We've explored the complete design of an online stock brokerage system in this chapter. We've looked at how a basic online stock brokerage system can be visualized using various UML diagrams and designed using object-oriented principles and design patterns.

# Getting Ready: Jigsaw Puzzle

Understand the jigsaw puzzle problem and learn the questions to simplify this problem.

**We'll cover the following**

* [Problem definition](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Problem-definition)
* [Expectations from the interviewee](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Expectations-from-the-interviewee)
  + [The puzzle board](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#The-puzzle-board)
  + [The puzzle pieces](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#The-puzzle-pieces)
* [Design approach](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Design-approach)
* [Design pattern](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Design-pattern)

## Problem definition

A **jigsaw puzzle**is a picture divided into irregularly shaped pieces that can be assembled together to form a complete picture. A puzzle has a fixed number of pieces that can only fit together in exactly one way. We can solve the jigsaw puzzle by aligning the pieces in a way that they fit with each other and also create a coherent picture.

## Expectations from the interviewee

Although the jigsaw problem is a simpler design problem asked in interviews, the interviewer still has some expectations. The following provides an overview of what the interviewer wants to hear you discuss in more detail during the interview.

### The puzzle board

You may want to ask the interviewer more about the kind of jigsaw puzzle. You can ask the following questions:

* What does a jigsaw puzzle look like. Is there a picture or a pattern on the puzzle?
* What type of shape does our board have? Is it rectangular, circular, or any other shape?

### The puzzle pieces

It is important to clarify the requirements for a single piece of the puzzle as it is a key feature of the problem. You can ask the following questions:

* What kind of shape do the puzzle pieces have? How many sides does a piece have?
* How do the pieces fit together?
* Will all the pieces of a jigsaw puzzle be unique?

## Design approach

We are going to design this jigsaw puzzle using the bottom-up design approach. For this, we will follow the steps below:

* Identify and design the smallest components first like the puzzle edges of a piece.
* Use these small components to design bigger components, for example, the puzzle piece.
* Repeat the steps above until we design the whole system, i.e., the puzzle board.

## Design pattern

It is always a good practice to discuss the design patterns that the jigsaw puzzle falls under, during the interview. Stating the design patterns will give the interviewer a positive impression and shows that the interviewee is well-versed in the advanced concepts of object-oriented design.

The following design pattern is used to design the jigsaw puzzle:

* Singleton design pattern

**Note:** The jigsaw puzzle design problem is a fairly simple problem for which we don’t need to create the use case, sequence, and activity diagrams. The set of requirements defined for this problem are not suitable for these diagrams.

Let’s explore the requirements of the jigsaw puzzle problem in the next lesson.

# Requirements for the Jigsaw Puzzle

Learn about all requirements of the jigsaw puzzle problem.

**We'll cover the following**

* [Requirement collection](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Requirement-collection)

In this lesson, we’ll list down the requirements of our jigsaw puzzle problem. This is a very crucial step since requirements define the scope of a problem, so getting them right from the interviewer and understanding them well will make the design of the rest of the problem smooth and easy.

We’ll use the notational convention to identify each requirement with a unique label "Rn", where "R" is short for Requirement and "n" is a natural number.

## Requirement collection

For the jigsaw puzzle problem, the requirements are defined below:

**R1:** Our board will be in the shape of a rectangle.

**R2:** All pieces will have four sides that can either have an indentation, an extrusion, or a flat edge.

**R3:** There are four corner pieces, some edge pieces, and the remaining ones are the middle pieces. A corner piece has two flat sides, an edge piece only has one flat side, and a middle piece doesn’t have any flat edge.

**R4:** All pieces will be unique, so only one piece will fit with one other piece.

**R5:** Two pieces fit together by the curvature of the indentation on one piece matching up to the curvature of the extrusion on another.

We've identified our requirements for the problem, and in the next lesson, we will define the class diagram of our jigsaw puzzle system.

# Class Diagram for the Jigsaw Puzzle

Learn to create a class diagram for the jigsaw puzzle using the bottom-up approach.

**We'll cover the following**

* [Components of a jigsaw puzzle](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Components-of-a-jigsaw-puzzle)
  + [Side](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Side)
  + [Piece](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Piece)
  + [Puzzle](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Puzzle)
  + [Puzzle solver](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Puzzle-solver)
  + [Edge enumeration](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Edge-enumeration)
* [Relationship between the classes](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Relationship-between-the-classes)
  + [Association](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Association)
  + [Composition](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Composition)
* [Class diagram for the jigsaw puzzle](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Class-diagram-for-the-jigsaw-puzzle)
* [Design pattern](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Design-pattern)
* [Additional requirements](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Additional-requirements)

In this lesson, we’ll identify and design the classes, abstract classes, and interfaces based on the requirements that we have previously gathered from the interviewer in our jigsaw puzzle.

## Components of a jigsaw puzzle

As mentioned earlier, we should design the jigsaw puzzle using a bottom-up approach.

### Side

The Side class represents the shape of our jigsaw piece and whether it contains an indentation, extrusion, or flat edge. The UML representation of the class is shown below:

A screenshot of a computer

Description automatically generated

A screenshot of a puzzle

Description automatically generated

A screenshot of a puzzle

Description automatically generated

A screenshot of a computer

Description automatically generated

A diagram of a jigsaw puzzle

Description automatically generated

A screenshot of a puzzle

Description automatically generated

We have completed the class diagram of the jigsaw puzzle according to the requirements. Now, let’s write the code for our designed classes in some of the most popular languages.

# Code of Jigsaw Puzzle

Write the object-oriented code to implement the design of the jigsaw problem.

**We'll cover the following**

* [Jigsaw puzzle](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Jigsaw-puzzle)
  + [Enumerations](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Enumerations)
  + [Side](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Side)
  + [Piece](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Piece)
  + [Puzzle](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Puzzle)
  + [Puzzle solver](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Puzzle-solver)
* [Wrapping up](https://www.educative.io/courses/grokking-the-low-level-design-interview-using-ood-principles/getting-ready-the-amazon-online-shopping-system#Wrapping-up)

We’ve gone over the different aspects of the jigsaw puzzle and observed the attributes attached to the problem using various UML diagrams. Let’s explore the more practical side of things, where we will work on implementing the jigsaw puzzle using multiple languages. This is usually the last step in an object-oriented design interview process.

We have chosen the following languages to write the skeleton code of the different classes present in the jigsaw puzzle:

* Java
* C#
* Python
* C++
* JavaScript

## Jigsaw puzzle

In this section, we’ll provide the skeleton code of the classes designed in the class diagram lesson.

**Note:** For simplicity, we are not defining getter and setter functions. The reader can assume that all class attributes are private and accessed through their respective public getter methods and modified only through their public method functions.

### Enumerations

The following code defines the Edge enum that represents the shape of the puzzle piece:

**Note:** JavaScript does not support enumerations, so we will be using the Object.freeze() method as an alternative that freezes an object and prevents further modifications.

enum Edge {

INDENTATION,

EXTRUSION,

FLAT

}

A screenshot of a computer

Description automatically generated

A screenshot of a computer

Description automatically generated

The PuzzleSolver class tries to solve the puzzle using the matchPieces() function. Its definition is given below:

public class PuzzleSolver {

public Puzzle matchPieces(Puzzle board) {}

}

## Wrapping up

We've explored the complete design of a jigsaw puzzle in this chapter. We've looked at how a basic jigsaw puzzle can be visualized using various UML diagrams and designed it using object-oriented principles and design patterns.