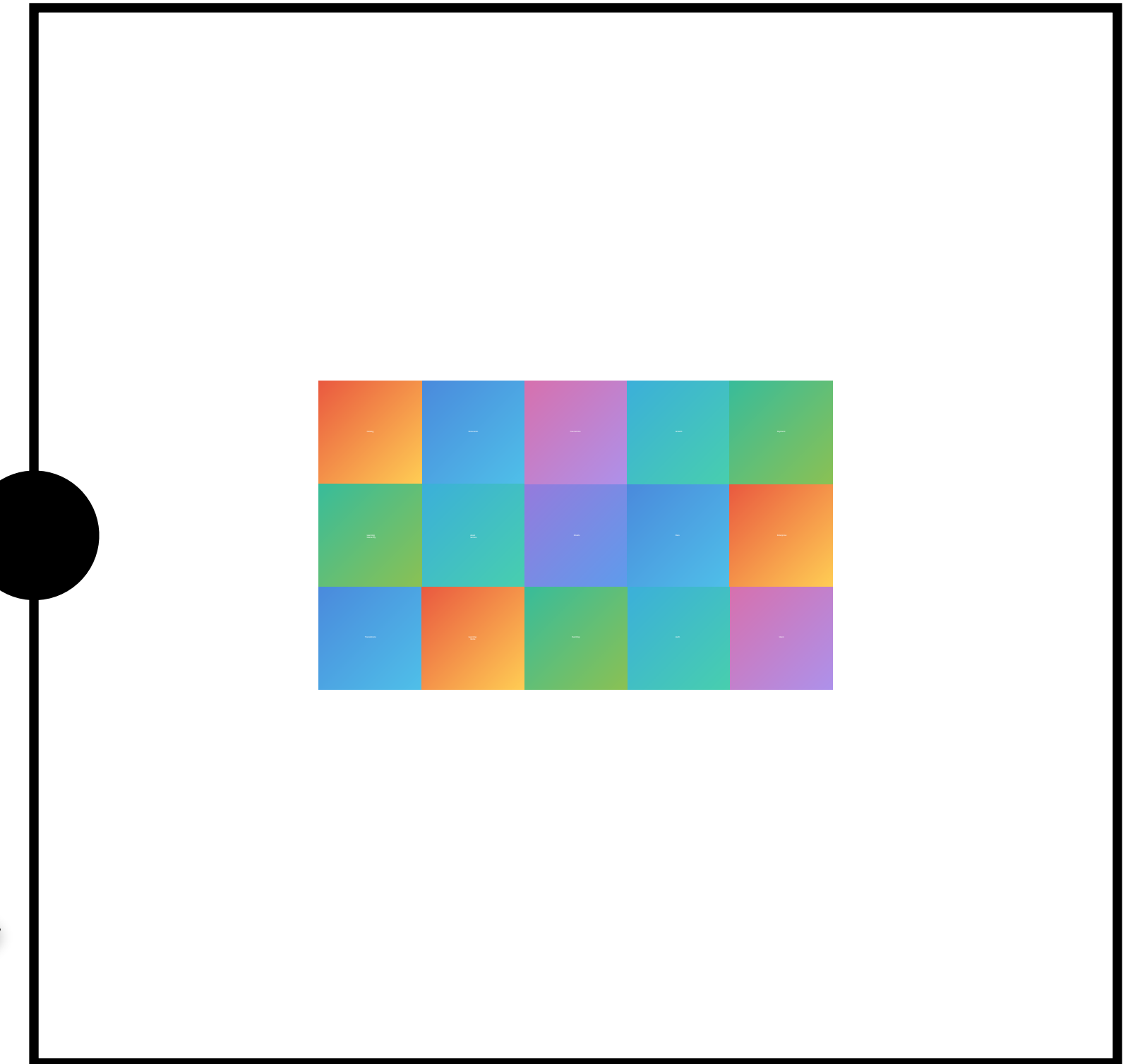
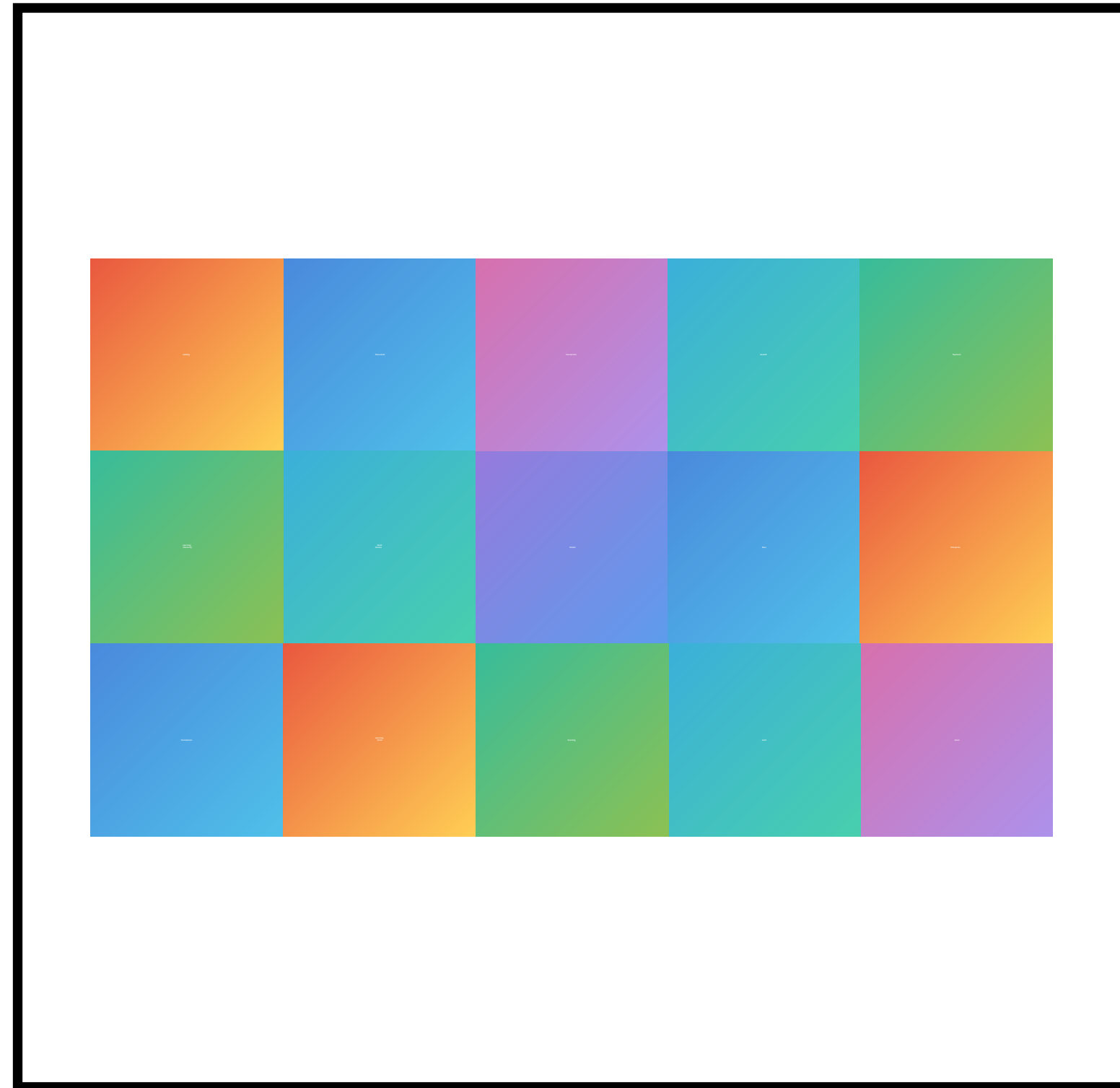
# Client

