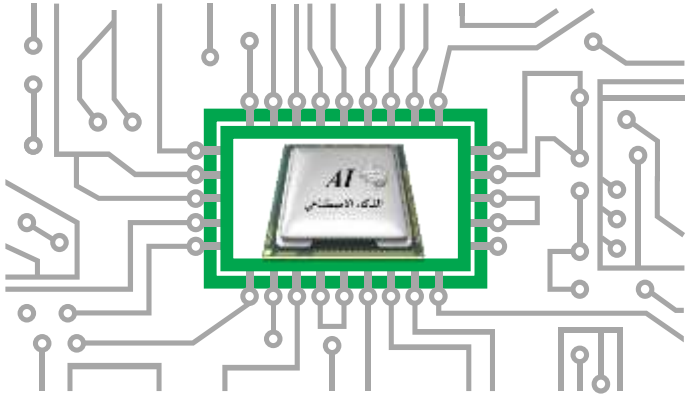
COE 292
Introduction to Artificial Intelligence



Introduction

What is AI?

- What is Artificial Intelligence?
- What are the Application Areas of AI?
- A (Short) History of AI
- AI Solution Strategies

What is AI?

- The definition of AI has been evolving with the advancements in technology

  Artificial Intelligence is the *theory* and *development* of ***computer systems*** able to *perform* tasks normally requiring human *intelligence*, such as visual perception, speech recognition, decision-making, and translation between languages

What are the application Areas of AI?

#	Area/Field/Things	#	Area/Field/Things
1	Virtual Assistant or Chatbots	7	Manufacturing and Production
2	Agriculture and Farming	8	Livestock and Inventory Management
3	Autonomous Flying	9	Self-driving Cars or Autonomous Vehicles
4	Retail, Shopping and Fashion	10	Healthcare and Medical Imaging Analysis
5	Security and Surveillance	11	Warehousing and Logistic Supply Chain
6	Sports Analytics and Activities		

Any area where *reasoning* is to be performed by a machine

Natural Language

- Speech technologies (e.g. Siri)
  - Automatic speech recognition (ASR)
  - Text-to-speech synthesis (TTS)
- Language processing technologies
  - Question answering
  - Machine translation
  - Web search
  - Text classification, spam filtering, etc…
- General Purposed Language Model?
  - GPT-3 by OpenAI: better funny stories here https://www.gwern.net/GPT-3
  - Jukebox by OpenAI: interesting music here https://openai.com/blog/jukebox/

Computer Vision

Image Captioning

"man in black shirt is playing guitar."

"construction worker in orange safety vest is working on road."

"girl in pink dress is jumping in air."

"black and white dog jumps over bar."

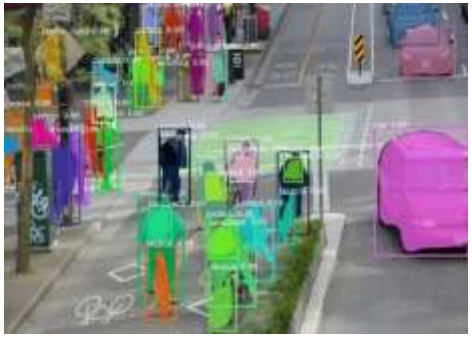


Image Segmentation

Facial Recognition (security)

Robotics

- Robotics
  - Part Mech. Eng. and Part AI
  - Reality much harder than simulations!
- Technologies
  - Self-driving cars
  - Rescue
  - Help in the home
  - Lots of automation…

Decision Making

- Applied AI involves many kinds of automation
  - Scheduling, e.g. airline routing, military
  - Route planning, e.g. Google maps
  - Medical diagnosis
  - Web search engines
  - Automated help desks
  - Fraud detection
  - Product recommendations
  - … Lots more!

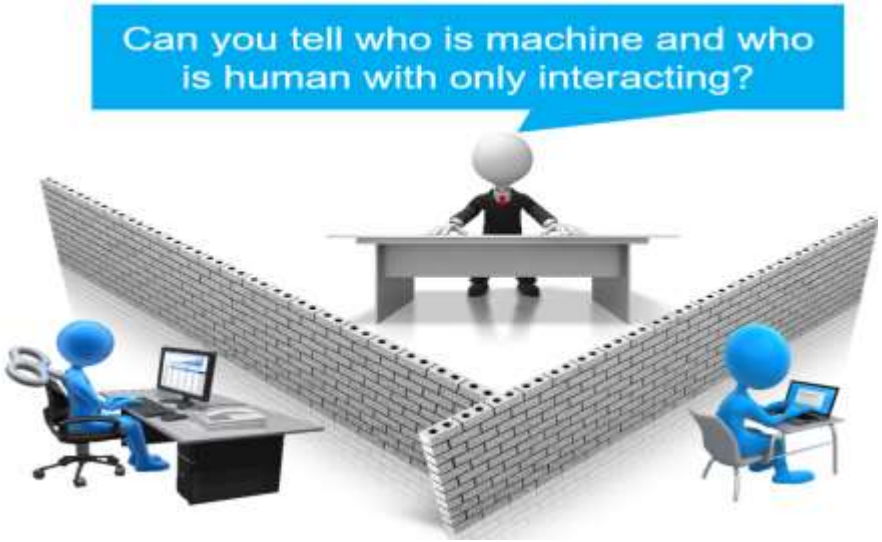
This slide was created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley

A (Short) History of AI

Event in History	Time Period
Alan Turing Wrote the Turing Test	1950s
Marvin Minsky: Steps towards Artificial Intelligence	1960s
Symbolic Integration by James Slagle	
Expert and Ruled based systems	1970s
Deep Blue Systems (AI) beats world champion of chess	1980s-1990s
Robotics, Computer Vision, Natural Language Processing, Deep Learning ... etc.	2000-now

Acting like a Human – Turing Test

- Laid the foundation of a method in artificial intelligence (AI) to determining whether a computer is capable of thinking like a human being
- What is the Turing Test:
  - If you **don't know** who is on the other side, **Can you tell** the **machine** from a **human** by interacting only?



Alan Turing

ELIZA Chatbot

- In **1966**, Prof. Weizenbaum at MIT developed the program ELIZA, which aimed at tricking its users by making them believe that they were having a conversation with a real human being.
- ELIZA was designed to imitate a therapist who would ask open-ended questions and even respond with follow-ups.
- Try it out: http://psych.fullerton.edu/mbirnbaum/psych101/eliza.htm

How AI was Viewed over Time

More concentrated on **Thinking**

1980

More concentrated on **Action**

1990

Balancing **Thinking** and **Action**

2000-now

Think and act Rationally

What is AI?

The science of making machines that:

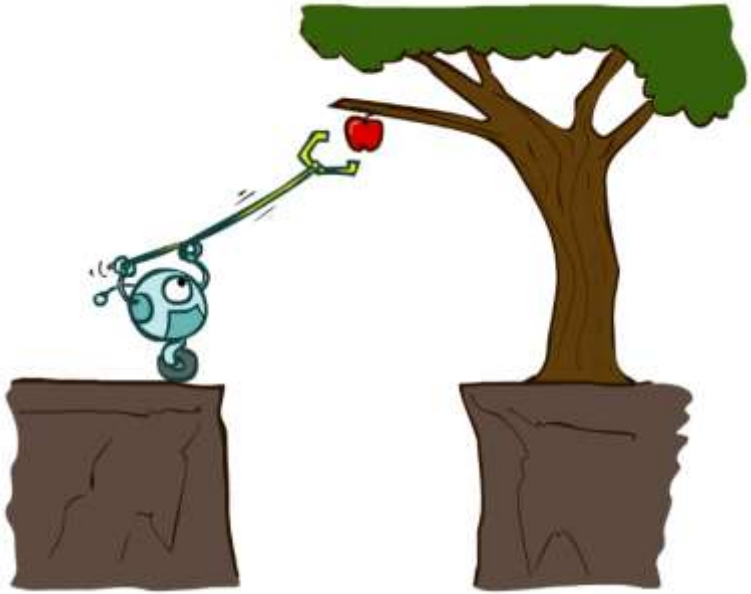
This slide was created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley

Definitions

- **Agent**: A thing that takes *inputs* using sensors and *acts* based on these inputs.
- **Utility** in AI: Preferred Outcome or Result. In other words, the mathematical treatment of “preferred outcomes” is called utility.
  - Example: An agent's preferences over possible outcomes can be captured by numbers; the higher the number the more that agent likes that outcome.

