

# Homework 8 Main

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Participation - section h5 form filled

## Competitor Analysis

### Competitor 1 - Visualgo

1. It teaches algorithms using a visual approach.
2. The target audience is students who want to gain a deeper understanding of algorithms with some examples or anyone who has trouble understanding a particular algorithm, and wants to see some visualization to understand better.
3. It uses text and animation to help people learn. For example in the screenshot below, bubble sort is shown along with the code and an example. The process is shown using animation on the given example and the relevant part of the code, which is being executed at that time, is highlighted.



4. It allows users to create a custom input to the program and perform the sorting. It also allows the user to pause and rewind the execution of the code.

The screenshot shows a web-based visualization tool for learning sorting algorithms. At the top, there's a navigation bar with links for BUBBLE SORT, SEL, INS, MER, QUI, R-Q, COU, RAD, Exploration Mode, and LOGIN. Below the navigation is a title "Bubble Sort". On the left, there's a sidebar with buttons for Create(A), Sort, Random, Sorted, Nearly sorted, Many Duplicates, and a text input for array A containing "29,10,14,37,14". On the right, there's a code editor window showing pseudocode for bubble sort:

```

Checking if 48 > 34 and swap them if that is true; swapped = true.

do
    swapped = false
    for i = 1 to indexOfLastUnsortedElement-1
        if leftElement > rightElement
            swap(leftElement, rightElement)
            swapped = true; ++swapCounter
    while swapped

```

At the bottom, there are playback controls (rewind, play, fast forward) and a speed slider set to 1x. The footer includes links for About, Team, Terms of use, and Privacy Policy.

There is also a quiz for each concept.

The screenshot shows a quiz question from VisualGo. The question is: "Rearrange the integers to produce the content of the array A=[22, 19, 24, 28] with n integers after 2 passes of this version of Bubble Sort." Below the question is the pseudocode for two passes of bubble sort:

```

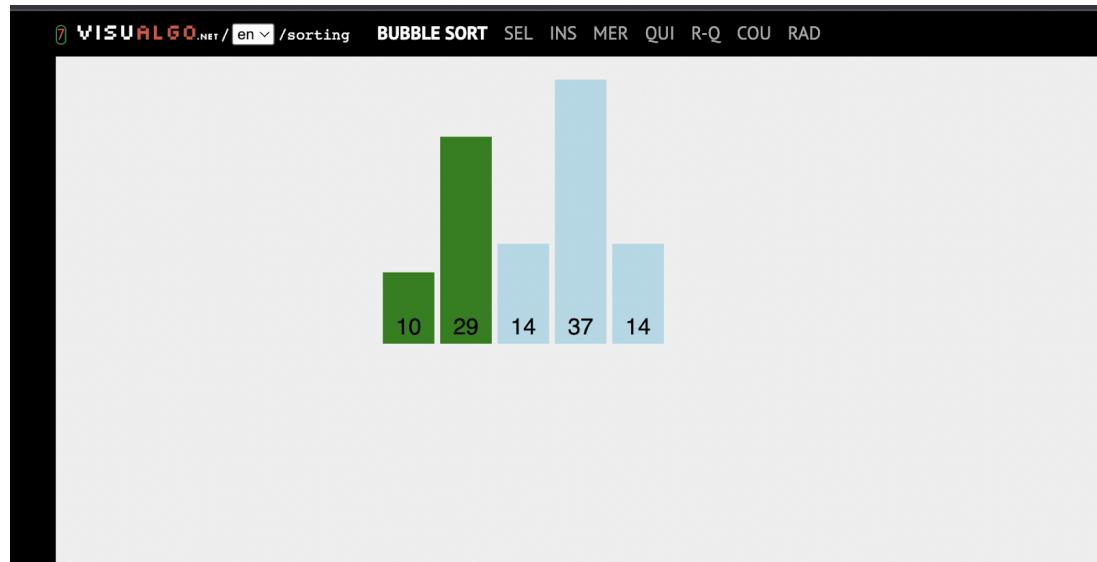
for (j = 0; j < 2; ++j) // 2 passes
    for (i = 0; i < n-j-1; ++i)
        if (A[i] > A[i+1])
            swap(A[i], A[i+1]);

```

Four numbered options are provided: 22, 19, 24, and 28. The page indicates "No time limit" and has a "SUBMIT QUIZ" button. The footer includes links for PREV QN, 1, 2, 3, 4, 5, 6, 7, and NEXT QN.

