


UNIVERSIDAD DE SEVILLA  
Escuela Técnica Superior  
de Ingeniería Informática  
Departamento de Lenguajes  
y Sistemas Informáticos

# Behavior Modeling Use Case Analysis

*Software Engineering and Databases Group  
Department of Computer Languages and Systems  
University of Seville  
November 2015*


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## Behavior Modeling: Use Case Analysis

- Learning objectives
  - Know the basic process of **analyzing use cases** and other functional or behavioral requirements.
  - Know the basics of **user interface prototyping**.
  - Know the basics of **UML sequence diagrams**.
  - Know the basics of the specification of **system operations**.
  - Be able to analyze use cases and other functional or behavioral requirements.



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5. System operations

Behavior Modeling: Use Case Analysis

- Models of a software system
  - Static model (conceptual model)
    - Describes the structure and constraints of the information representing the system **state**.
  - Behavior model
    - Describes how the system **interacts** with actors and how its state evolves as a result of the interactions.

Model =

Static model =

Structure

+

Constraints

+

Behavior model =

External interactions

+

Internal evolution

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Behavior Modeling: Use Case Analysis

- Behavior model of a software system

Behavior model

External interactions

Internal evolution

User Interface

Service Interface

System operations

State diagrams


uses

must be consistent with

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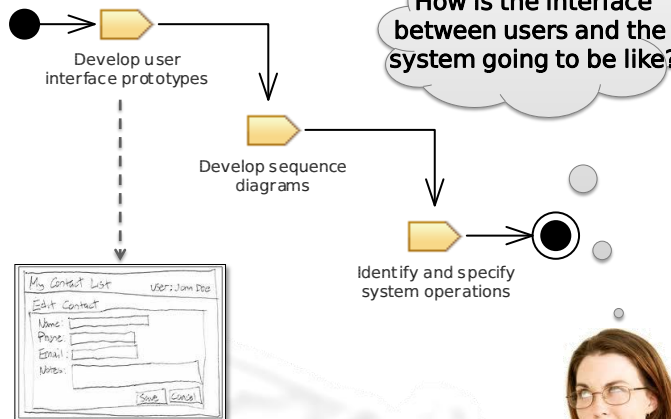


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### Behavior Modeling: Use Case Analysis

• For each use case...

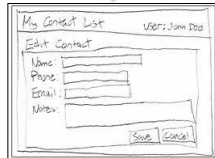


How is the interface between users and the system going to be like?

Develop user interface prototypes

Develop sequence diagrams


Identify and specify system operations



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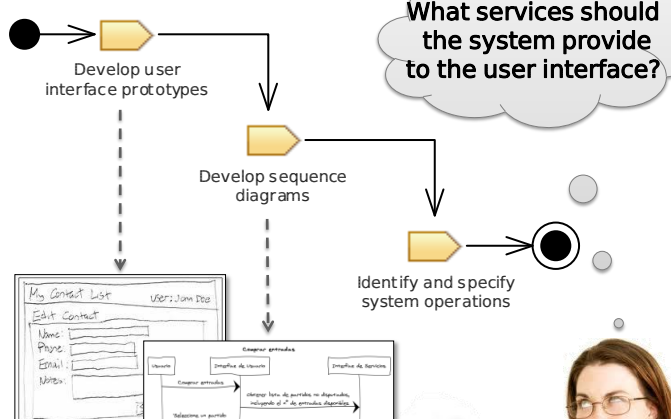


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### Behavior Modeling: Use Case Analysis

• For each use case ...

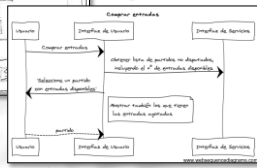



What services should the system provide to the user interface?

Develop user interface prototypes

Develop sequence diagrams

Identify and specify system operations



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# Behavior Modeling: Use Case Analysis

- For each use case ...

1. Behavior model of a system
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Can the system provide those services with its static model?

Develop user interface prototypes

Develop sequence diagrams

Identify and specify system operations

My Contact List

UML Sequence Diagram: Comprovar generadores


```

context op( p1:T1, ..., pN:TN )
pre: p1 > 0
pre: customers->excludes( p2 )
post: customers->forAll( ... )
post: invoices->exists( ... )
post: invoices->includesAll( ... )
  
```

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## Behavior Modeling: Use Case Analysis

- Example: football tickets purchase
  - A football club wants its fans to purchase match tickets through internet.
- Why? (business objectives)
  - Improve the image of the club and fans' satisfaction by avoiding queues at the box offices.
  - Increase revenues by facilitating the fans to purchase tickets without having to travel.
  - Save costs of box-office staff and security personnel to watch fan queues at box offices.



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Behavior Modeling: Use Case Analysis

• Example: football tickets purchase

1. The user requests the system to purchase tickets.

2. The system displays a list of matches and prompts the user to select the one to buy tickets for.

3. The user selects the match to buy tickets for.

4. The system shows, for each area of the stadium, the availability of tickets.

5. The user selects the tickets to be purchased.

6. The system displays the amount for the selected tickets.

7. The user confirms the purchase of the selected tickets.\*

8. The system displays images of the tickets so that the user prints them or use them directly to access the stadium.

\* For the sake of simplicity, no details are provided about the economic transaction.

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Behavior Modeling: Use Case Analysis

• Example: football tickets purchase

– Developed static model

Area

name: String

1

Seat

row: Integer  
column: Integer

1

SeasonTicket

1

Member

TIN: String  
name: String  
address: String

1

Area

\*

Seat

\*

SeasonTicket

\*

Member

\*

Ticket

1

Match

1

Season

yearBegin: Integer  
yearEnd: Integer

1

Price

seasonTicketPrice: Integer  
ticketPrice: Integer

\*

Area

\*

Season

1

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Behavior Modeling: Use Case Analysis

• What is user interface prototyping?

- It is a **requirements validation** technique which aims to ensure (as far as possible) that the system to be developed (i.e. the requirements) matches users' expectations.
- In general, user interface prototypes must **avoid detailed aesthetical aspects** and focus on the interaction.
- Some authors recommend using paper prototypes and/or black and white only (wireframe).



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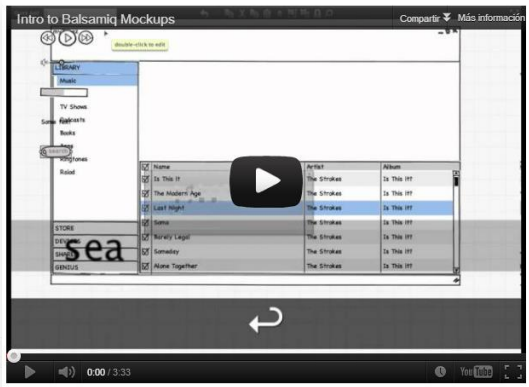
5. System operations

Behavior Modeling: Use Case Analysis

• Prototyping tools

balsamiq

- Desktop tool (Adobe AIR)
- Trial period of 7 days
- Free demo web version




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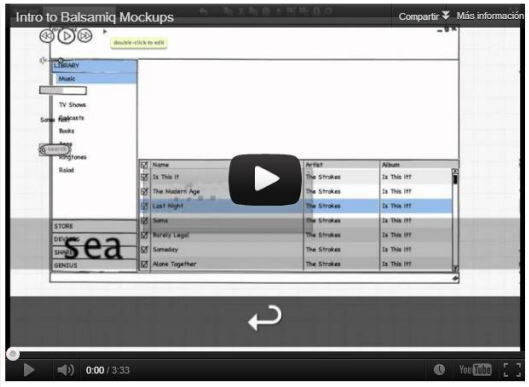
Prototyping tools

balsamiq

– Agreement with the University of Seville

<https://unisevilla.mybalsamiq.com>


– Invitation from a professor is required



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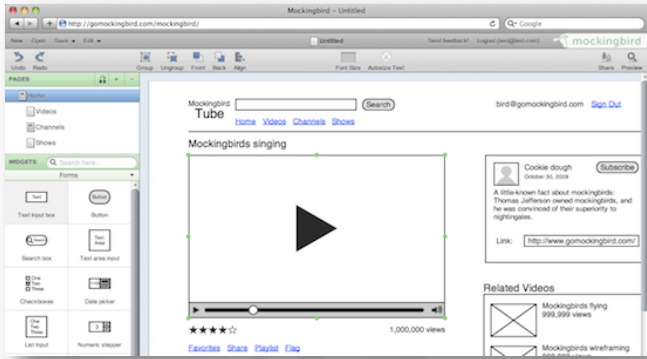
Behavior Modeling: Use Case Analysis

Prototyping tools

mockingbird

– Web tool

– Free version with 10 screens and two users



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Behavior Modeling: Use Case Analysis

• Prototyping tools

– Web tool

– Trial period of 14 days

– Free version does not allow wireframe prototyping

Wireframing with Lucidchart

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Behavior Modeling: Use Case Analysis

• How to prototype a use case?

– Put yourself in users' shoes

• If we were users, how would we like the system to assist us doing our everyday tasks?

– Show necessary information, no more no less

• Essential information should be available without searching, whereas...

• Non-essential information should be displayed only under user request.

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Behavior Modeling: Use Case Analysis

• How to prototype a use case?


- Facilitate most common options
  - Most common options should be the default values, saving user work.
- Use problem domain metaphors when possible
  - If technologically feasible, simulate the user physical environment in the system interface.



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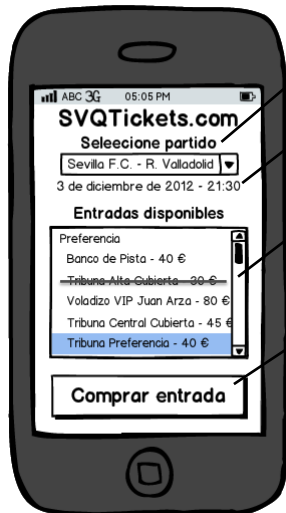
3. User interface prototype

4. Sequence diagrams

5. System operations

Behavior Modeling: Use Case Analysis

• Example: football tickets purchase (mobile)



Drop-down list of matches with next match selected by default

Date and time of the selected match

List of all areas of the stadium with its ticket price, even those with all tickets sold out


Button to begin the process of ticket selection and purchase (provided there are available tickets)

It allows the user to see the matches with available tickets and their price

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5. System operations

Behavior Modeling: Use Case Analysis

• Example: football tickets purchase (mobile)



Match corresponding to the tickets to be purchased, indicating date and time

Stadium area for to the ticket to be purchased, indicating price

View of the stadium areas in which the user can navigate and select an area using his finger

Selected area should be visually highlighted


Button to confirm purchase

It allows the user to get an idea of the seat location

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Behavior Modeling: Use Case Analysis

• Sequence diagrams in UML

– Used to model **interactions** sequences among objects.

– In use cases analysis, objects are usually:

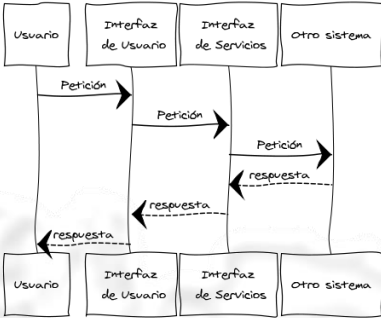
• Human actors

• System user interface

• System service interface

• Other systems whose services are required (integration requirements)

Diagrama de secuencia




www.websequencediagrams.com

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4. Sequence diagrams

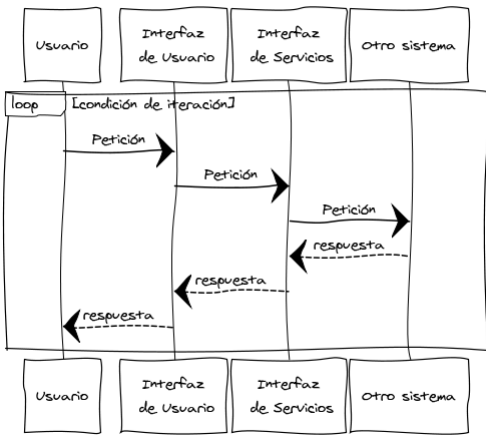
5. System operations

Behavior Modeling: Use Case Analysis

• Sequence diagrams in UML

– Iterations and alternatives can be specified

Diagrama de secuencia




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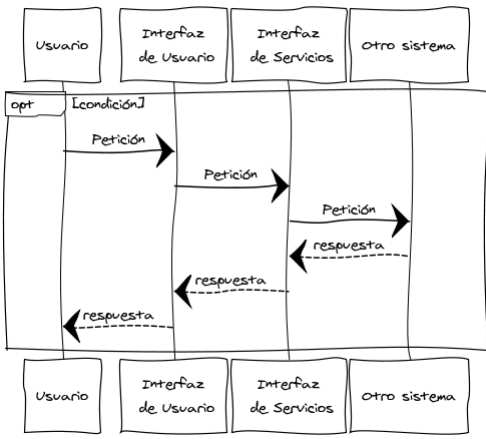
5. System operations

Behavior Modeling: Use Case Analysis

• Sequence diagrams in UML

– Iterations and alternatives can be specified

Diagrama de secuencia



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Behavior Modeling: Use Case Analysis

• Sequence diagrams in UML

– Iterations and alternatives can be specified

Diagrama de secuencia

```
sequenceDiagram
    participant U as Usuario
    participant IU as Interfaz de Usuario
    participant IS as Interfaz de Servicios
    participant OS as Otro sistema

    alt [Condición]
        U->>IU: Petición
        IU-->>U: respuesta
    else [Condición]
        U->>IU: Petición
        IU->>IS: Petición
        IS->>OS: Petición
        OS-->>IS: respuesta
        IS-->>IU: respuesta
        IU-->>U: respuesta
    end
```

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Behavior Modeling: Use Case Analysis

• Example: football tickets purchase\*

```
sequenceDiagram
    participant User
    participant UI as User Interface
    participant SI as Service Interface

    User->>UI: Buy Tickets
    UI->>SI: Get list of not played matches, indicating for each stadium area, ticket availability and price
    SI-->>UI: 
    Note over UI: Show also sold out matches for the user to know
    UI-->>User: 'Select a match with available tickets'
    User->>UI: match
    UI->>SI: Get list of available seats with price and organized by areas ( match )
    SI-->>UI: 
    Note over UI: Show the location of every seat in the stadium
```

\* Version for desktop or tablet. Mobile version is slightly different.

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Behavior Modeling: Use Case Analysis

• Example: football tickets purchase\*

\* Version for desktop or tablet. Mobile version is slightly different.

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Behavior Modeling: Use Case Analysis

• Specification of system operations


– A **System** class, which is a composition of all the entity classes in the static model, is assumed.

– The operations of the System class are the system **service interface**.

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Behavior Modeling: Use Case Analysis

- Specification of system operations
  - Operations returning no values

**context** System::Operation(  $p_1:T_1, \dots, p_N:T_N$  )

**pre name**Pre<sub>1</sub>: expression<sub>1</sub>

...

**pre name**Pre<sub>M</sub>: expression<sub>M</sub>

**post name**Post<sub>1</sub>: expression<sub>M + 1</sub>

...

**post name**Post<sub>p</sub>: expression<sub>M + p</sub>


Conditions on parameters and/or system state

Conditions on system state

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Behavior Modeling: Use Case Analysis

- Specification of system operations
  - Operations returning values

**context** System::Operation(  $p_1:T_1, \dots, p_N:T_N$  ) : T<sub>R</sub>

**pre name**Pre<sub>1</sub>: expression<sub>1</sub>

...

**pre name**Pre<sub>M</sub>: expression<sub>M</sub>

**post name**Post<sub>1</sub>: expression<sub>M + 1</sub>

...

**post name**Post<sub>p</sub>: expression<sub>M + p</sub>

Conditions on parameters and/or system state

Conditions on **result** and/or system state

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Behavior Modeling: Use Case Analysis

• Specification of system operations

– Query-only operations

context

System::Operation(  $p_1:T_1, \dots, p_N:T_N$  ) :  $T_R$

pre name

Pre<sub>1</sub>: expression<sub>1</sub>

...

pre name

Pre<sub>M</sub>: expression<sub>M</sub>

body: expression<sub>M + 1</sub>

Conditions on parameters and/or system state

Result expression

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Behavior Modeling: Use Case Analysis

• Example: football tickets purchase

User

User Interface

Service Interface

Buy Tickets

Get list of not played matches, indicating for each stadium area, ticket availability and price

Show also sold out matches for the user to know

Search a match with available tickets

System::Areas()  
: Set( Area )  
- Returns the set of the stadium areas

System::NotPlayedMatches()  
: Set( Match )  
- Returns the set of matches not played in the current season

System::PriceAndAvailability( m : Match, a : Area )  
: TupleType( p : Integer, a : Boolean )  
- Returns a tuple (price, availability) for a given match and a given area

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Behavior Modeling: Use Case Analysis

• Example: football tickets purchase

Area

name: String

1

\*

Seat

row: Integer  
column: Integer

1

\*

SeasonTicket

1

\*

Member

TIN: String  
name: String  
address: String

1

\*

Ticket

1

\*

Match

1

\*

Season

yearBegin: Integer  
yearEnd: Integer

1

\*

Price

seasonTicketPrice: Integer  
ticketPrice: Integer

\*

\*

context System::Areas() : Set( Area )  
-- Returns the set of the stadium areas  
body: System.area  
-- Extension of class Area  
-- Equivalent to Area.allInstances()

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Behavior Modeling: Use Case Analysis

• Example: football tickets purchase

context System::NotPlayedMatches() : Set( Match )  
-- Let s be the current season  
-- Return all matches of s whose date is later than the current date  
body:  
let s = current season? in  
s.match->select( m | m.date >= ? )

Match

1

\*

Season

yearBegin: Integer  
yearEnd: Integer

1

\*

Price

seasonTicketPrice: Integer  
ticketPrice: Integer

\*

\*

Problems in the static model!

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Behavior Modeling: Use Case Analysis

• Example: football tickets purchase

Context

System::PriceAndAvailability( m : Match, a : Area )

: TupleType( p : Integer, a : Boolean )

-- Returns a tuple (price, availability) for a given match and a given area

body: Tuple {

-- p = ticket price of the area for the season of the match

p = price->any( area = a and season = m.season ).ticketPrice,

-- a = there exists at least one seat without season ticket

-- in the match season and for which no ticket has been sold

a = a.seat->exists( s |

s.seasonTicket->select( season = m.season )->isEmpty() and

s.ticket->select( match = m )->isEmpty() )

}

Season

yearBegin: Integer

yearEnd: Integer

Price

seasonTicketPrice: Integer

ticketPrice: Integer

1


\*

1

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Behavior Modeling: Use Case Analysis

• Bibliography

– C. Larman, *UML y Patrones*.  
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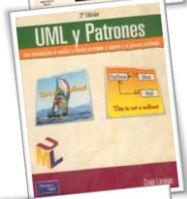
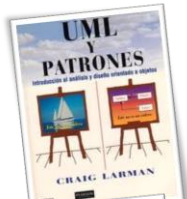
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1. Behavior model  
of a system

2. Use case  
analysis


3. User interface  
prototype

4. Sequence  
diagrams

5. System  
operations

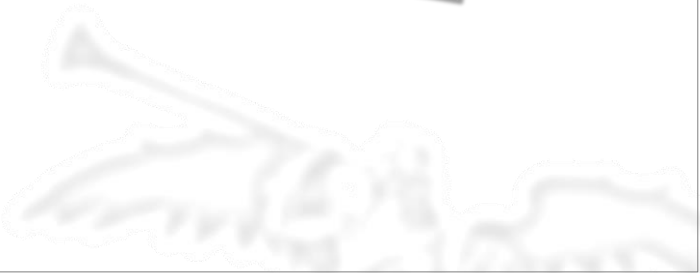
Behavior Modeling: Use Case Analysis

- Comments, suggestions, ...



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