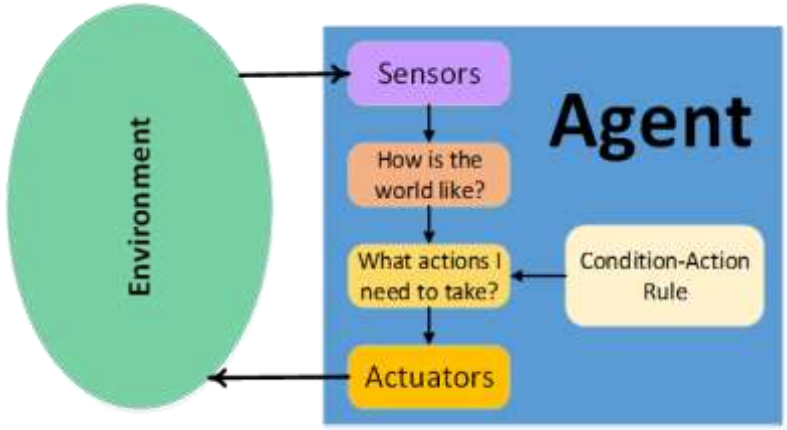
Definitions

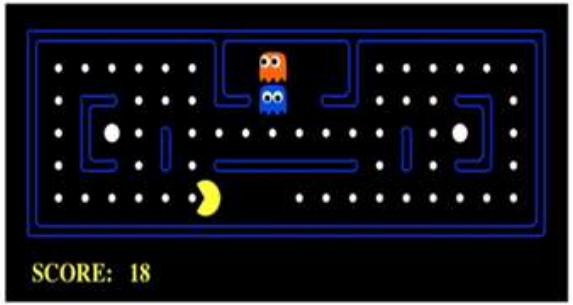
- **Rational Agent**: is one that acts to achieve the best outcome or, when there is uncertainty, the best expected outcome.
  - A rational agent often has clear preference. It models uncertainty and acts in a way to maximize its Utility (performance) with all possible actions.



Designing Rational Agents

- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** *selects* actions that *maximize* its (expected) **utility**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting *rational* actions





Human Brains

- Very good in making rational decisions but not perfect
- It is not completely understood how human brain works.
  - Difficulty in copying its behavior to a machine
- How brain works?
  - Has a huge amount of data (lessons learned across the life of a human)
  - Can simulate, compute or predict the outcome based on available data or by inference. i.e., unroll the consequences without trying them.

What is this Course About

1. Get introduced to a suite of representations that will help you make programs that are intelligent
2. Use representations to model a problem and produce useful solutions or predictions

You will Learn

- Constructing Algorithms (or methods, or procedures) by
  - Exposing the constraints of the problem and
  - Using a representation that supports making of models which facilitate understanding of:
    1. Perception
    2. Thinking
    3. Action

AI Solution Strategies

- Next, we will show the application of two AI strategies in solving problems:
  - Use of Perception to solve problems
  - Use of “Generate and Test” strategy to solve problems

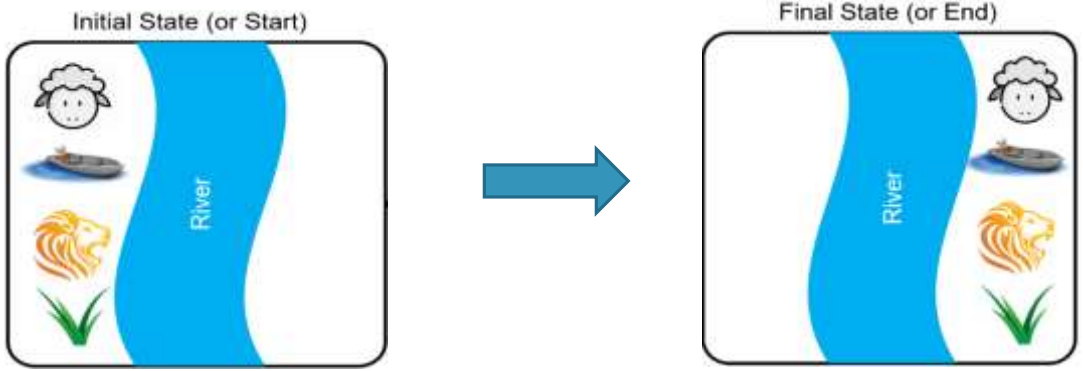
Example1: Use of Perception to Solve Problems

- Problem: A person has one pet lion, one lamb and a bundle of grass. He wants to cross a river but there is only one boat, and it can't sustain the weight of more than two articles at time. Also, he must make sure that the lion doesn't eat the lamb and the lamb doesn't eat the grass. The questions we want to answer are:

1. How will he get to the other side of the river with all three living beings intact?.
2. How will you tell (or program) a computer to solve this problem? **(the bigger question)**
3. How many possible ways are there to solve such a problem?

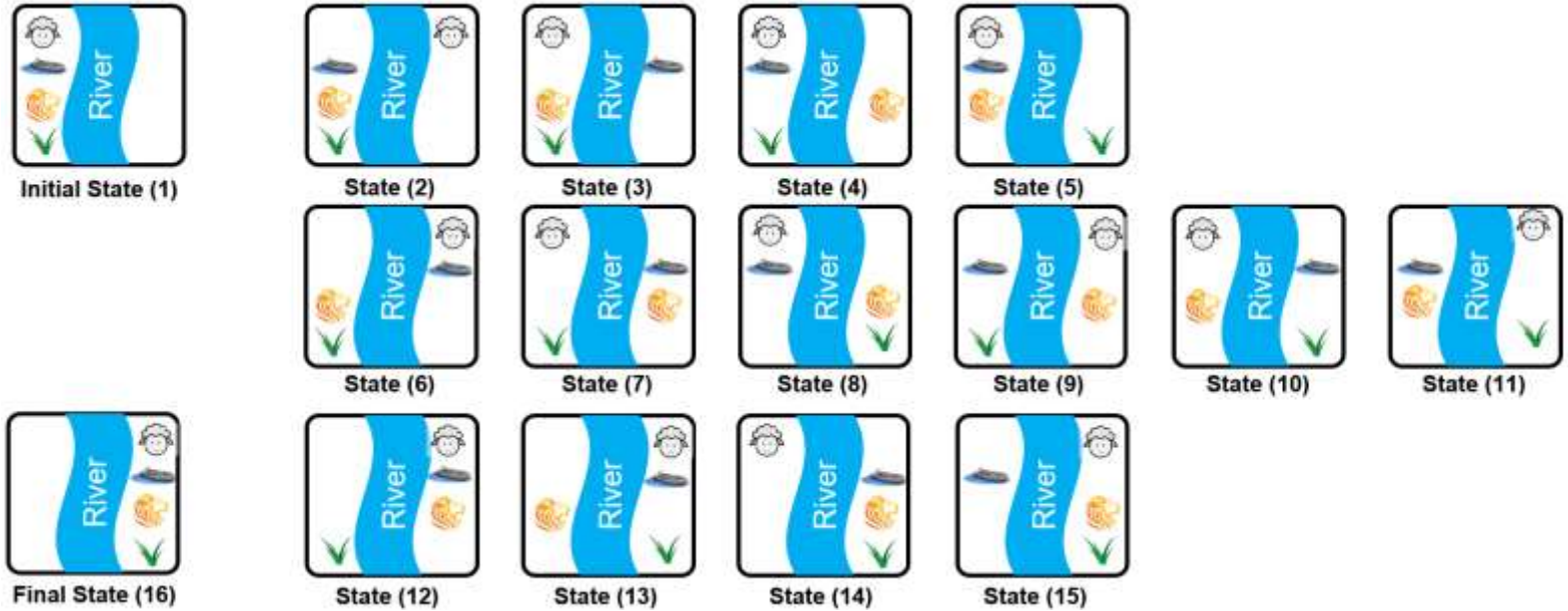
Example1: Use of Perception to Solve Problems

- First, we must understand the problem
  - Using the right perception will aid our understanding
- What is the best representation for the problem?
  - Visual perception: drawing the situation so we use our visual capabilities



Example1: Use of Perception to Solve Problems

- How many more **States** (or situation) can there be?
  - List of all states is shown below:

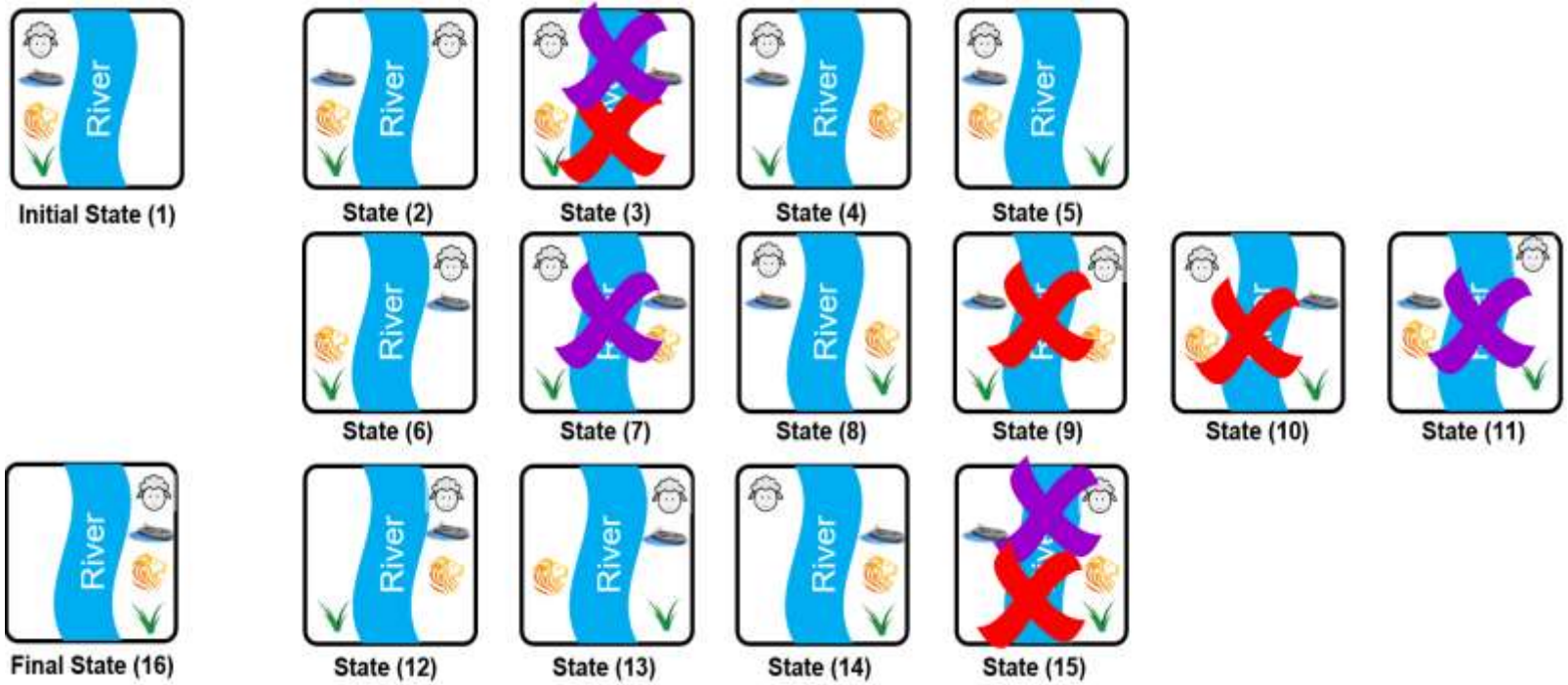


Example 1: Use of Perception to Solve Problems

- Expose constraints
  - Lion will eat sheep → state not allowed (✗)
  - Sheep will eat grass → state not allowed (✗)
- **We now detect those states in which we find someone eating someone else and delete them**

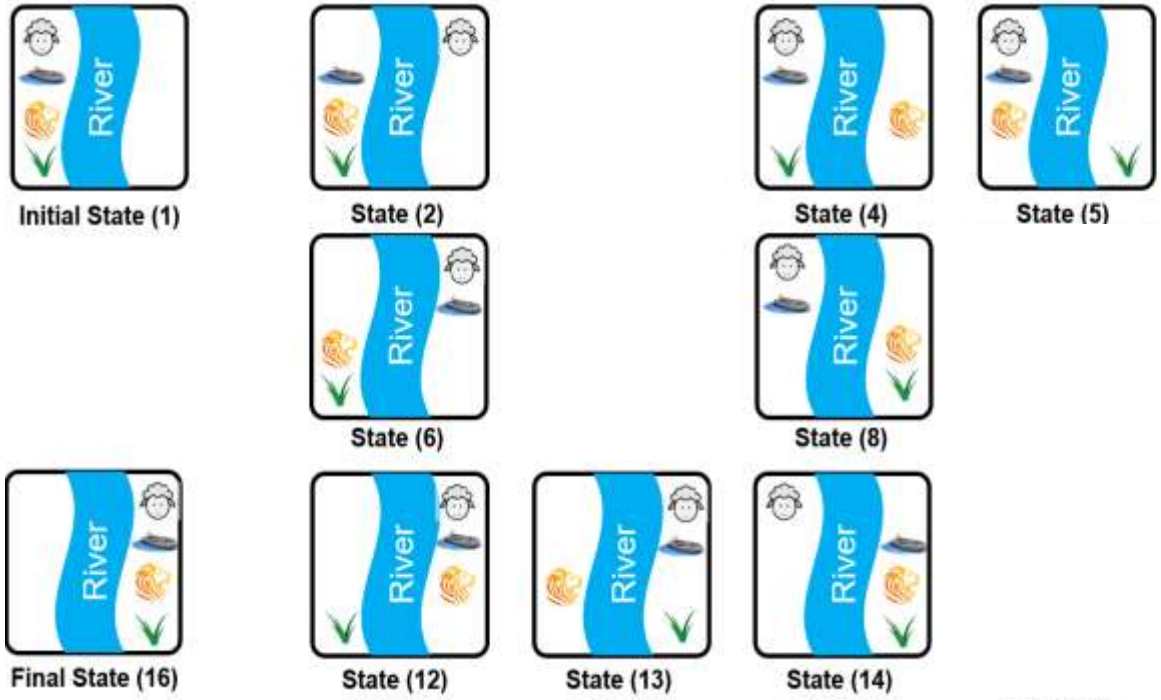
Example 1: Use of Perception to Solve Problems

- Identify the states that violate constraints



Example 1: Use of Perception to Solve Problems

- Removing the states with anomaly will yield



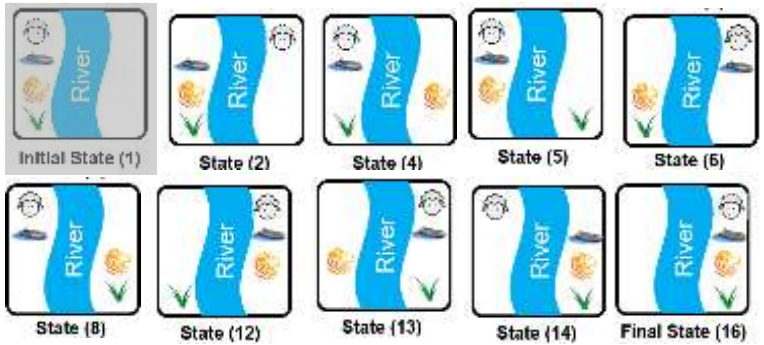
Example 1: Use of Perception to Solve Problems

- **Add the final constraints**
  - From one state to another, **only one** OR **no item** can accompany the person
  - Reorder states to go from initial to final states with the above constraint
- Apply Reordering Algorithm

```
Make your state equal to the initial State
Repeat until you reach to the final state:
    If you are on the left side of the river, then
        Next state = State with single item moved with you to the other side
    Else
        Next state = State with you moving to the other side with or without item
    End If
End Repeat
```

Example 1: Use of Perception to Solve Problems

- Available States

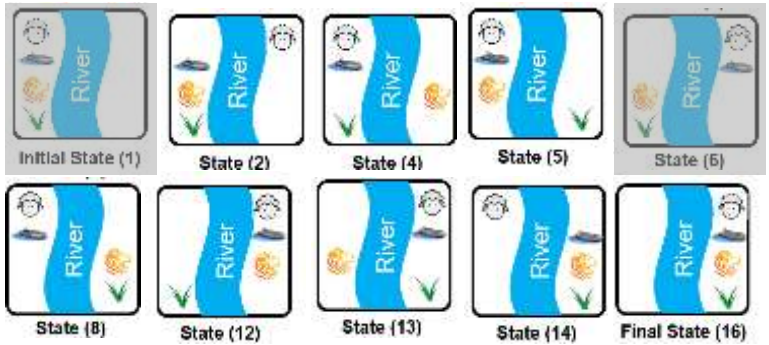


- Solution

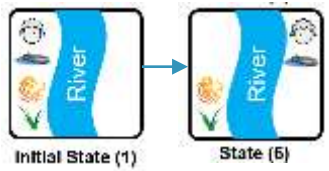

```
Make your state equal to the initial State
Repeat until you reach to the final state:
    If you are on the left side of the
    river, then
        Next state = State with single
        item moved with you to the other
        side
    Else
        Next state = State with you
        moving to the other side
        with or without item
    End If
End Repeat
```

Example 1: Use of Perception to Solve Problems

Available State



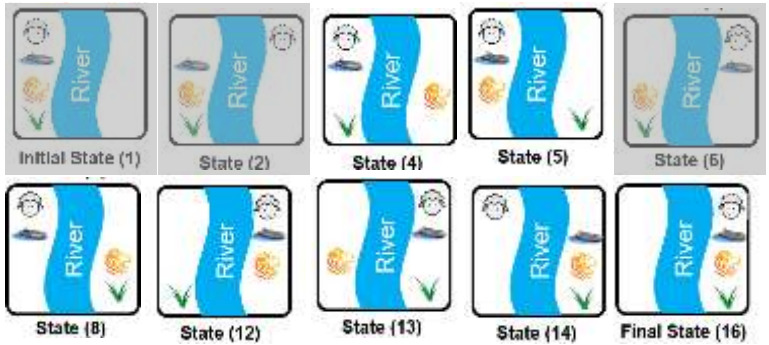
Solution




```
Make your state equal to the initial State
Repeat until you reach to the final state:
    If you are on the left side of the
    river, then
        Next state = State with single
        item moved with you to the other
        side
    Else
        Next state = State with you
        moving to the other side
        with or without item
    End If
End Repeat
```

Example 1: Use of Perception to Solve Problems

Available State

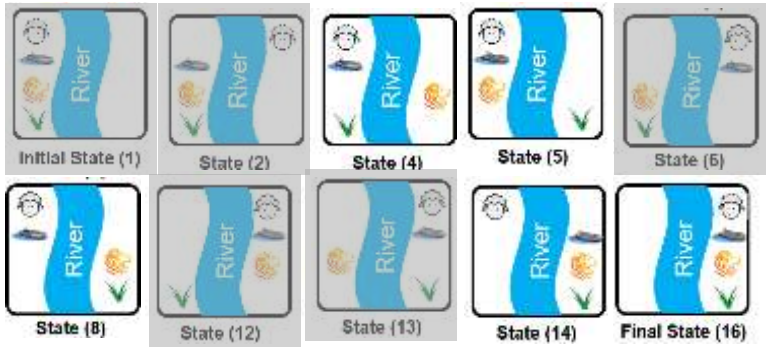


Solution

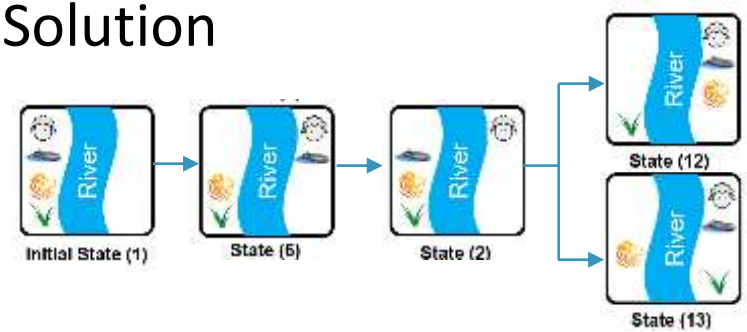

```
Make your state equal to the initial State
Repeat until you reach to the final state:
    If you are on the left side of the river, then
        Next state = State with single item moved with you to the other side
    Else
        Next state = State with you moving to the other side with or without item
    End If
End Repeat
```

Example 1: Use of Perception to Solve Problems

Available State



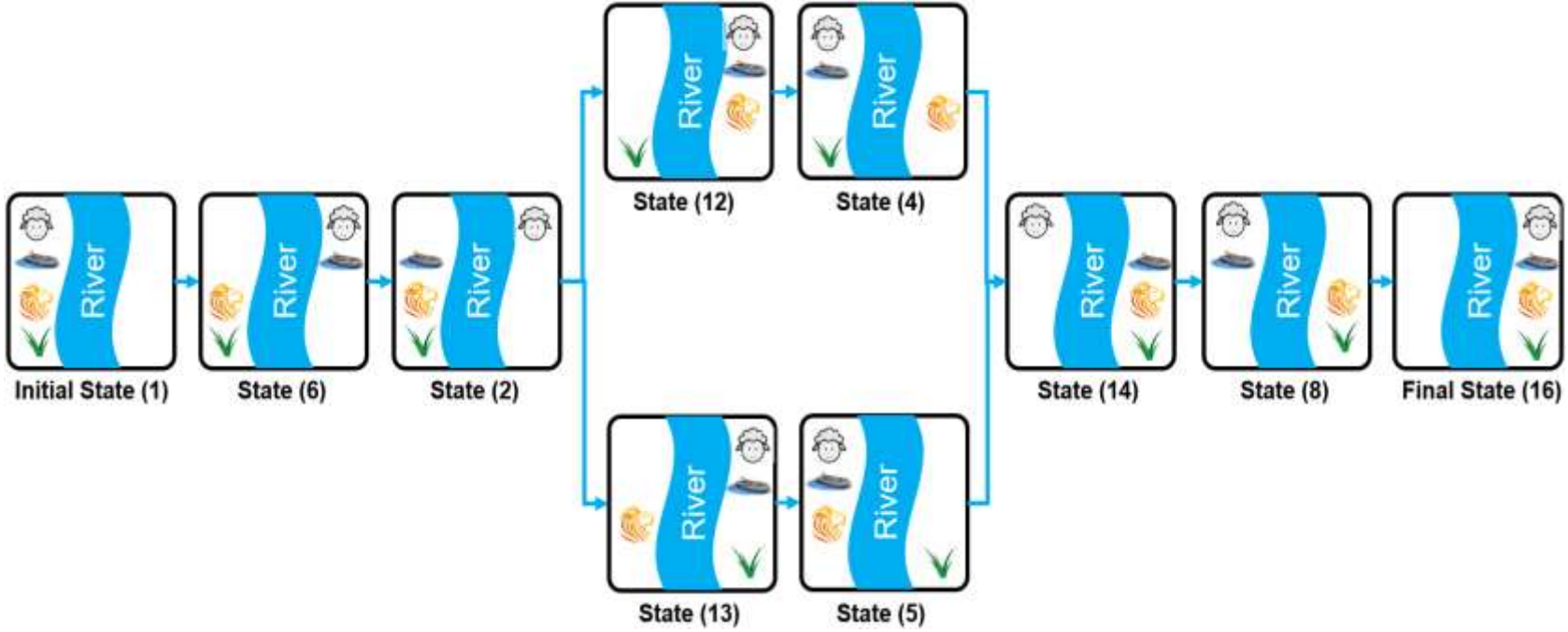
Solution




```
Make your state equal to the initial State
Repeat until you reach to the final state:
    If you are on the left side of the
    river, then
        Next state = State with single
        item moved with you to the other
        side
    Else
        Next state = State with you
        moving to the other side
        with or without item
    End If
End Repeat
```

Example 1: Use of Perception to Solve Problems

- Result



Example 2: Generate and Test in AI

- Problem: What is the name of the fish shown?

- Before thinking of AI and if you don't already know it, what would you do?

Example 2: Generate and Test in AI

- Go online and search for the fish by flipping web pages until it is found
- Try to find a match by extracting some features (shape, size, color … etc.) and matching it with pictures of the fish on the web
  - This step is a form of *feature extraction*
- Good features are often discriminating features and are unique about the object under consideration.

Example 2: Generate and Test in AI

- Examples of Good features (for the fish under investigation):
  - Has a square head (since not many fish have square shaped head)
  - Comes in different colors and has patterns on its body
  - Mouth is pointing downwards (many fish don't have pointy mouth)
  - Eyes on the side of the square head (eyes are close to the head edge) … etc.

Example 2: Generate and Test in AI

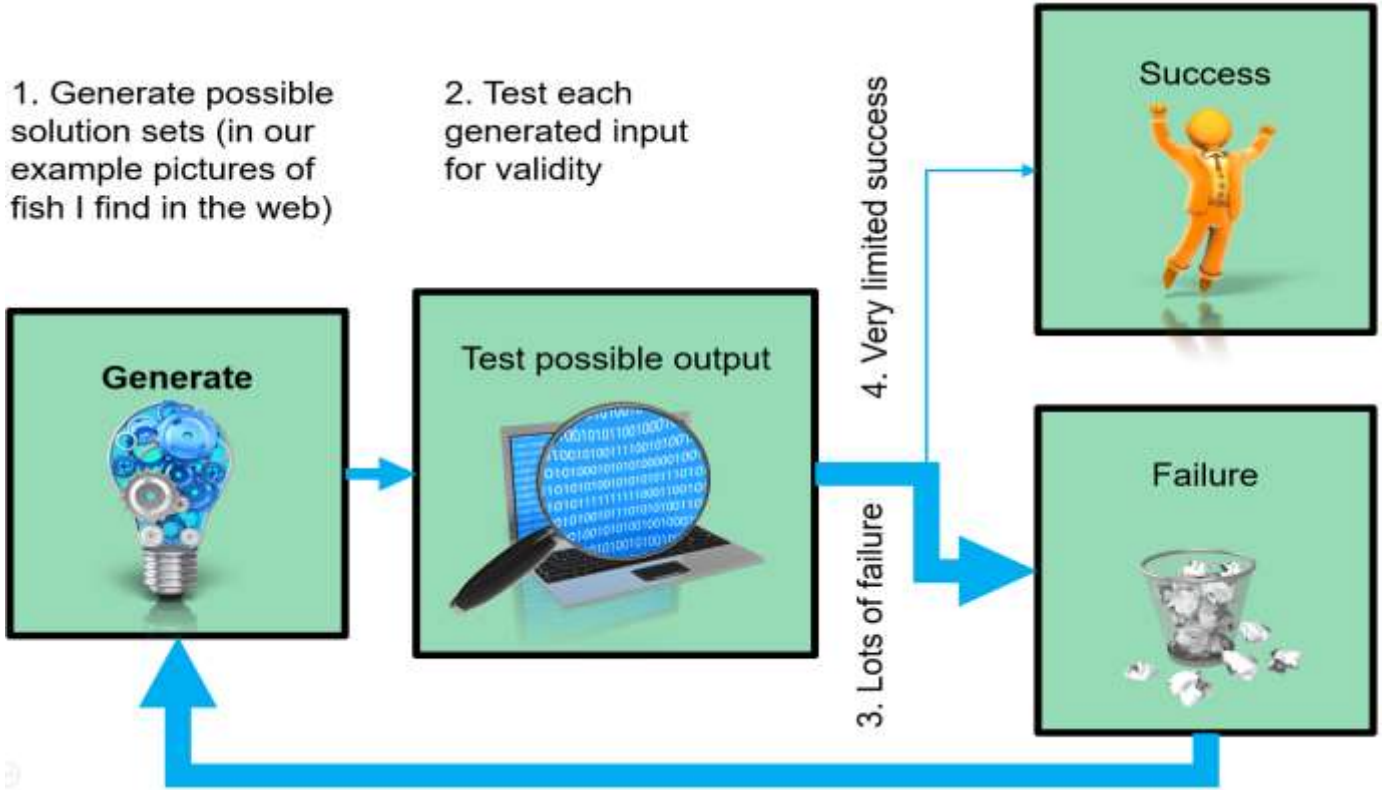
- Examples of Bad features (for the fish under investigation):
  - Lives in water or sea (all fish live in water or sea, so this feature does not add any value)
  - Swims close to rocks (features should give unique information about the object that help in identifying fish, again this is something common to all fish)
  - Lives only in lighted area (to take good pictures we need to have a light but that does not mean that this fish cannot live in the dark)

Example 2: Generate and Test in AI

- Generally, Good features
  - Should take you closer to the target, while bad features do not add any value
  - Should help us or the computer to identify *unique* things about the fish. Since one feature may not be enough to identify the fish, the goal is to have the minimum number of features to uniquely identify the fish.

Example 2: Generate and Test in AI

- Procedure



Generate and Test Properties

- A generator must have good properties:
  1. Should not be redundant: i.e., should not generate the same case more than once.
     - In the example of the fish, we don't want to test the same fish more than once.
  2. Should be informable: supply knowledge related to the matter or subject in hand.
     - In the fish example, we don't want the generator to produce pictures of dogs, cats, planes or cars
- Extract meaningful test features to determine success vs failure
- Test should be fast and efficient

Summary

- We introduced the subject of AI
- Went over some definitions
  - Agents in AI
  - Rationality in AI
  - Rational Agents
- We presented two ways to solve problems
  - Using representation and constraints to find a solution
  - Generate and test methodology