5. The following features of the interaction and media usage inspire me:

- a. The animation with bar graphs created dynamically for a given input. This is a good way to visualize the input and see the array as the code runs.



- b. The code being highlighted as it is executed. This helps us to see the part of the code which is being run at a given time and helps us to learn which statements are responsible for having a certain effect on the input in the algorithm.

### Bubble Sort

Swapping the positions of 29 and 10 and set **swapped** = true.  
For inversion index: Add 1 to **swapCounter**, now = 1.

```
do
    swapped = false
    for i = 1 to indexOfLastUnsortedElement-1
        if leftElement > rightElement
            swap(leftElement, rightElement)
            swapped = true; ++swapCounter
    while swapped
```

- c. The quiz for each topic, with a text box to enter the answer.

```

1. How many comparison(s) is/are required to sort an array of n=6 integers: [14,17,13,15,16,18] using this version of
Selection Sort?
for (i = 0; i < n-1; ++i) {
    cur_min = i;
    for (j = i+1; j < n; ++j)
        if (A[j] < A[cur_min]) // each execution of this if-statement is counted as one comparison
            cur_min = j;
    swap(A[i], A[cur_min]);
}

```

Enter a number

ANONYMOUS, DIFF: MEDIUM  
No time limit  
SUBMIT QUIZ

PREV QN 1 2 3 4 5 6 7 NEXT QN

6. Three things that could be changed to improve the learning quality are:
- Having multiple choice options in the quiz (as it would help to give clues to learners when trying to answer the question).
  - A short audio/video clip for each algorithm would help to bring a human touch to the learning process and help students get a better feel of the concept.
  - Making better use of the large amount of empty space, by mentioning other important information like time and memory complexity, etc.

BUBBLE SORT SEL INS MER QUI R-Q COU RAD

Exploration Mode v LOGIN

Bubble Sort

```

Set the swapped flag to false.
Then iterate from index 1 to 3 inclusive.

do
    swapped = false
    for i = 1 to indexOfLastUnsortedElement-1
        if leftElement > rightElement
            swap(leftElement, rightElement)
            swapped = true; ++swapCounter
    while swapped

```

Create(A)  
Sort

1x

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## Competitor 2 - Chess.com (Learn)

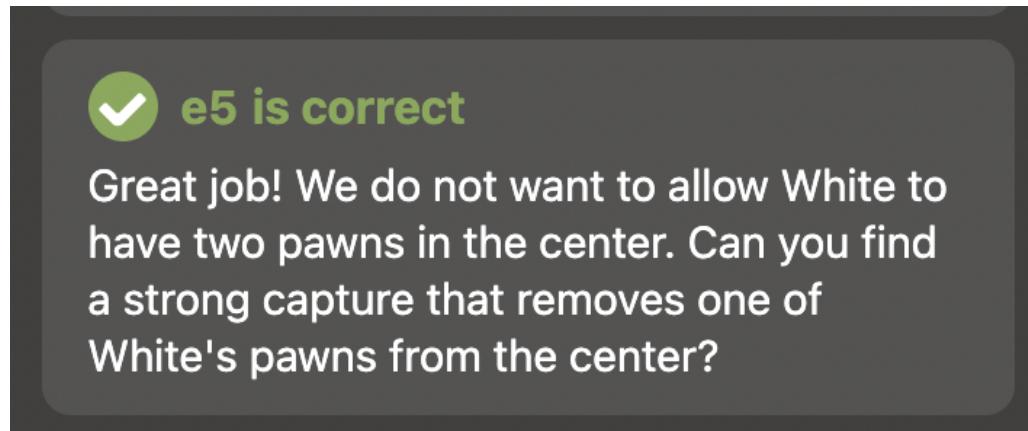
1. The learn section of the website teaches various lessons on how to play chess, starting from the very basics.
2. The target audience is anyone who is interested in learning to play chess or to improve their skills in the game, whether they may be beginners or long time players.
3. Media used - video and text. The lesson contains a video and a short text about it. The video includes a verbal explanation of the concept.



4. It uses interaction in the form of a gameplay which can be started by clicking on the Start Challenges button. After a move is made, we get feedback on whether it was correct.



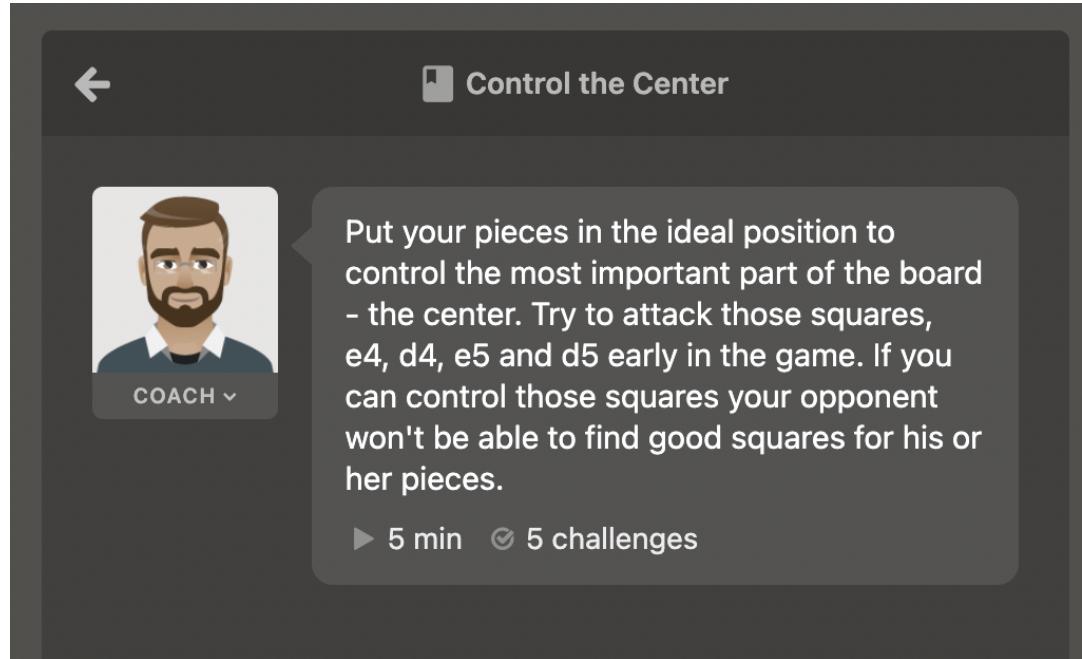
5. Things I like about the interaction and media usage:
- Feedback after every move helps us know if we have understood the concept and have made the right moves.



- b. Video explanation for each lesson, which greatly helps in learning.



- c. The text which appears on the side, which clearly shows the logic move-by-move.



- 6. Three things that could be different:
  - a. Additional multiple choice questions which could test that we have understood the logic behind the moves.

- b. Labels (like e4) inside each square would help while learning initially.



- c. Better formatting of text on the side to make it more readable. Like putting it in separate lines, using different highlighting, etc.

Put your pieces in the ideal position to control the most important part of the board - the center. Try to attack those squares, e4, d4, e5 and d5 early in the game. If you can control those squares your opponent won't be able to find good squares for his or her pieces.

▶ 5 min    5 challenges

## Competitor 3 - Sudoku.com

1. It teaches the rules of sudoku.
2. The target audience is anyone who wants to learn sudoku and also people looking for tips and practice to improve their skills.
3. Media used - text and video. We have some text and also a video explanation and some pictures.

## What is Sudoku and what are the rules of this game?

Sudoku is a popular logic puzzle with numbers. Its rules are quite simple, so even beginners can handle the simple levels.

### What are the basic rules of Sudoku?

- Sudoku grid consists of 9x9 spaces.
- You can use only numbers from 1 to 9.
- Each 3x3 block can only contain numbers from 1 to 9.
- Each vertical column can only contain numbers from 1 to 9.
- Each horizontal row can only contain numbers from 1 to 9.
- Each number in the 3x3 block, vertical column or horizontal row can be used only once.
- The game is over when the whole Sudoku grid is correctly filled with numbers.

There are already many numbers filled in on the grid in the simple Sudoku puzzles. Therefore it's not so difficult to cope with the solution if you are familiar with the basic rules. However, in order to solve difficult levels and deal with them quickly, you need to use some tricks and learn advanced Sudoku techniques.

Our Sudoku guide has a lot of tutorial videos for players of all skill levels: from Sudoku absolute beginners to experts. Watch the videos to check out all the rules, tips and strategies of Sudoku and enjoy the game!

[Sudoku.com](#)

Rules

Tips

Daily Challenge

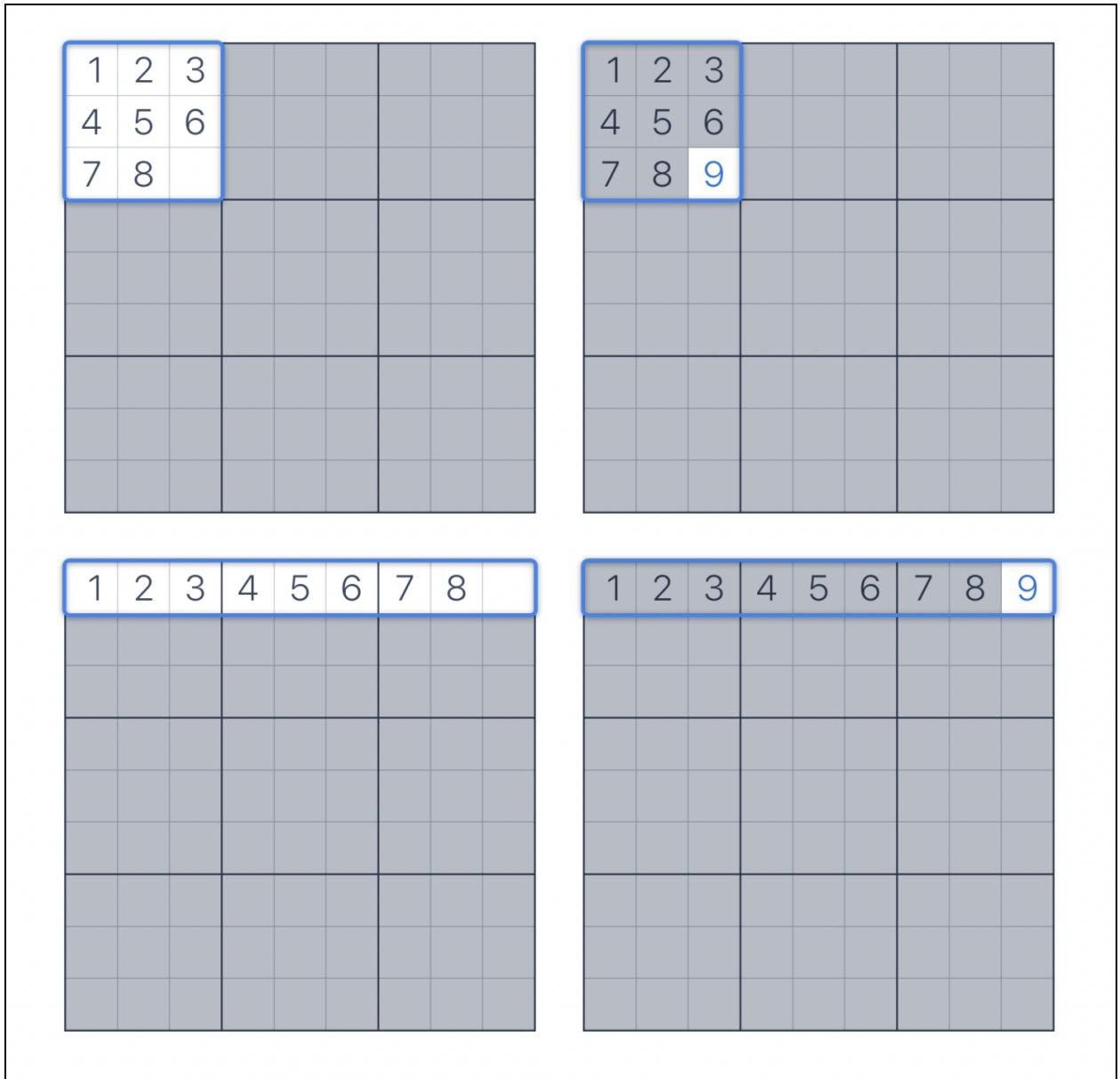
Classic ▾

🇺🇸 ▾

### "Last free cell" technique.



"Last free cell" is the basic Sudoku solving technique. It's pretty simple and based on the fact that each 3x3 block, vertical column or horizontal row on Sudoku grid should contain numbers from 1 to 9 and each number can be used only once within 3x3 block, vertical column or horizontal row.



4. It allows interaction in the form of the daily challenge / classic puzzles in which one can learn by solving the puzzles. While solving, it automatically checks for mistakes and

gives feedback to the user by highlighting the errors in red.

The screenshot shows a 9x9 Sudoku grid on the Sudoku.com website. The grid has some numbers filled in, and the number 2 in the first cell (row 1, column 1) is highlighted in red, indicating it's an error. The interface includes a difficulty selector set to 'Easy', a timer at 00:43, and various game control buttons like 'New Game', 'Undo', 'Erase', 'Notes', and 'Hint'. To the right, there's an advertisement for 'Sudoku.com - Number Games' with a 4-star rating and download links for Google Play and the App Store.

5. Three things I like about the interaction and media usage:
  - a. Short videos with verbal explanations.

The screenshot shows a YouTube video player for a tutorial on the "Last free cell" Sudoku technique. The video title is "Last free cell - a Sudoku technique for beginners" and it's from "Tutorial by Sudoku.com". The video progress bar shows it's at 0:02 of 0:40. The video content area has a large title "Last free cell" and subtitle "Tutorial by Sudoku.com". There are buttons for "MORE VIDEOS", "Watch later", and "Share". The YouTube interface includes a play button, volume icon, and other standard controls.

- b. Mistakes being highlighted as they are made helps beginners while learning to play sudoku.

2				8		7		
8	3	2		5				
7		5	3	9			1	
	1	3	5			8	2	
2				3		4	9	
9	8							
	7							
4		9		6		1	8	5
		1						

- c. We can write down the possible number in each cell using the Notes option, which is similar to what we would do on paper.

The screenshot shows a Sudoku puzzle grid on a mobile device. The top status bar indicates the date as March 27, the time as 01:59, and battery level. Below the status bar is a toolbar with a 'New Game' button and four icons: Undo, Erase, Notes (which is highlighted with a blue circle labeled 'ON'), and Hint. The main area displays a 9x9 Sudoku grid with some numbers filled in. The bottom right corner of the grid shows a numeric keypad with digits 1 through 9.

6. Things that could be different:

- There could be small tests in the section corresponding to each concept / rule which tests that concept, so that the learners could apply what they learned immediately and retain the knowledge.
- There could be one example video in which the puzzle is worked out completely, so that users can see how to proceed to solve a real puzzle and how to use the interface which they will solve it in.
- Better text formatting (more bold) and usage of whitespace (on the side) in the lesson pages.

The screenshot shows a tutorial page from Sudoku.com titled "Last free cell" technique. The page includes a video thumbnail for "Tutorial #1 Last Free Cell" with a 'Watch on YouTube' link. To the right is a 9x9 Sudoku grid with some numbers filled in, illustrating the technique. Below the grid is a brief explanatory text: "'Last free cell'" is the basic Sudoku solving technique. It's pretty simple and based on the fact that each 3x3 block, vertical column or horizontal row on Sudoku grid should contain numbers from 1 to 9 and each number can be used only once within 3x3 block, vertical column or horizontal row.'

## Competitor 4 - Brilliant

1. Brilliant teaches a wide variety of topics, in this case we will look at one of them - Neural networks, which teaches the fundamentals of artificial neural networks.
2. The target audience is a beginner in the field of machine learning who wants an introduction to neural networks, which is widely used in machine learning.
3. Media used - text and images / animations. The lesson does not contain videos. Instead, it has animations and text which can be read interactively.

x <  > 0 %

### Artificial Neurons

Just as biological neurons are the basic units of the brain, artificial neurons are the computational building blocks of an artificial neural network (ANN).

And, like biological neurons, artificial neurons respond to the information that's presented to them.

They can use this information to make predictions. Let's see an example.

This is Chester. He's a pretty easygoing cat.

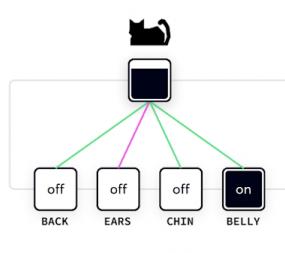


?

x <  > 0 %

He likes when his human scratches his back, his chin, his belly — pretty much anywhere.

This is an ANN with four **inputs** and one **artificial neuron**. It predicts how satisfied Chester will be when his human gives him attention:



The inputs to this neuron are labeled with the places where Chester's human can rub him.

Switching an input to **on** means Chester will get a rub there. The artificial neuron labeled with a Chester icon displays his predicted **response**.

Try flipping a few of the inputs to **on** and notice how the artificial neuron's appearance changes.

Okay, that's... nice?

?

Isn't it?

4. Interaction - Animations which we can interact with (like the one above) and questions / exercises. Feedback (correct / incorrect) is shown once the answer is submitted.

The **fuller** it is, the **happier** we can expect Chester to be after receiving rubs for a few minutes in all of the places corresponding to inputs that are switched **on**.

When the neuron is **entirely black**, the neural net predicts that Chester starts to purr.

If you want to make Chester happy, where **shouldn't** you rub him today?

His back  
 His ears  
 His chin  
 His belly

**Submit** **Show explanation**

Skip ▾

5. Things I like about the interaction / media usage:

- a. Multiple choice questions / exercises

When the neuron is **entirely black**, the neural net predicts that Chester starts to purr.

If you want to make Chester happy, where **shouldn't** you rub him today?

- His back  
 His ears  
 His chin  
 His belly

 **Correct!**

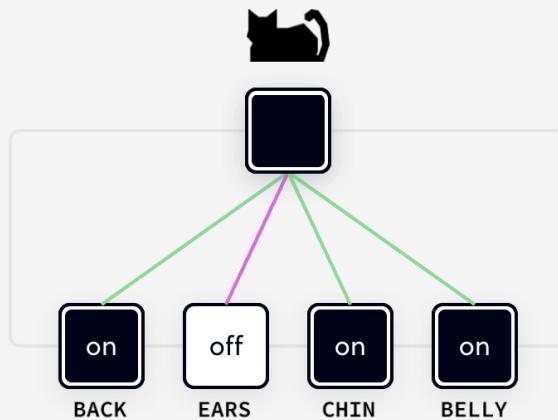
**Okay**

**Show explanation**

- b. Explanations for the answer - the explanations are given in a detailed manner.

### