

Databases II
2025-I
Workshop No. 1
Project Definition and Database Modeling
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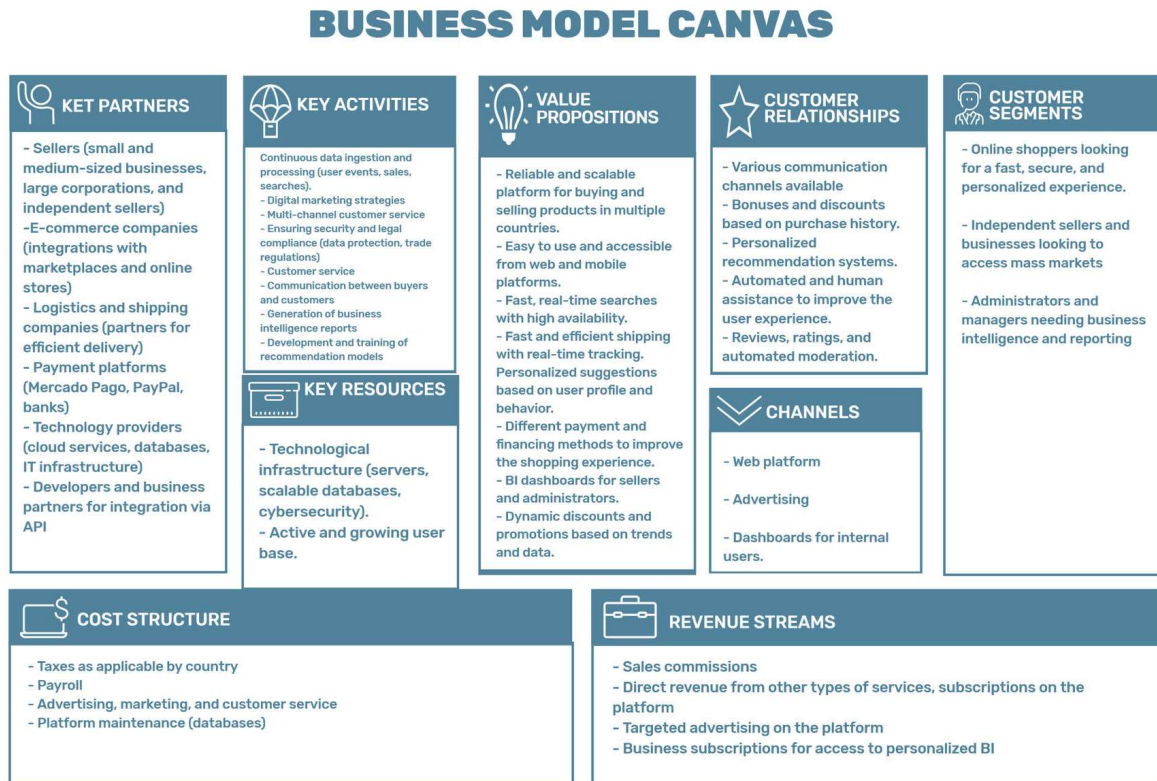
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Introduction

In the competitive landscape of e-commerce, platforms like Mercado Libre demand robust, scalable, and secure database systems to manage millions of daily transactions, diverse user interactions, and real-time analytics. This workshop solution focuses on designing a high-level database architecture tailored to such needs, integrating strategic business alignment, user-centric workflows, and cutting-edge technical infrastructure.

Model canvas



User Stories:

Role: User

1. **As a Buyer, I want to** register with my email **so that I** can access the platform easily.
Acceptance Criteria:
 - a. Must allow email registration.
 - b. Email validation required
 - c. Account confirmation via email.
2. **As a Buyer, I want to** search for products with filters **so that I** can find what I need quickly
Acceptance Criteria:

- a. Filters by category, price, and rating.
 - b. Response time < 1 second.
 - c. Search event logging.
3. **As a Buyer, I want to** see personalized recommendations **so that** I discover relevant products.
- Acceptance Criteria:*
- a. At least 5 suggested products.
 - b. Updates based on browsing and purchase history.
4. **As a Buyer, I want to** pay with different methods **so that** the purchase is more convenient.
- Acceptance Criteria:*
- a. Methods: card, bank transfer, cash on delivery.
 - b. Automatic payment confirmation.
 - c. Real-time error handling.
5. **As a Buyer, I want to** leave reviews for purchased products **so that** I can help other buyers.
- Acceptance Criteria:*
- a. Only available for purchased products.
 - b. Minimum 1 star, maximum 5 stars.
 - c. Automatically moderated review.

Role: Seller

1. **As a Seller, I want to** create detailed product listings **so that** I attract more buyers.
- Acceptance Criteria:*
- a. Minimum fields: title, description, price, stock.
 - b. Upload up to 5 images per product.
2. **As a Seller, I want to** monitor my product statistics **so that** I can optimize their performance.
- Acceptance Criteria:*
- a. Metrics: views, sales, reviews, stock.
 - b. Date and category filters.
 - c. Dashboard visualization.
3. **As a Seller, I want to** receive notifications about low-stock products **so that** I can restock them.
- Acceptance Criteria:*
- a. Configurable threshold per product.
 - b. Notification via email and platform.
4. **As a Seller, I want to** apply temporary promotions **so that** I can boost sales.
- Acceptance Criteria:*

- a. Batch product selection.
 - b. Defined start and end date.
 - c. Visualization of sales impact.
5. **As a Seller, I want to** manage user questions **so that I** build trust with buyers.
- Acceptance Criteria:*
- a. Immediate notification of new questions.
 - b. Recommended response time <24h.

Role: Database Administrator (DBA)

1. **As a DBA, I want to** monitor cluster health **so that** the system remains highly available.
- Acceptance Criteria:*
- a. Real-time dashboard.
 - b. Automated alerts.
 - c. Centralized logs.
2. **As a DBA, I want to** configure cross-region replication **so that** there is fast access in multiple locations.
- Acceptance Criteria:*
- a. Synchronized replicas.
 - b. Latency below 150 ms.
 - c. Daily integrity validation.
3. **As a DBA, I want to** implement automated backup processes **so that** critical data remains protected against loss or corruption.
- Acceptance Criteria:*
- a. Daily and weekly backups.
 - b. Restoration verification.
 - c. Secure storage.
4. **As a DBA, I want to** optimize frequent queries **so that** response times remain low.
- Acceptance Criteria:*
- a. Use of indexes and partitions.
 - b. Queries under 1 second.
 - c. Continuous performance monitoring.
5. **As a DBA, I want to** control who can access sensitive data **so that** we prevent unauthorized use and meet security standards.
- Acceptance Criteria:*
- a. Access auditing.
 - 1. Active encryption.

Role: Administrator

1. **As an Administrator, I want to** manage product categories **so that** the platform stays organized.
Acceptance Criteria:
 - a. Create, edit, and delete categories.
 - b. Immediate impact on search filters.
2. **As an Administrator, I want to** access real-time global platform metrics **so that** I can proactively identify and address performance issues.
Acceptance Criteria:
 - a. Reports by region, day, and category.
 - b. Growth charts and alerts.
3. **As an Administrator, I want to** review and moderate user-generated content **so that** the platform maintains high-quality listings and trustworthy reviews.
Acceptance Criteria:
 - a. List of reported posts.
 - b. Actions: approve, hide, delete.
 - c. Log of responsible moderator.
4. **As an Administrator, I want to** monitor system uptime **so that** outages are prevented.
Acceptance Criteria:
 - a. Alerts for latency or 500 errors.
 - b. Real-time status panel (critical services).
 - c. Centralized error logs.

Role: Platform Manager

1. **As a Manager, I want to** analyze sales data **so that** I can make strategic decisions.
Acceptance Criteria:
 - a. Consolidated dashboard.
 - b. Real-time KPIs.
 - c. Monthly comparison.
2. **As a Manager, I want to** evaluate category performance **so that** I can prioritize promotions.
Acceptance Criteria:
 - a. Category rankings.
 - b. Growth indicators.
 - c. Automated BI suggestions.
3. **As a Manager, I want to** compare regional metrics **so that** I understand geographic trends.
Acceptance Criteria:

- a. Segmentation by country/city.
 - b. PDF export.
 - c. Daily data updates.
4. **As a Manager, I want to** analyze recommendation system performance metrics so that I can improve personalization and increase conversion rates.
- Acceptance Criteria:*
- a. Report of clicks vs. purchases per user.
 - b. Comparison between users with/without recommendations.
 - c. Visual dashboard indicators.
5. **As a Manager, I want to** monitor query performance metrics **so that** I can identify database bottlenecks and ensure optimal system responsiveness.
- Acceptance Criteria:*
- a. List of most-used queries.
 - b. Average execution times.
 - c. Historical database load visualization.

Role: BI Analyst

1. **As a BI Analyst, I want to** study sales by region/category **so that** I can assess market impact.
- Acceptance Criteria:*
- a. Interactive dashboard with date filters.
 - b. Aggregation of totals and trends.
 - c. Export for presentations.
2. **As a BI Analyst, I want to** analyze weekly product performance trends **so that** I can strategically plan promotions for high-potential and underperforming products.
- Acceptance Criteria:*
- a. Product rankings with key metrics.
 - b. Filters by brand, region, and seller.
 - c. Integration with promotions module.
3. **As a BI Analyst, I want to** analyze customer engagement patterns **so that** I can develop targeted retention strategies.
- Acceptance Criteria:*
- a. Cart abandonment metrics.
 - b. Average browsing time.
 - c. Conversion funnel visualization.
4. **As a BI Analyst, I want to** extract insights from customer reviews **so that** I can identify recurring product issues and improve quality control.
- Acceptance Criteria:*
- a. Classification by negative keywords.
 - b. Average rating graphs.

- c. Filters by seller and category.

Role: Marketing Specialist

1. **As a Marketer, I want to** launch segmented campaigns **so that I** maximize holiday sales.
Acceptance Criteria:
 - a. Segmentation by region and category.
 - b. Defined duration.
 - c. Effectiveness report.
2. **As a Marketer, I want to** monitor campaign performance metrics in real-time **so that I** can optimize ad spend and maximize conversion rates.
Acceptance Criteria:
 - a. Analytics dashboard.
 - b. Campaign filters.
 - c. Data export.
3. **As a Marketer, I want to** prominently feature trending products on high-visibility pages **so that I** can increase site traffic and conversion opportunities.
Acceptance Criteria:
 - a. Automatic selection from BI.
 - b. Homepage placement.
 - c. Results evaluation.
4. **As a Marketer, I want to** schedule and automate digital ad deployments **so that I** can execute campaigns efficiently with perfect timing.
Acceptance Criteria:
 - a. Campaign calendar.
 - b. Approval system.

Requirements Documentation:

Functional Requirements

ID	Requirement Name	Description	Required Inputs (Fields)
RF01	User Registration	The system must allow user registration with secure authentication.	Full Name, Email, ID Number, Address, Phone Number, Password
RF02	Product Search	The system must allow product searches using	Keyword, Category, Minimum Price, Maximum Price, Minimum Rating

		quick filters (category, price, rating).	
RF03	Personalized Recommendations	The system must display recommendations based on user behavior.	User ID, Browsing History, Purchase History
RF04	Multiple Payment Methods	The system must allow payments via card, transfer, or cash on delivery.	Order ID, Payment Method, Card/Bank Info, Shipping Address
RF05	Publish Reviews	The system must allow reviews to be published only for purchased products.	User ID, Product ID, Rating, Comment
RF06	Create Listings	The system must allow products to be published with details and images.	Product Name, Description, Price, Stock, Images, Category
RF07	Product Statistics	The system must display statistics on views, sales, reviews, and stock.	Seller ID, Product ID, Date Range
RF08	Low Stock Alerts	The system must send notifications when stock is low.	Product ID, Threshold, Current Stock
RF09	Promotion Management	The system must allow creation of promotions with rules and duration.	Products, Discount, Start Date, End Date, Conditions
RF10	Q&A Management	The system must allow management of questions and answers in listings.	Product ID, Question ID, Response Text
RF11	Cluster Monitoring	The system must monitor node status and alerts.	System Logs, Node Metrics, Alert Thresholds
RF12	Multi-Region Replication	The system must allow data replication across regions with low latency.	Regions, Cluster Configuration
RF13	Automatic Backups	The system must schedule and store backups.	Date/Time, Backup Type, Destination
RF14	Query Optimization	The system must optimize response time for frequent queries.	Frequent Queries, Fields for Indexing/Partitioning
RF15	Category Management	The system must allow creation/modification of categories visible in filters.	Name, Parent Category, Description

RF16	Metrics by Region and Category	The system must display segmented key performance indicators.	Date, Region, Category, Metric Type
RF17	Content Moderation	The system must allow moderation of listings and reviews with traceability.	Content ID, Action, Justification, Moderator ID
RF18	System Error Notification	The system must alert the administrator in case of system errors.	Error Type, Affected Service, Date/Time, Severity
RF19	Sales KPIs Dashboard	The system must display key sales indicators in real time.	Date, Region, Category, KPI
RF20	Category/Region Performance	The system must visualize segment comparisons.	Date, Category, Region, Metric Type
RF21	Recommendation Effectiveness Report	The system must measure the effectiveness of personalized recommendations.	User ID, Recommended Products, Interactions, Purchases
RF22	Query Efficiency	The system must evaluate the performance and frequency of system queries.	Query Name, Execution Time, Frequency
RF23	Sales by Country and Category	The system must allow consultation of consolidated sales by region and category.	Country, Category, Time Period
RF24	Product Ranking	The system must display best and worst selling products for promotion.	Date, Region, Category, Metric (sales, clicks)
RF25	Customer Behavior	The system must analyze browsing and purchasing habits.	User ID, Session Events, Time on Site, Cart Abandonment
RF26	Review Analysis	The system must detect common issues based on reviews.	Review Text, Keywords, Product ID
RF27	Segmented Campaigns	The system must allow creation of marketing campaigns by region and category.	Name, Region, Category, Dates, Campaign Type

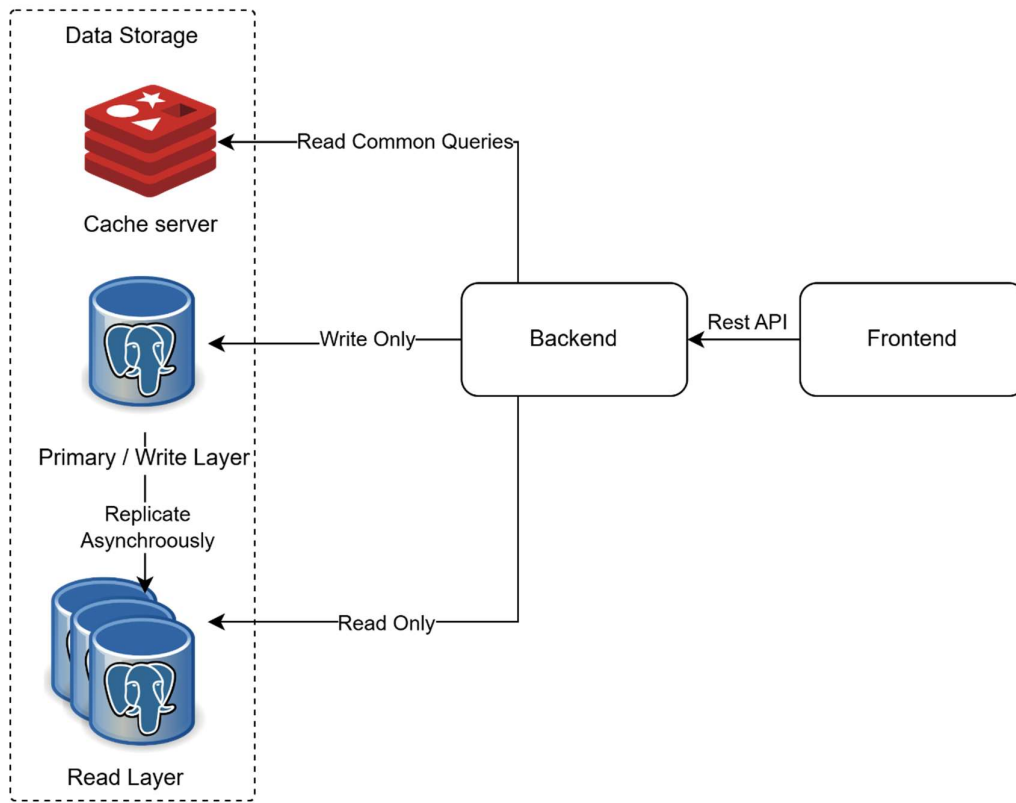
RF28	Campaign Metrics	The system must display clicks and conversions per campaign.	Campaign ID, Date, CTR, Conversions
RF29	Trending Products	The system must highlight trending products on the homepage.	Product ID, Trend Score, Featured Image
RF30	Promotion Automation	The system must allow scheduling and managing banners and ads.	Name, Dates, Banner, Location, Target Audience
RF31	Historical Promotion Suggestions	The system must suggest effective promotions based on historical campaigns.	Campaign History, Target Segment, Featured Products

Non- functional Requirements

ID	Requirement Name	Description
NFR01	Big Data	The system must process and store large volumes of structured and unstructured data in both real-time and batch modes using centralized repositories for analysis.
NFR02	Fast Query Response	The system must ensure low latency for read/write operations using optimized transactional databases, in-memory caching, and advanced indexing for complex queries.
NFR03	Data Ingestion	The system must support massive batch ingestion and real-time streaming with fault tolerance and the ability to reprocess data when needed.
NFR04	Business Intelligence	The system must integrate with analytics tools and provide real-time information for dashboards to strategic insights.
NFR05	Multi-Location Access	The system must provide global access through automatic geographic replication, proximity-based load balancing, and efficient delivery of static content to reduce latency.
NFR06	Recommendation System	The system must dynamically generate personalized recommendations, maintain user and product profiles,

		and update them in real-time based on recent interactions.
NFR07	High Availability	The system must ensure 24/7 operation using automatic data replication, disaster recovery mechanisms (failover), and continuous performance monitoring.
NFR08	Scalability	The system must adapt to variable demand using horizontal scaling, data sharding, and elastic architecture with auto-scaling of resources.
NFR09	Security	The system must provide data encryption at rest and in transit, implement role-based access control (RBAC), and audit critical operations to prevent vulnerabilities.
NFR10	Regulatory Compliance	The system must comply with data privacy regulations and industry standards, including payment security certifications.
NFR11	Maintainability	The system must be modular to allow updates without interruption, include detailed technical documentation, and support automated deployment and monitoring.
NFR12	Cost Optimization	The system must optimize infrastructure usage through auto-scaling, cold storage for historical data, and strategies to avoid overprovisioning.

Database Architecture



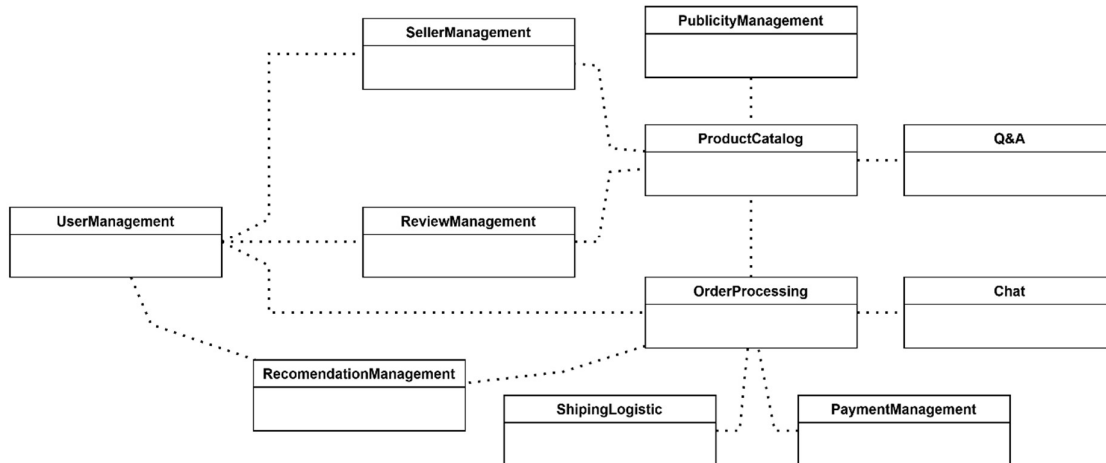
Main Components

1. Write Layer
 - a. Technology: PostgreSQL.
 - b. Responsibility: Write operations like INSERT, UPDATE, DELETE.
2. Read Layer
 - a. Technology: PostgreSQL.
 - b. Responsibility: Read operations like SELECT, and horizontal scalable replicas under load.
3. Cache Layer
 - a. Technology: REDIS
 - b. Use pattern: The application search first in REDIS, if the data doesn't exist, search in the database, also all writes in the primary database are written in REDIS.
 - c. Data in cache
 - i. Popular products, saving titles, prices and discounts.
 - ii. Daily offers, saving titles, prices and discounts.
 - iii. User data (tokens).
 - d. TTL
 - i. Popular products 24 hours

- ii. Daily offers 24 hours
- iii. User data 30 minutes

ER Model

Componentes



Relationships

1. UserManagement have a relation with:
 - a. SellerManagement if the user is a store owner.
 - b. OrdersProcessing
 - c. ReviewsManagement
2. ProductCatalog have a relation with:
 - a. SellerManagement
 - b. Orders
 - c. Reviews
 - d. Q&A if some questions exist
3. Orders have relation with:
 - a. PaymentManagement
 - b. ShipingLogistic
 - c. Chat post-sale
4. RecommendationManagement
 - a. UserManagement to write all the queries from the customer
 - b. OrderProcessing to get all the purchases from the customer
5. PublicityManagement
 - a. ProductCatalog

Entities

UserManagement

- E1.Users, E2.Roles, E3.Addresses

SellerManagement

- E4.Stores

ReviewManagement

- E5.Reviews

ProductCatalog

- E6.Products, E7.Categories, E8.ProductImages, E9.ProductDiscounts

Q&A

- E10.ProductQuestions, E11.ProductAnswers

OrderProcessing

- E12.Orders, E13.OrderDetails, E14.OrderStatuses, E15.Coupons

Chat

- E16.Conversations, E17.Messages

ShippingLogistic

- E18.Shipments, E19.ShipmentStatuses

PaymentManagement

- E20.Payments, E21.PaymentMethod, E22.PaymentStatuses

RecommendationManagement

- E23.UserSearchHistory

PlublicityManagement

- E24.Campaign, E.25Ad

Attributes per Entity

E1.Users	id, name, email, password, phone, birthday, createdAt
E2.Roles	Id, nameRole
E3.Addresses	Id, address, city, zipCode, country
E4.Stores	Id, name, isOfficial, createdAt
E5.Reviews	Id, rating, coment, createdAt
E6.Products	Id, title, description, price, stock, createdAt
E7.Categories	Id, nameCategories
E8.ProductImages	Id, imageURL
E9.ProductDiscounts	Id, percentage, startDate, endDate, isActive
E10.ProductQuestions	Id, questionText, createdAt

E11.ProductAnswers	Id, answerText, createdAt
E12.Orders	Id, totalPrice, createdAt
E13.OrderDetails	Id, quantity, unitPrice
E14.OrderStatuses	Id, nameOrderStatus
E15.Coupons	Id, code, isPercentage,valuePercentage, valueFixed, isFixed, maxUsage, usageCount, expirationDate, isActive
E16.Conversations	Id, createdAt
E17.Messages	Id, textMessage, isRead, sendAt
E18.Shipments	Id, trackingNumber, carrier, shippedAt, deliveredAt
E19.ShipmentStatuses	Id, nameShipmentStatus
E20.Payments	Id, amount, createdAt
E21.PaymentMethod	Id, methodName
E22.PaymentStatuses	Id, namePaymentStatus
E23.UserSearchHistory	Id, searchQuery, date
E24.Campaign	Id, name, startDate, endDate, status, targetKeywords
E25.Ad	Id, imageURL, bidAmount, clicksAmount

Relationship Matrix

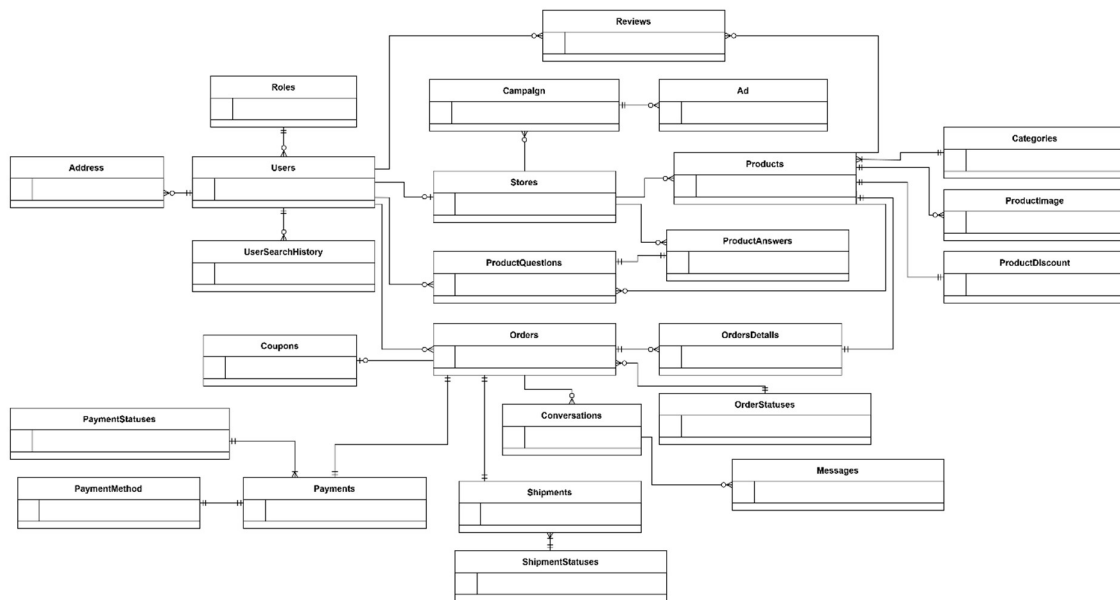
E	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1		X	X	X						X		X					X						X		
2	X																								
3	X																								
4	X				X	X					X													X	
5				X																					
6				X			X	X	X	X			X												
7					X																				
8					X																				
9					X																				
10	X				X																				
11				X																					
12	X												X	X	X	X		X		X					
13					X							X													
14												X													
15												X													

			Each search belongs to one user.
E1.Users	0..N → 1..1	E17.Messages	A user can have 0 or many messages. Each message belongs to one user.
E4.Stores	0..N → 1..1	E6.Products	A store can have 0 or many products. Each product belongs to one store.
E4.Stores	0..N → 1..1	E11.ProductAnswer	A store can have 0 or many answers. Each question belongs to one user.
E4.Stores	0..N → 1..1	E24.Campaign	A store can have 0 or many campaigns. Each campaign belongs to one store.
E6.Products	1..1 → 1..N	E7.Categories	Each product belongs to one category (mandatory). A category can have many products.
E6.Products	1..N → 1..1	E8.ProductImages	Each product must have at least 1 image. Each image belongs to one product.
E6.Products	0..N → 1..1	E9.ProductDiscounts	A product can have 0 or many discounts. Each discount belongs to one product.
E6.Products	0..N → 1..1	E10.ProductQuestions	A product can have 0 or many questions. Each question belongs to one product.
E6.Products	0..N → 1..1	E9.Reviews	A product can have 0 or many reviews. Each review belongs to one product.
E10.ProductQuestions	0..N → 1..1	E11.ProductAnswer	A question can have 0 or many answers. Each answer

			belongs to one question.
E12.Orders	1..N → 1..1	E13.OrderDetails	Each order must contain at least 1 product. Each detail belongs to one order.
E12.Orders	1..1 → 1..N	E14.OrderStatuses	Each order has one status (mandatory). A status can apply to many orders.
E12.Orders	0..1 → 0..N	E15.Coupons	An order may use 0 or 1 coupon. A coupon can be used in 0 or many orders.
E12.Orders	0..N → 1..1	E16.Conversations	An order may use 0 or many conversations (per seller). Each conversation belongs to one order.
E12.Orders	1..1 → 1..1	E18.Shipments	Each order has one shipment (mandatory). Each shipment belongs to one order.
E12.Orders	1..1 → 1..1	E20.Payments	Each order has one payment (mandatory). Each payment belongs to one order.
E13.OrderDetails	1..1 → 0..N	E6.Products	Each order detail belongs to one product. A product can appear in 0 or many orders
E16.Conversations	1..N → 1..1	E17.Messages	Each conversation must have at least 1 message. Each message belongs to one conversation.
E18.Shipments	1..1 → 1..N	E19.ShipmentStatuses	Each shipment has one status (mandatory). A status can apply to many shipments.

E20.Payments	1..1 → 1..N	E21.PaymentMethod	Each payment uses one method (mandatory). A method can be used in many payments.
E20.Payments	1..1 → 1..N	E22.PaymentStatuses	Each payment has one status (mandatory). A status can apply to many payments.
E24.Campaign	1..N → 1..1	E25.Ad	Each campaign must contain at least 1 ad. Each ad belongs to one campaign.

First Model only with entities and relationships



Second Model with attributes and data types