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APIs

# Backend

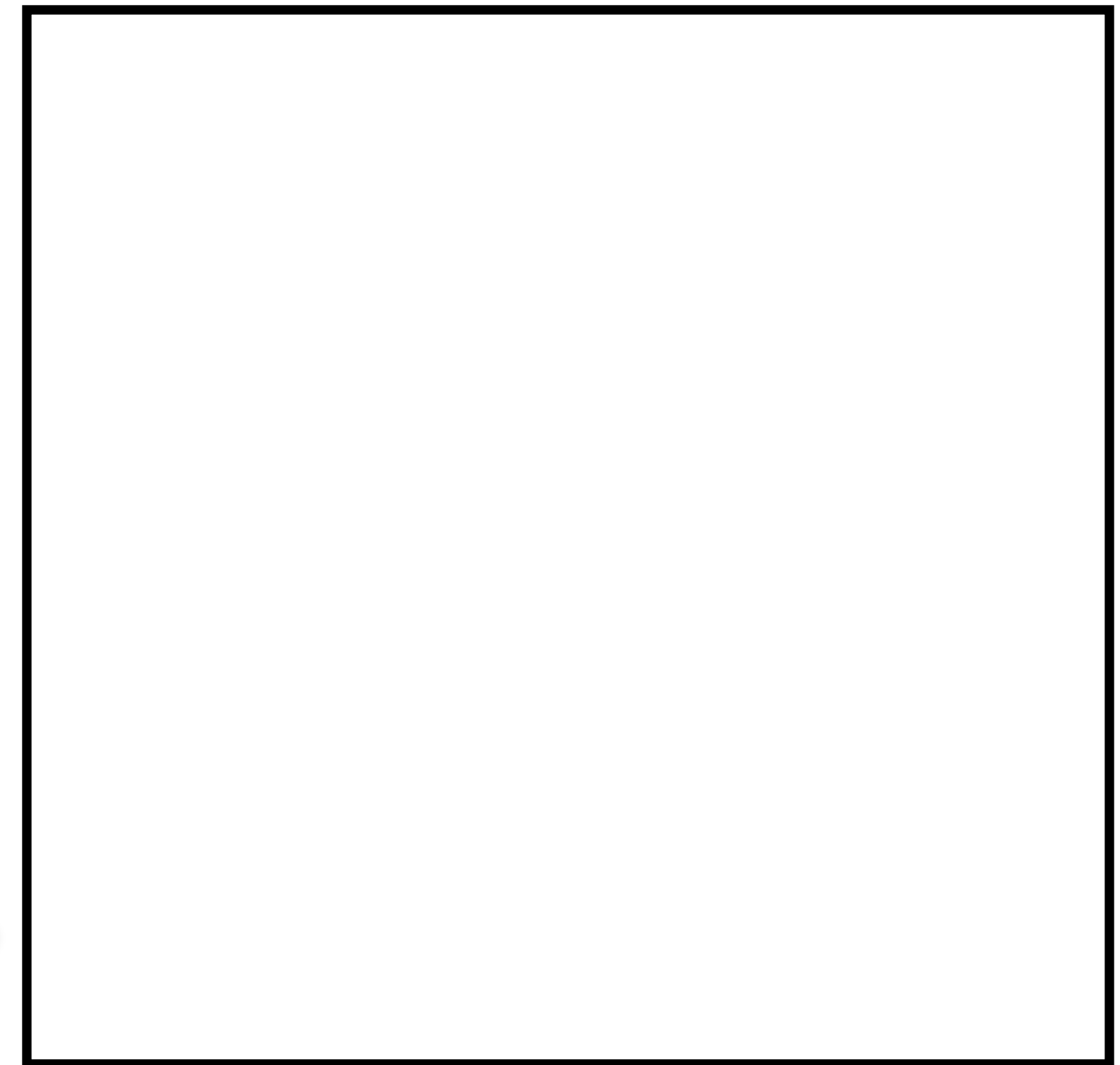
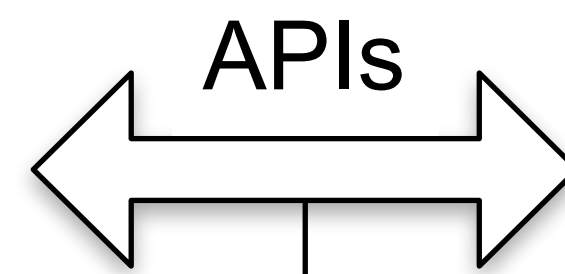
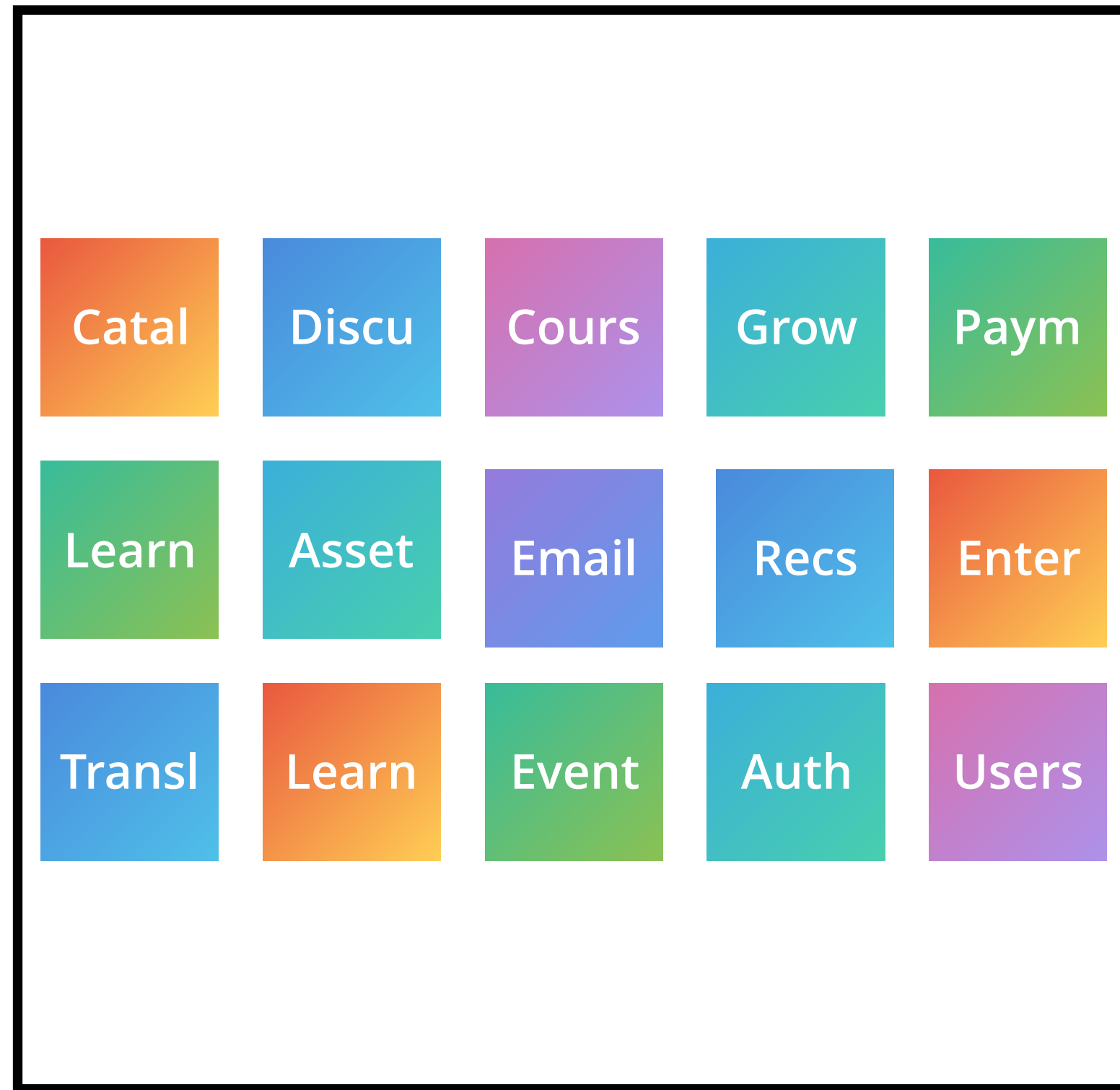
# Client

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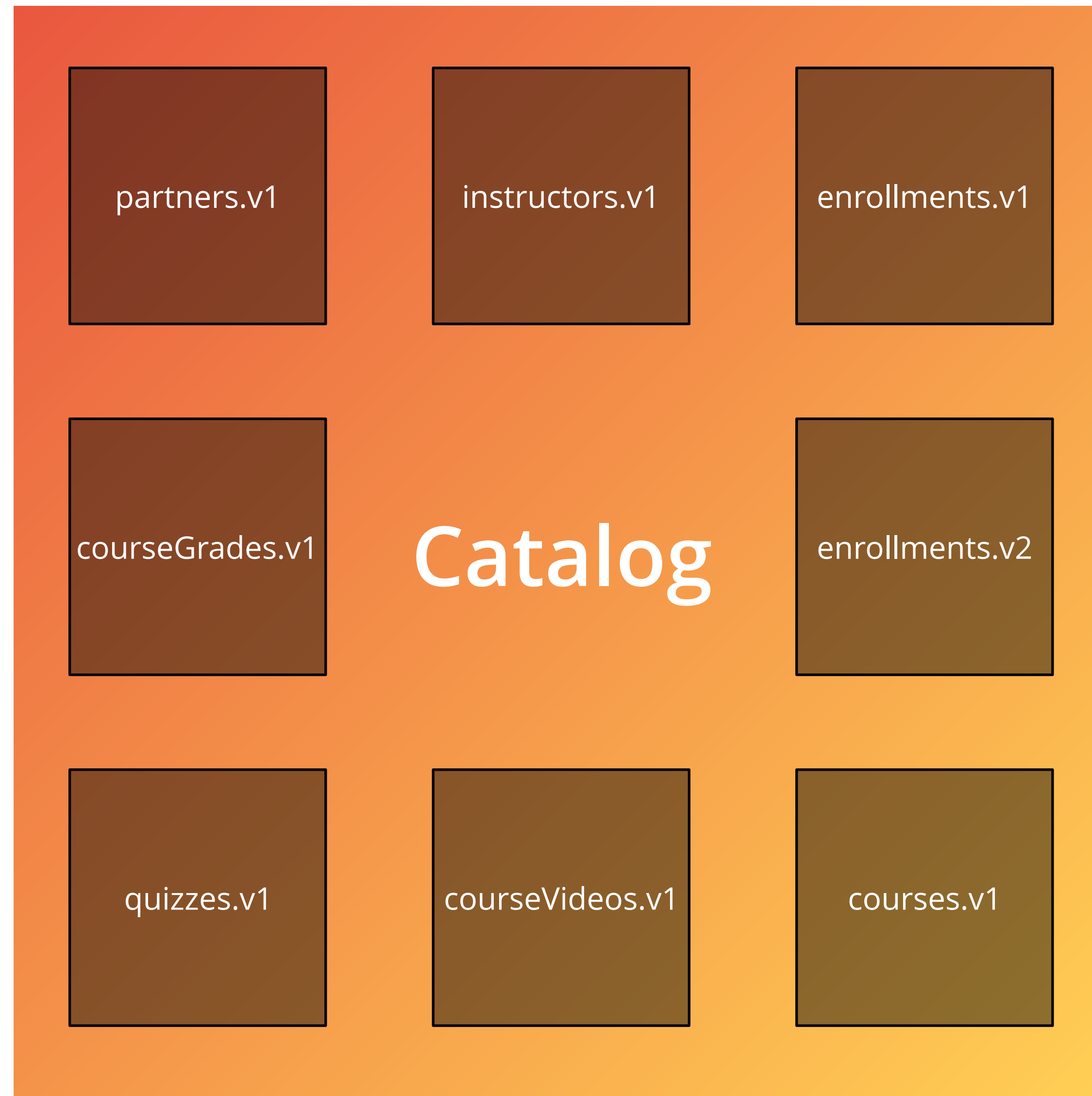
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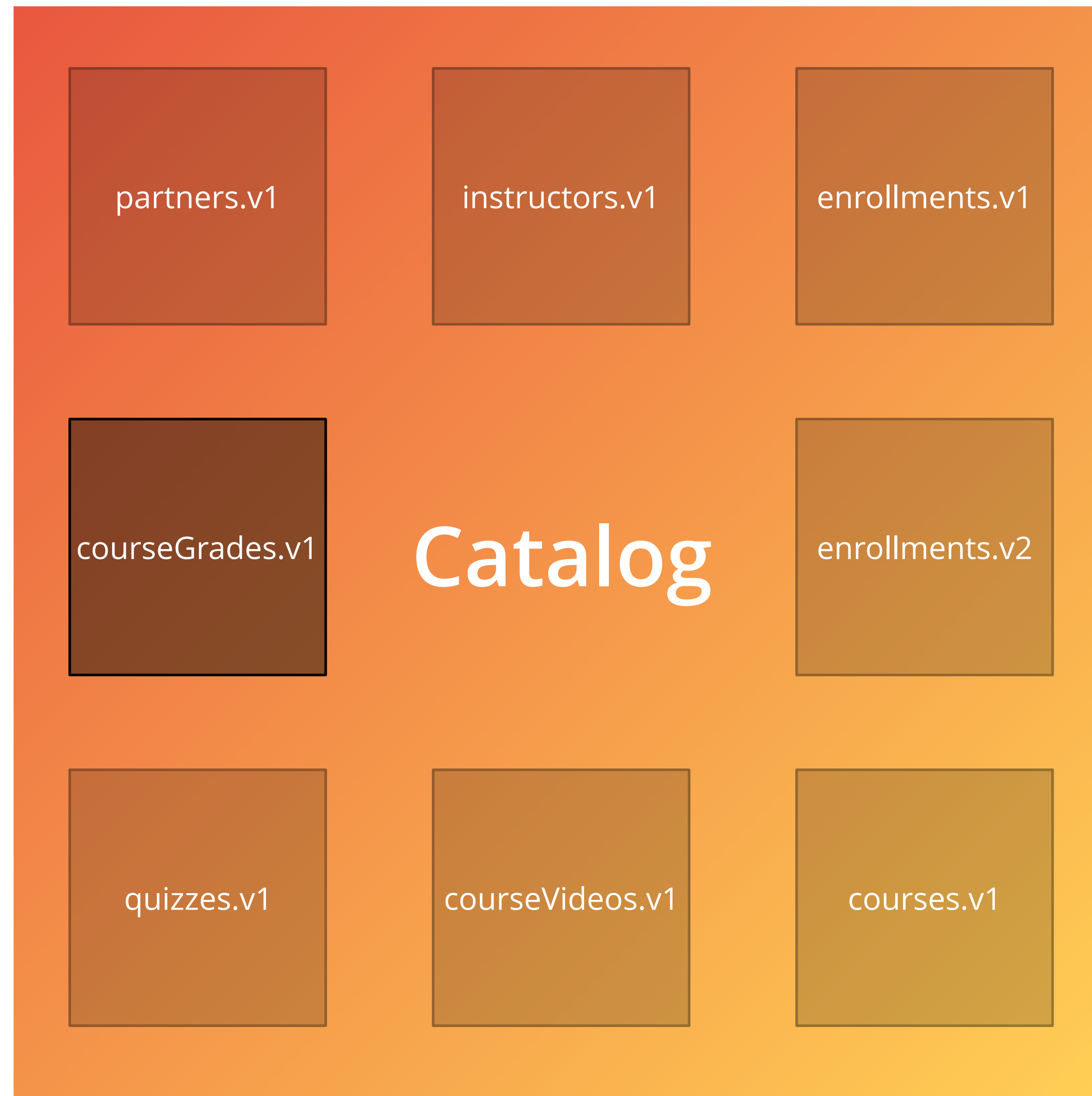
Intro to GraphQL

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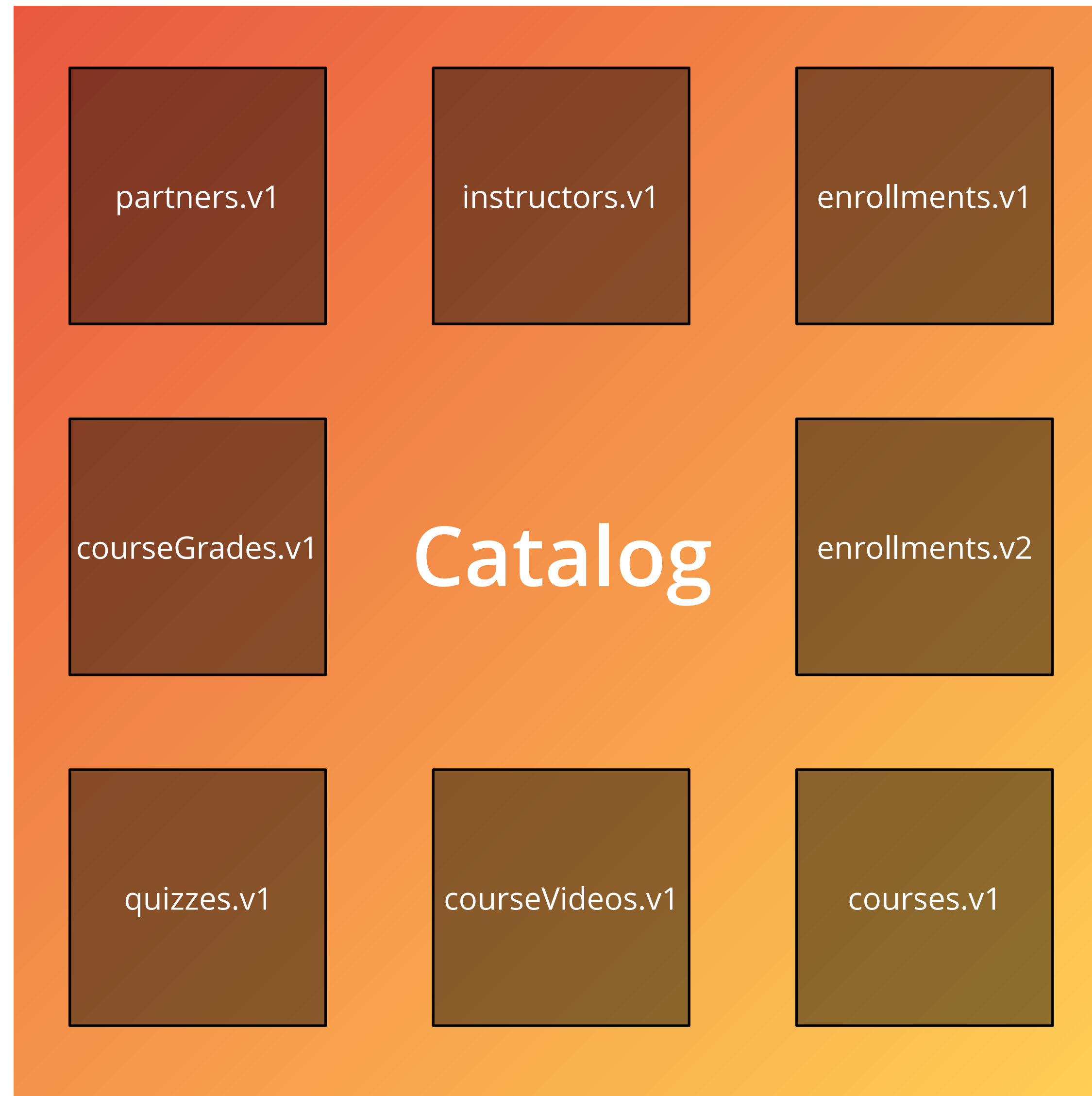
Intro to GraphQL

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# Backend

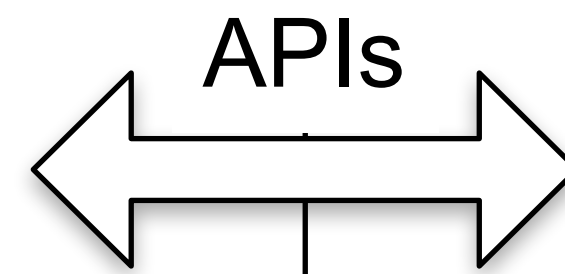
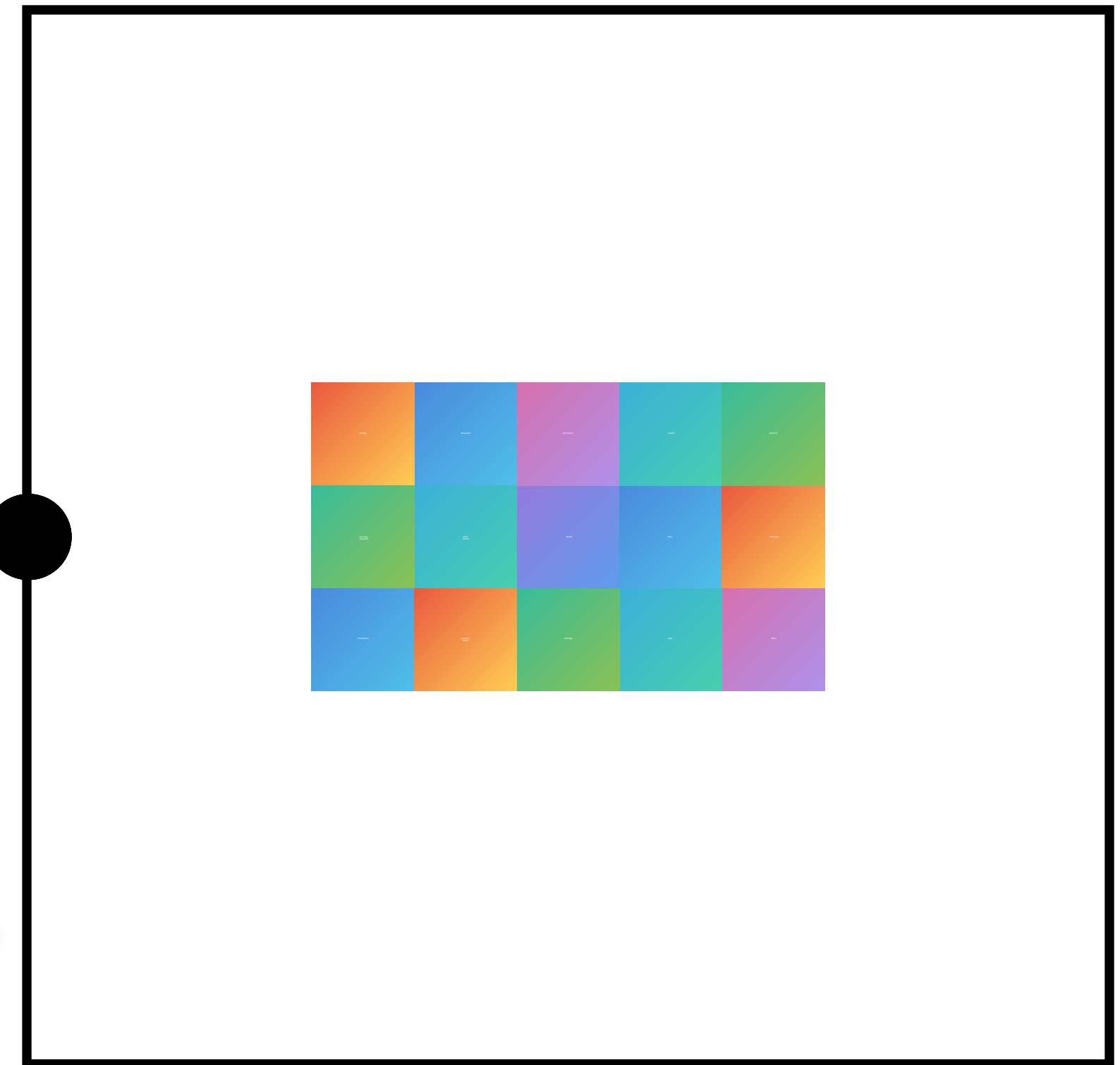
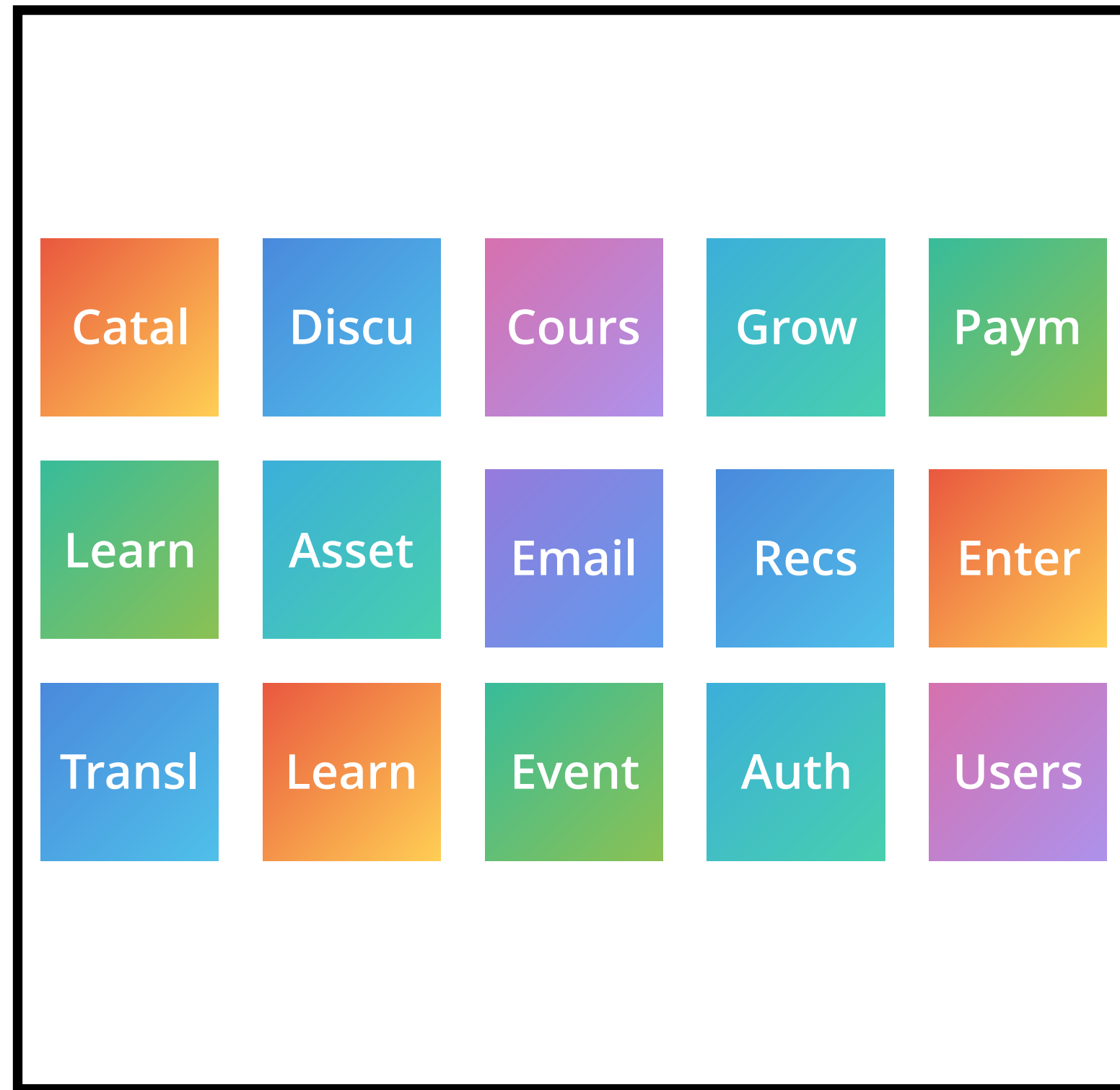
# Client

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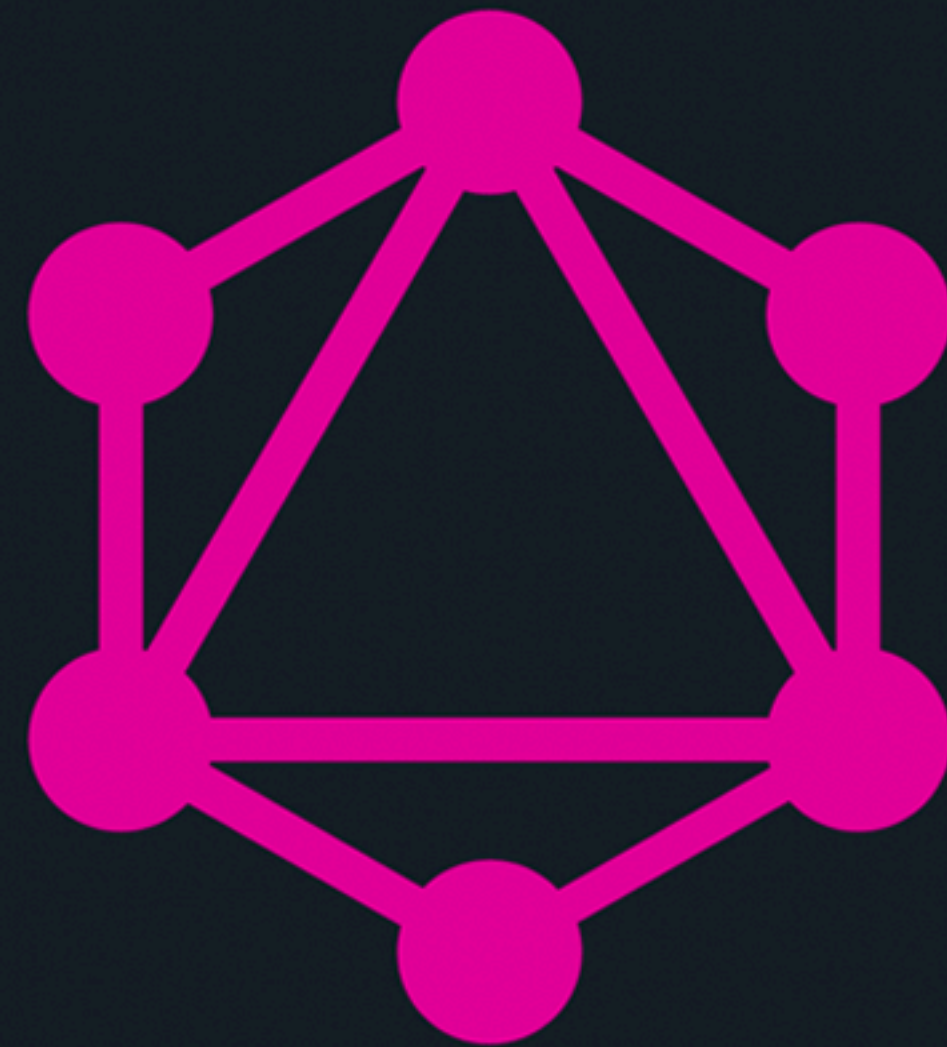
**We didn't break up the monolith —**  
*we just moved it to the clients.*

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# GraphQL

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GraphQL is a  
query language,  
not a library.

```
query MyCoursesQuery {
  myCourses(limit: 5, sortBy: RECENT) {
    name
    slug
    instructors {
      firstName
      lastName
      university(filter: VISIBLE_TO_LEARNERS) {
        name
        country
        slug
      }
    }
  }
}
```

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```
query MyCoursesQuery {  
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    name  
    slug  
    instructors {  
      firstName  
      lastName  
      university(filter: VISIBLE_TO_LEARNERS) {  
        name  
        country  
        slug  
      }  
    }  
  }  
}
```

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```
query MyCoursesQuery {  
  myCourses(limit: 5, sortBy: RECENT) {  
    name  
    slug  
    instructors {  
      firstName  
      lastName  
      university(filter: VISIBLE_TO_LEARNERS) {  
        name  
        country  
        slug  
      }  
    }  
  }  
}
```

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```
query MyCoursesQuery {  
  myCourses(limit: 5, sortBy: RECENT) {  
    name  
    slug  
    instructors {  
      firstName  
      lastName  
      university(filter: VISIBLE_TO_LEARNERS) {  
        name  
        country  
        slug  
      }  
    }  
  }  
}
```



```
query MyCoursesQuery {
  myCourses(limit: 5, sortBy: RECENT) {
    name
    slug
    instructors {
      firstName
      lastName
      university(filter: VISIBLE_TO_LEARNERS) {
        name
        country
        slug
      }
    }
  }
}
```

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```
{
  "myCourses": [
    {
      "name": "Machine Learning",
      "slug": "machine-learning",
      "instructors": [
        {
          "firstName": "Andrew",
          "lastName": "Ng",
          "university": {
            "name": "Stanford University",
            "country": "United States",
            "slug": "stanford"
          }
        }
      ]
    }
  ]
}
```

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```
query MyCoursesQuery {  
  myCourses(limit: 5, sortBy: RECENT) {  
    name  
    slug  
    instructors {  
      firstName  
      lastName  
      university(filter: VISIBLE_TO_LEARNERS) {  
        name  
        country  
        slug  
      }  
    }  
  }  
}
```

```
{  
  "myCourses": [{  
    "name": "Machine Learning",  
    "slug": "machine-learning",  
    "instructors": [{  
      "firstName": "Andrew",  
      "lastName": "Ng",  
      "university": {  
        "name": "Stanford University",  
        "country": "United States",  
        "slug": "stanford"  
      }  
    }  
  ]  
}]
```

[Overview](#)[Syllabus](#)[FAQs](#)[Creators](#)[Ratings and Reviews](#)

## Machine Learning

[Go to Course](#)

Already enrolled

[Admin](#)[Preview Course Materials](#)

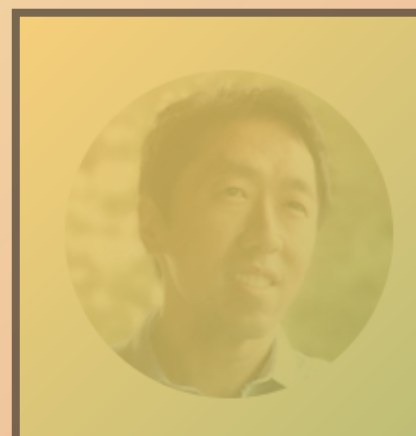
# Machine Learning

**About this course:** Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is so

[More](#)

**Created by:**

Stanford University



**Taught by:**

Andrew Ng

Associate Professor, Stanford University;

Chief Scientist, Baidu; Chairman and Co-founder, Coursera



**Language**

English, **Subtitles:** Spanish, Hindi, Japanese, Chinese (Simplified)

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The screenshot shows the Coursera website interface for the 'Machine Learning' course. At the top, there is a search bar and a 'For Enterprise' link. The left sidebar contains a navigation menu with items: Overview, Syllabus, FAQs, Creators, Ratings and Reviews, Machine Learning (highlighted), Go to Course, Already enrolled, Admin, Preview Course Materials. The main content area shows the course title 'Machine Learning', a breadcrumb trail 'Home > Data Science > Machine Learning', and a description: 'About this course: Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is so'. Below the description is a 'More' link. The 'Created by' section shows the Stanford University logo and name. The 'Taught by' section features a profile picture of Andrew Ng and his title: 'Associate Professor, Stanford University; Chief Scientist, Baidu; Chairman and Co-founder, Coursera'. At the bottom, there is a 'Language' section with 'English' and 'Subtitles: Spanish, Hindi, Japanese, Chinese (Simplified)'.

```
<Course />  
  
query CoursePage {  
  course(slug: "machine-learning") {  
    title  
    description  
  }  
}
```

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The screenshot shows the Coursera website interface for the 'Machine Learning' course. The top navigation bar includes the Coursera logo, a search bar, and a 'For Enterprise' link. The left sidebar contains a navigation menu with items: Overview, Syllabus, FAQs, Creators, Ratings and Reviews, Machine Learning (selected), Go to Course, Already enrolled, Admin, Preview Course Materials. The main content area displays the course title 'Machine Learning', a breadcrumb trail 'Home > Data Science > Machine Learning', and a description: 'About this course: Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is so'. Below the description is a 'More' link. The 'Created by' section shows 'Stanford University' and 'Stanford University'. The 'Taught by' section features a profile picture of Andrew Ng, his name, and his titles: 'Associate Professor, Stanford University; Chief Scientist, Baidu; Chairman and Co-founder, Coursera'. At the bottom, the 'Language' section indicates 'English, Subtitles: Spanish, Hindi, Japanese, Chinese (Simplified)'.

```
<Course />  
  
query CoursePage {  
  course(slug: "machine-learning") {  
    title  
    description  
    university {  
      name  
      logo  
    }  
  }  
}
```

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The screenshot shows the Coursera website interface for the 'Machine Learning' course. At the top, there is a search bar and a 'For Enterprise' link. The main content area is divided into a sidebar and a main section. The sidebar contains a navigation menu with items: Overview, Syllabus, FAQs, Creators, Ratings and Reviews, Machine Learning (selected), Go to Course, Already enrolled, and Admin. The main section displays the course title 'Machine Learning', a breadcrumb trail 'Home > Data Science > Machine Learning', and a description: 'About this course: Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is so'. Below the description is a 'Created by' section for Stanford University and a 'Taught by' section for Andrew Ng, Associate Professor at Stanford University and Chief Scientist at Baidu. At the bottom, there is a 'Language' section indicating the course is in English with subtitles in Spanish, Hindi, Japanese, and Chinese (Simplified).

```
<Course />  
query CoursePage {  
  course(slug: "machine-learning") {  
    title  
    description  
    university {  
      name  
      logo  
    }  
    instructor {  
      name  
      title  
    }  
  }  
}
```

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The screenshot shows the Coursera website interface. At the top, there is a search bar with the text 'Catalog Search catalog' and a magnifying glass icon. To the right, there is a 'For Enterprise' link and a user profile icon. The main content area is titled 'Machine Learning' and includes a breadcrumb trail: 'Home > Data Science > Machine Learning'. Below the title, there is a description of the course: 'About this course: Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is so'. A 'More' link is visible below the description. The course is created by Stanford University, as indicated by the 'Created by: Stanford University' section. The instructor is Andrew Ng, an Associate Professor at Stanford University and Chief Scientist at Baidu. The course is available in English, with subtitles in Spanish, Hindi, Japanese, and Chinese (Simplified). A 'Go to Course' button is prominently displayed, along with an 'Already enrolled' status and an 'Admin' button. A 'Preview Course Materials' link is also present.

```
<Course />  
query CoursePage {  
  course(slug: machine-learning) {  
    title  
    description  
    university {  
      name  
      logo  
    }  
    instructor {  
      name  
      title  
      profile {  
        photo  
      }  
    }  
  }  
}
```



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All queries are backed  
by a **typed schema**

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```
type root {  
  myCourses(limit: Int, sortBy: COURSE_SORT): [Course]  
}
```

```
enum COURSE_SORT {  
  RECENT  
  ENROLL_DATE  
}
```

```
type Course {  
  name: String  
  slug: String  
  instructors: [Instructor]  
}
```


```
type Instructor {  
  firstName: String  
  lastName: String  
  university(filter: VISIBILITY_FILTER): University  
}
```

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GraphiQL  [Docs](#)

```
1 # Welcome to GraphiQL
2 #
3 # GraphiQL is an in-browser IDE for writing, validating, and
4 # testing GraphQL queries.
5 #
6 # Type queries into this side of the screen, and you will
7 # see intelligent typeaheads aware of the current GraphQL type schema and
8 # live syntax and validation errors highlighted within the text.
9 #
10 # To bring up the auto-complete at any point, just press Ctrl-Space.
11 #
12 # Press the run button above, or Cmd-Enter to execute the query, and the result
13 # will appear in the pane to the right.
14 {
15   viewer{
16     posts(post_type:"Page") {
17       edges {
18         node {
19           id
20           p|
21         } post_type
22       } post_name
23     } post_meta
24   } post_title
25 } post_status
  post_content
  post_excerpt
  PostmetaConnection Self descriptive.
```

```
{
  "data": {
    "viewer": {
      "posts": {
        "edges": [
          {
            "node": {
              "id": "4"
            }
          },
          {
            "node": {
              "id": "37"
            }
          },
          {
            "node": {
              "id": "53"
            }
          }
        ]
      }
    }
  }
}
```

QUERY VARIABLES

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# Small, but rapidly growing community

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visit [graphql.org](https://graphql.org)

for more info

# Migrating to GraphQL

# Backend

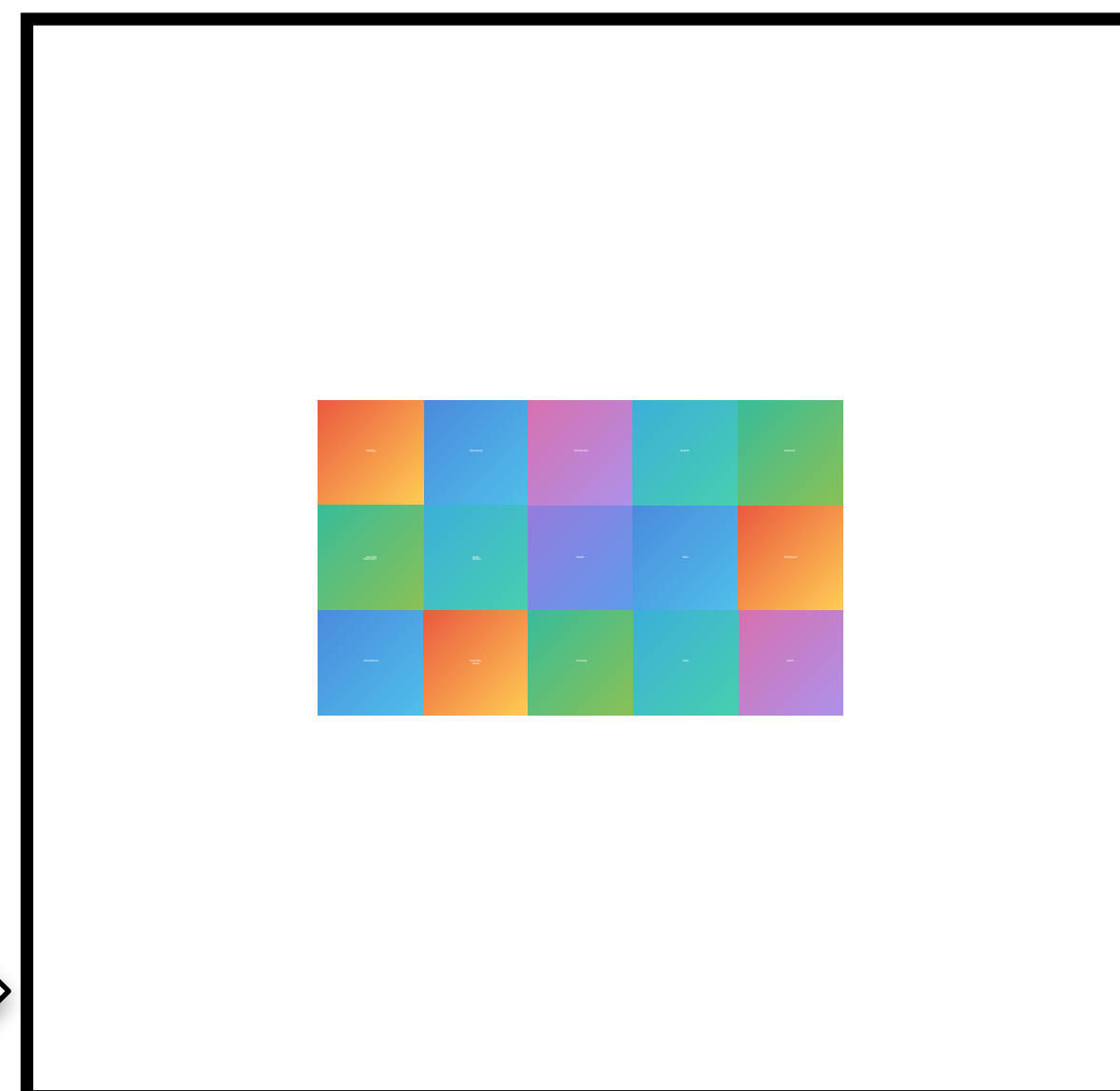
# Client

## Chapter One

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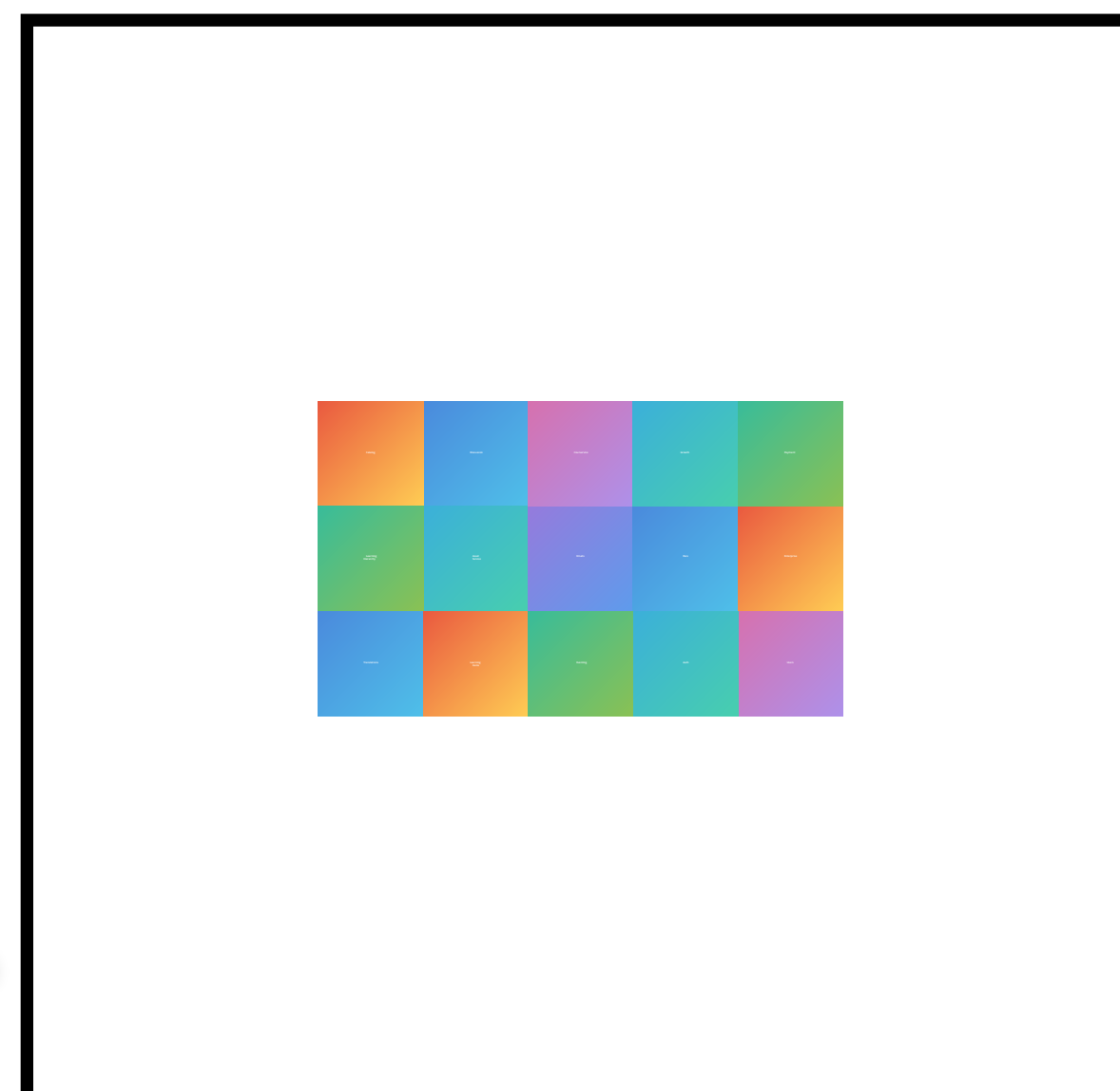
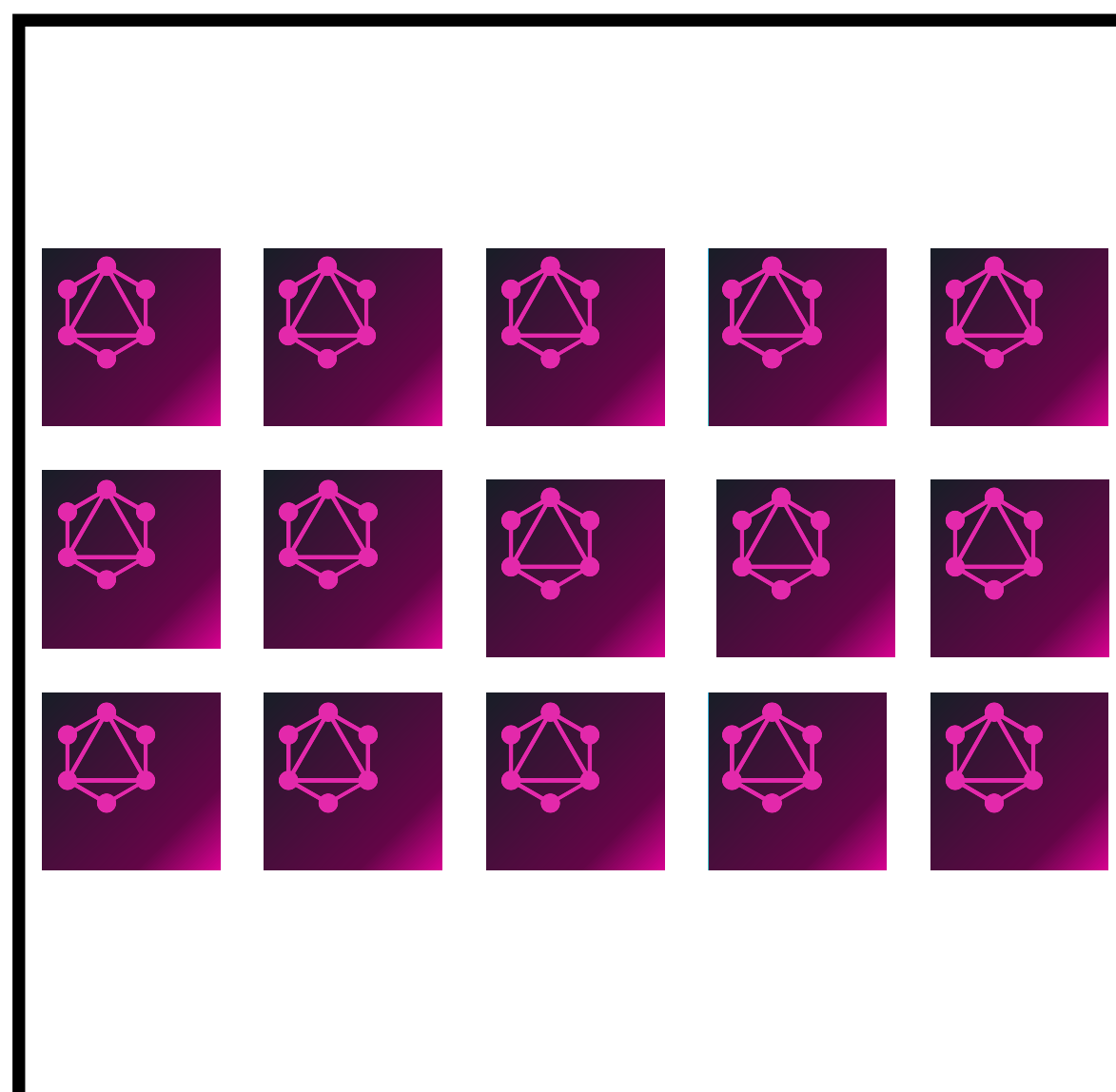


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**Codebase consistency**

**Convert REST  
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**Add GraphQL  
on top of REST**

**One API format**

Multiple API formats



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**Codebase consistency**

**Time investment**

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**More flexible**

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Less flexible

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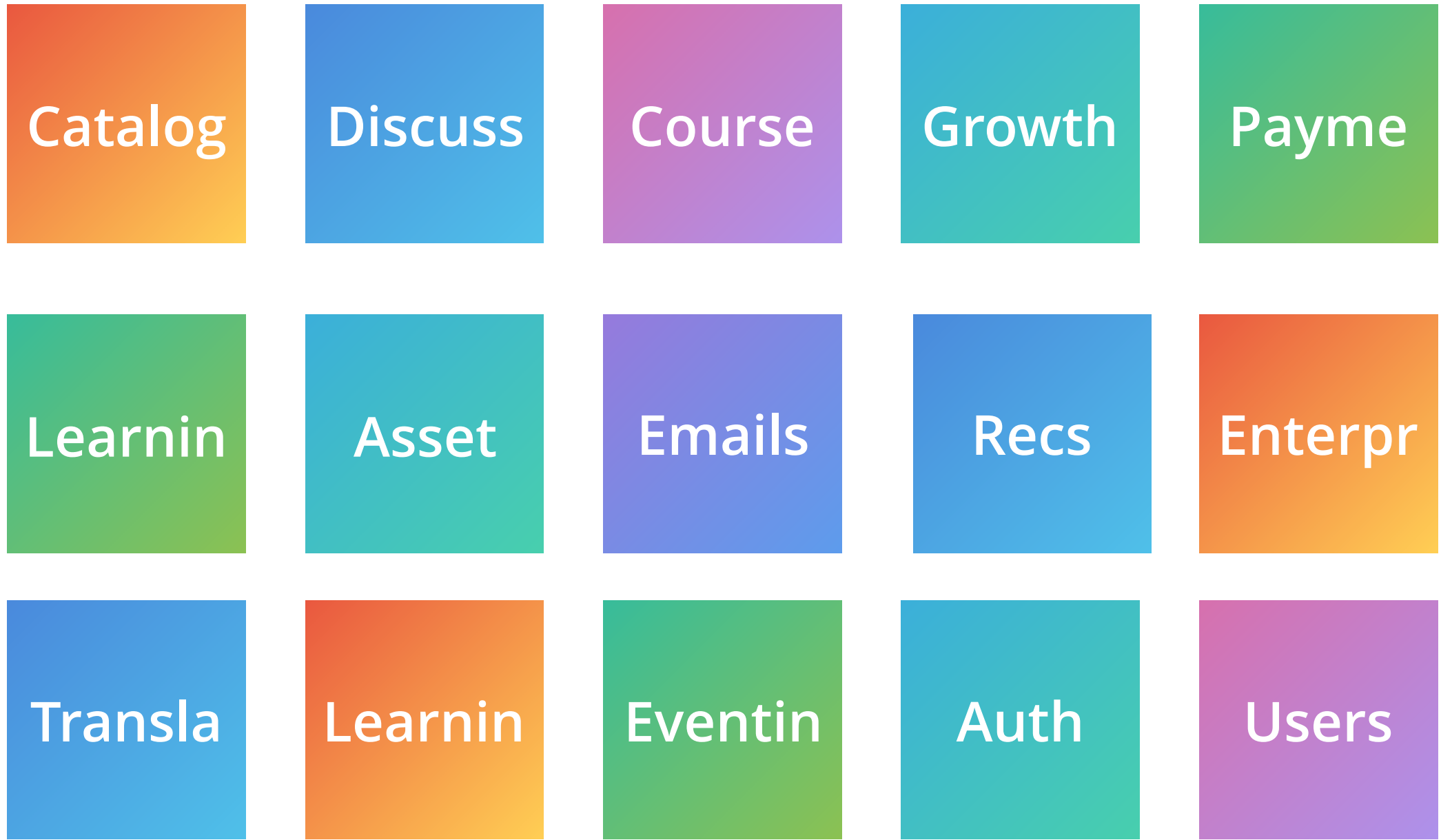
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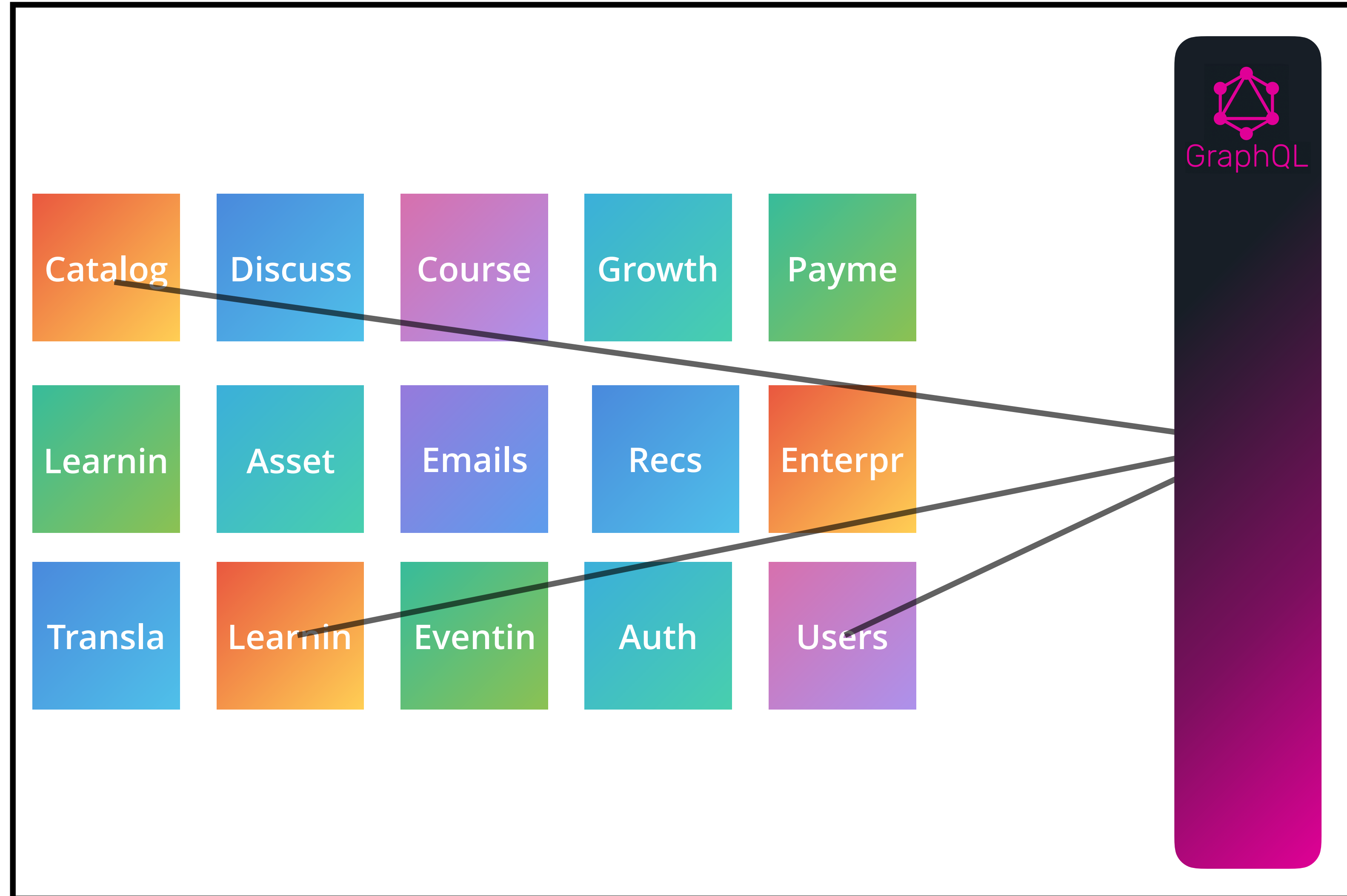


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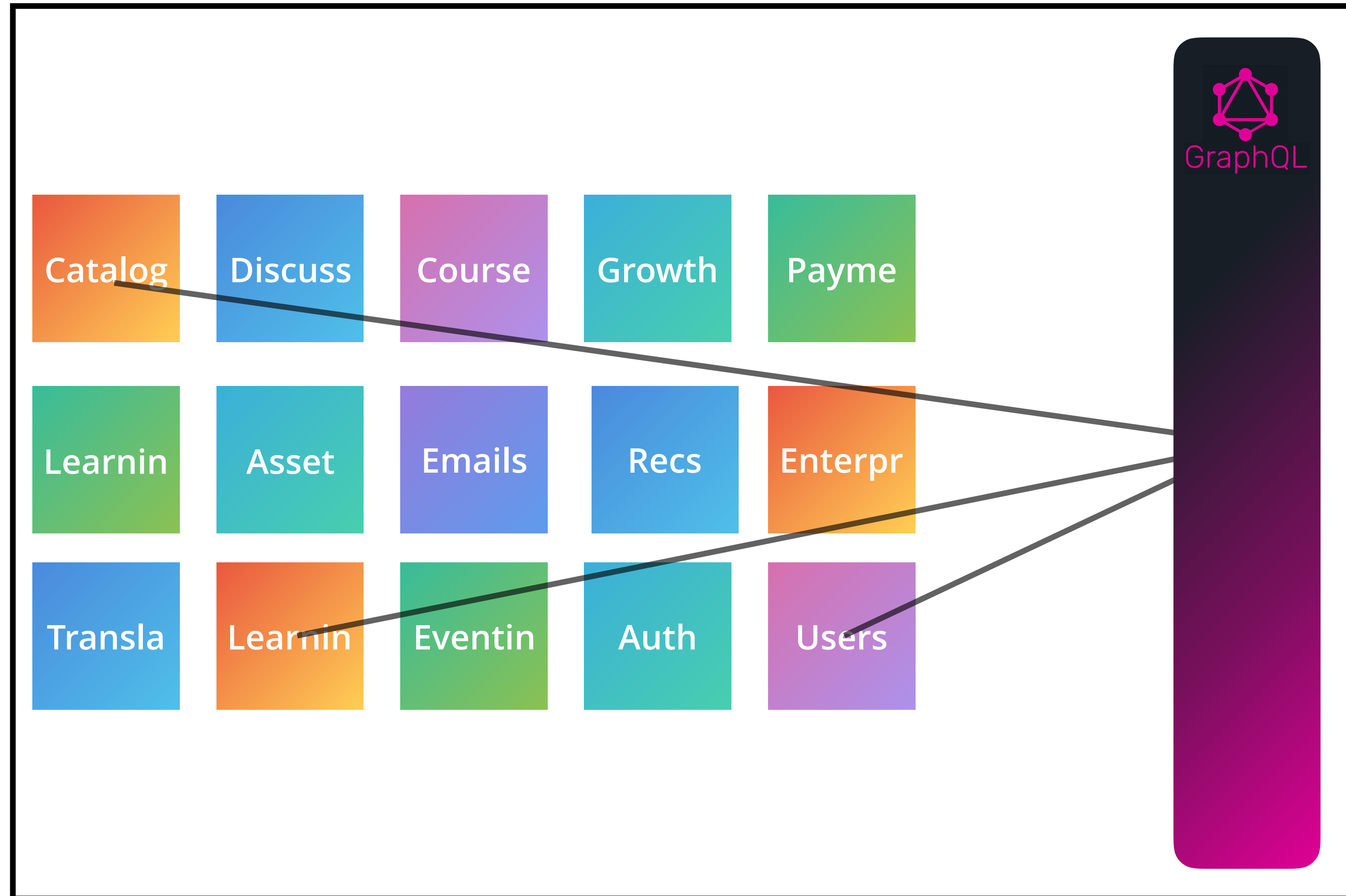


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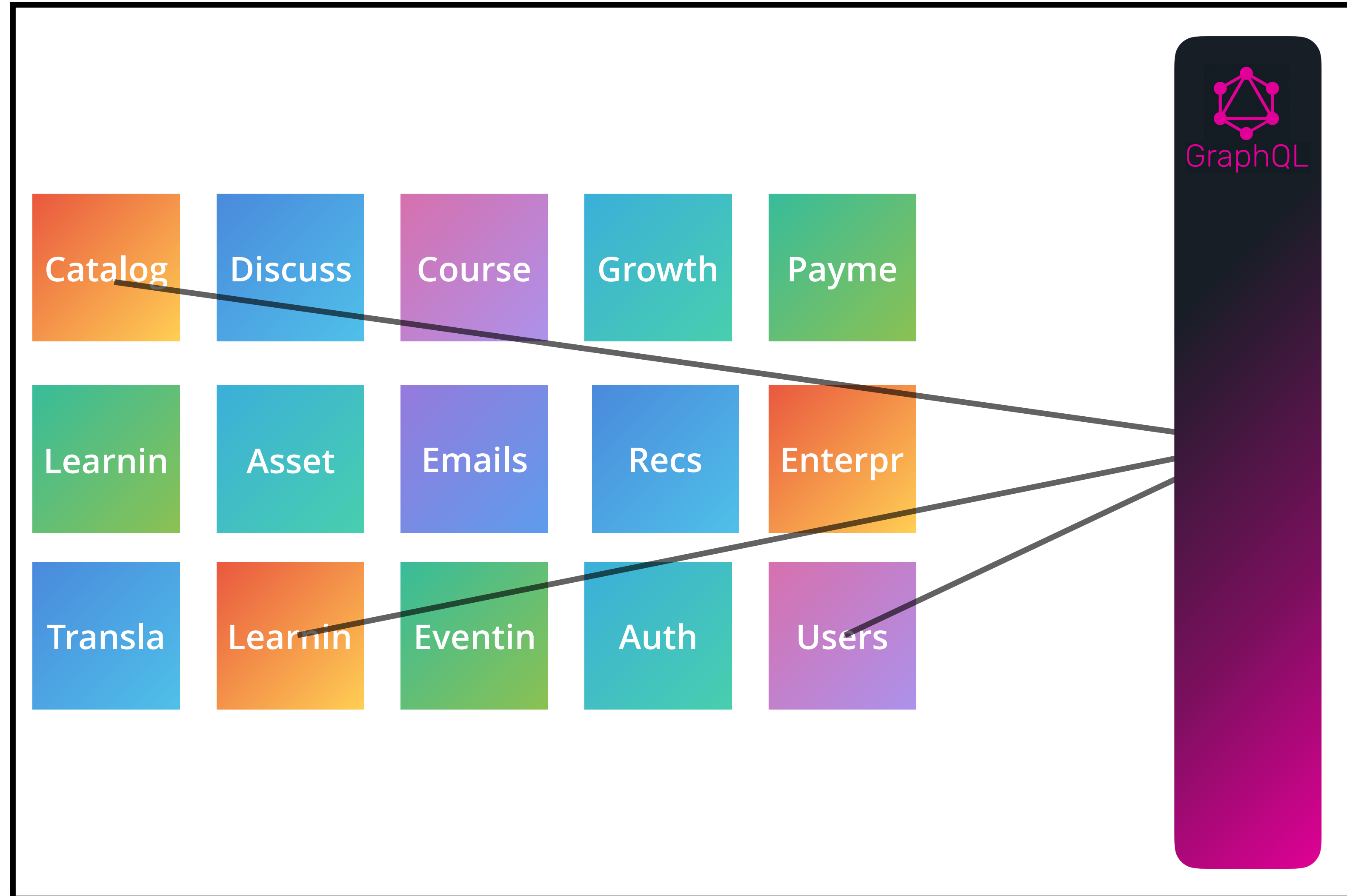


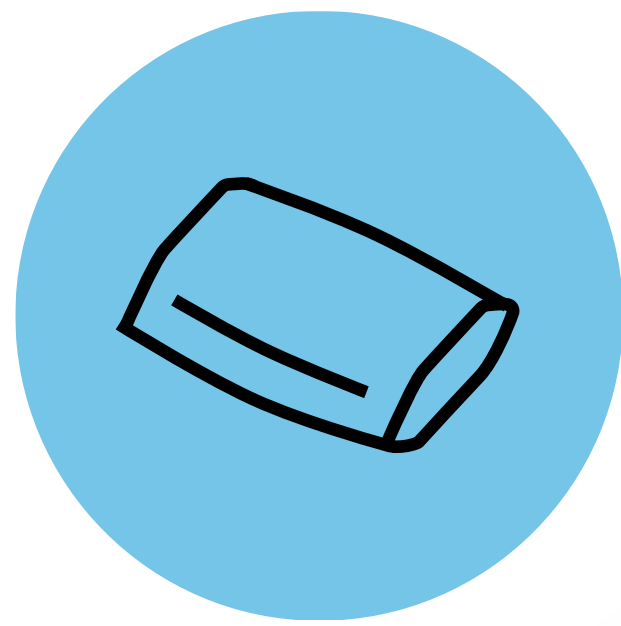
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# Naptime

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1

**List of public APIs**

2

**Endpoints and  
arguments**

3

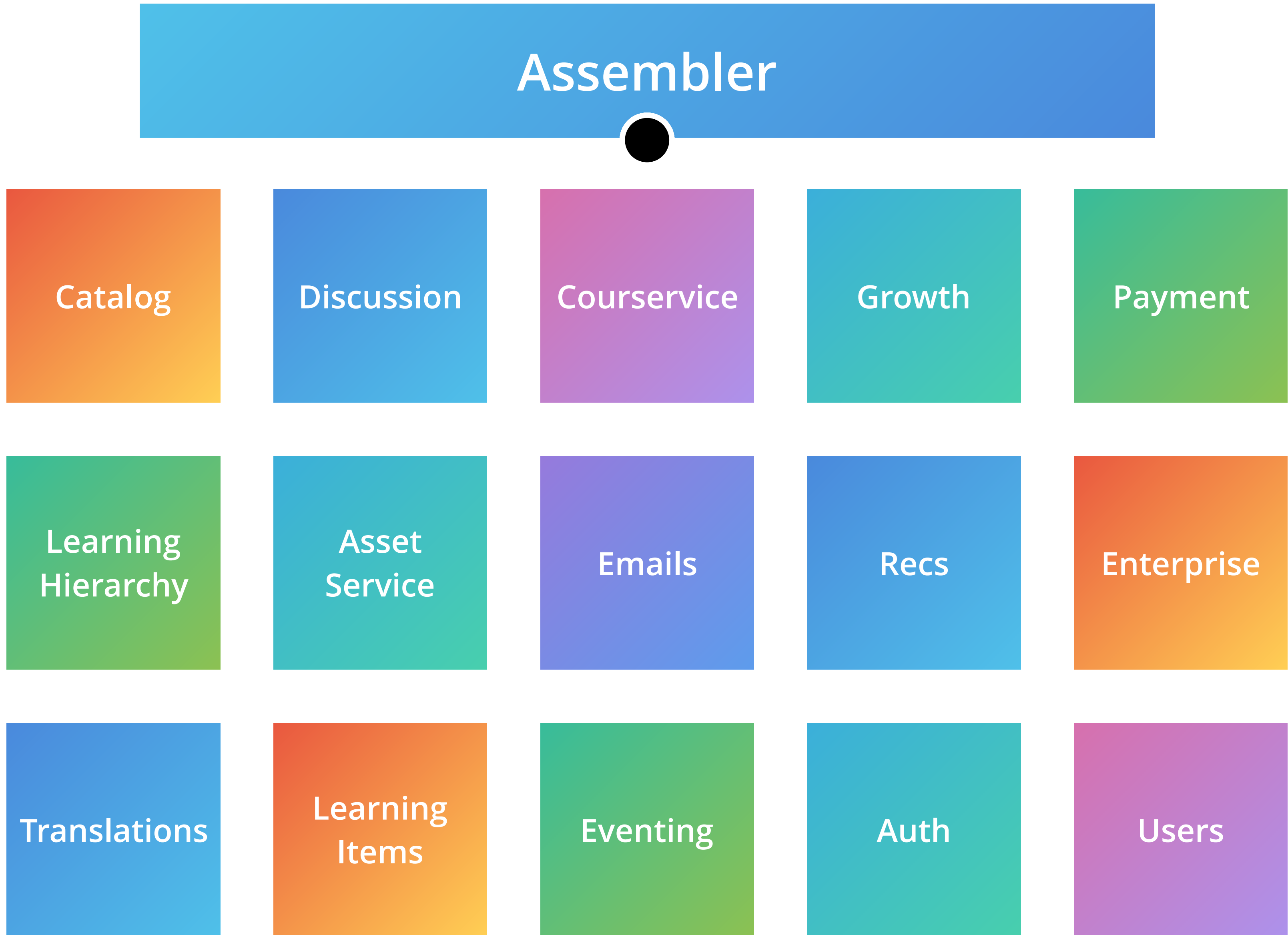
**Model schemas**

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# Schema Design

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```
type CoursesV1 {
  id: String
  slug: String
  ...more fields
}

type CoursesV1Resource {
  myWatchlist(limit: Int, start: String): CoursesV1Connection
  bySlug(slug: String, limit: Int, start: String): CoursesV1Connection
  getAll(limit: Int, start: String): CoursesV1Connection
  get(id: String!): CoursesV1
  multiGet(ids: [String], limit: Int, start: String): CoursesV1Connection
}

type CoursesV1Connection {
  elements: [CoursesV1]
  paging: ResponsePagination
}
```

# REST to GraphQL

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```
https://www.coursera.org  
/api/courses.v1  
?q=bySlug  
&slug=ml  
&fields=id,name,courseUrl
```

```
query CoursePageQuery {  
  CoursesV1Resource {  
    bySlug(slug: "ml") {  
      id  
      name  
      courseUrl  
    }  
  }  
}
```

# Data Relations are Powerful

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```
query CoursePageQuery {  
  CoursesV1Resource {  
    course(limit: 123) {  
      instructor {  
        name  
        university {  
          slug  
          country  
        }  
      }  
      myEnrollments {  
        grade  
      }  
    }  
  }  
}
```

# Backend APIs are a black box

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# Backend APIs are a black box

- Joining across APIs is hard

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# Backend APIs are a black box

- Joining across APIs is hard
- We don't use relational databases
  - Most data is stored in Cassandra, a NoSQL database
  - This requires explicit indexes on data for lookups

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# Backend APIs are a black box

- Joining across APIs is hard
- We don't use relational databases
  - Most data is stored in Cassandra, a NoSQL database
  - This requires explicit indexes on data for lookups
- We want to keep services as independent as possible

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# Two types of relationships

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**model A knows about model B**



```
model Course {  
  id  
  slug  
  instructorIds  
}
```

```
model Instructor {  
  id  
  name  
}
```

# Two types of relationships

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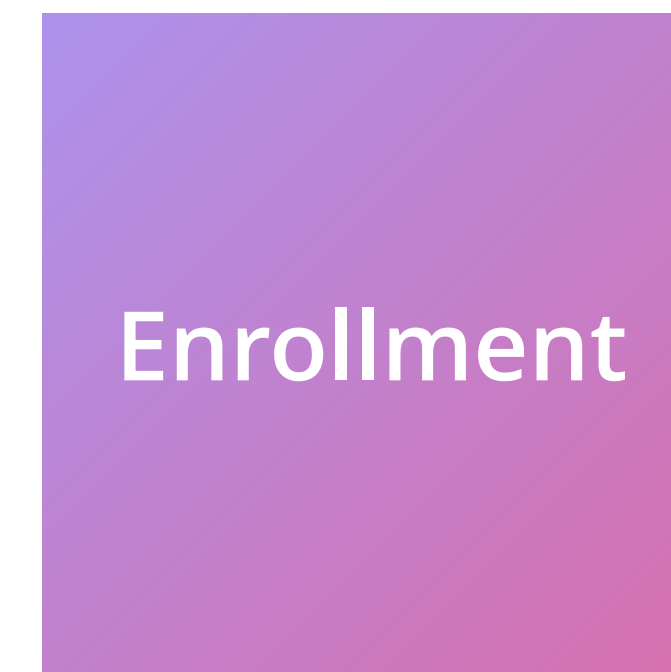
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**model A** *doesn't know about* **model B**

**model B** *knows about* **model A**



```
model Course {  
  id  
  slug  
}
```

```
model Enrollment {  
  id  
  userId  
  courseId  
}
```

# Forward Relationships

These are easy — just fetch the data you need by ID

```
courseAPI.addRelation(  
  "instructors" -> ForwardRelation(  
    resourceName = "instructors.v1",  
    idField = "instructorIds",  
    arguments = Map("includeHidden" -> "true"))
```

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# Reverse Relationships

- Define an endpoint on resource B to lookup by model A
- Define in resource A how to look up on resource B

```
courseAPI.addRelation(  
  "enrollment" -> ReverseRelation(  
    resourceName = "enrollments.v1",  
    finderName = "byCourseAndUser",  
    arguments = Map(  
      "courseId" -> "$id",  
      "version" -> "$version"))
```

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# Imperative

```
courseAPI.addRelation({ course =>
  instructorClient.fetchByCourseId(course.id, course.version)
    .onComplete { instructors =>
      course.set("instructors", instructors)
    }.onFailure {
      course.set("instructors", List.empty)
    }
})
```

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# Imperative

```
courseAPI.addRelation({ course =>
  instructorClient.fetchByCourseId(course.id, course.version)
    .onComplete { instructors =>
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    }
})
```

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# Declarative

```
courseAPI.addRelation(
  "instructors" -> ReverseRelation(
    resourceName = "instructors.v1",
    finderName = "byCourseId",
    arguments = Map("courseId" -> "$id", "version" -> "$version")))
```





COURSE 3 of 6  
**Accounting: Making Sound Decisions**  
 Your Session: Apr 18 - May 22

☆☆☆☆☆

Start Wk1 Wk2 Wk3 Wk 4 Wk 5

**WEEK 2 Retake Quiz: Introduction to Accounting**  
 You're reviewed the material and we know you'll do great!  
 5 min [Retake](#)

COURSE 4 of 6  
**Accounting: Making Sound Decisions**  
 Your Session: Apr 18 - May 22

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Wk 4 Wk 5 Wk 6 Wk 7 Wk 8 Wk 9

**WEEK 6 Video: Introduction to Accounting**  
 Good job staying ahead. Keep it up!  
 5 min [Start](#)

COURSE 4 of 6  
**Accounting: Making Sound Decisions**  
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# Actual Query

```
query {  
  CoursesV1Resource {  
    bySlug(slug: "machine-learning") {  
      coursePurchases {  
        transactions {  
          transactionDate  
          expirationDate  
        }  
      }  
      certificates {  
        certificateGrantDate  
        certificateGrade  
      }  
    }  
    offersCertificateForPurchase  
  }  
  EnterpriseProgramsV1Resource {  
    myPrograms {  
      eligibleCourses  
    }  
  }  
}
```

# Ideal Query

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# Actual Query

```
query {  
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    bySlug(slug: "machine-learning") {  
      coursePurchases {  
        transactions {  
          transactionDate  
          expirationDate  
        }  
      }  
      certificates {  
        certificateGrantDate  
        certificateGrade  
      }  
    }  
    offersCertificateForPurchase  
  }  
  EnterpriseProgramsV1Resource {  
    myPrograms {  
      eligibleCourses  
    }  
  }  
}
```

# Ideal Query

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# Actual Query

```
query {  
  CoursesV1Resource {  
    bySlug(slug: "machine-learning") {  
      coursePurchases {  
        transactions {  
          transactionDate  
          expirationDate  
        }  
      }  
      certificates {  
        certificateGrantDate  
        certificateGrade  
      }  
    }  
    offersCertificateForPurchase  
  }  
  EnterpriseProgramsV1Resource {  
    myPrograms {  
      eligibleCourses  
    }  
  }  
}
```

# Ideal Query

```
query {  
  CoursesV1Resource {  
    bySlug(slug: "machine-learning") {  
      shouldShowUpsell  
    }  
  }  
}
```

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# GraphQL isn't magic

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# GraphQL isn't magic

- Don't let your GraphQL queries become too complex — move your business logic downstream.

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# GraphQL isn't magic

- Don't let your GraphQL queries become too complex — move your business logic downstream.
- Build your APIs with GraphQL in mind — don't let them live in a silo.

# Popular Courses for Journalists

Learn what it takes to report the news, conduct historical research, understand different viewpoints, and even produce your own intro music.

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```
query CourseCollectionQuery(slug: String!) {  
  CourseCollectionV1Resource {  
    bySlug(slug: $slug) {  
      title  
      subtitle  
      entries {  
        isEnrolled  
        isOnWishlist  
        course {  
          name  
          photo  
        }  
      }  
    }  
  }  
}
```

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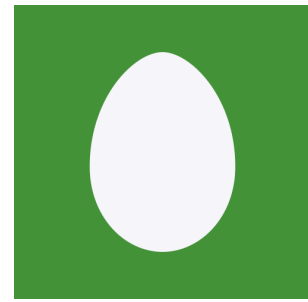
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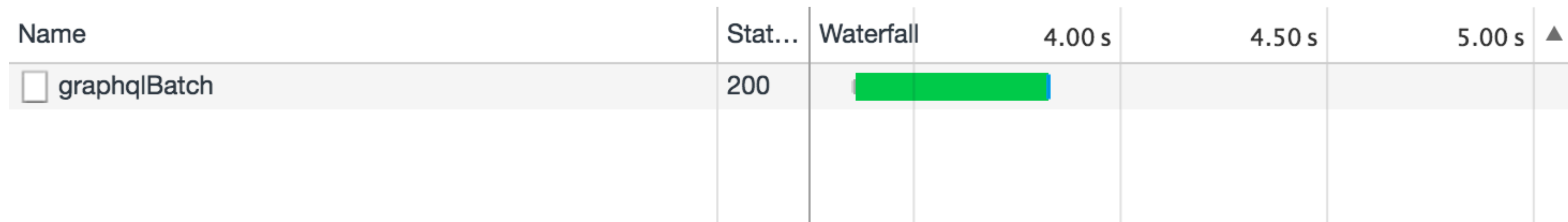
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2:00 PM - 28 June 2017

# Thanks!

Bryan Kane



@bryanskane



bryan-coursera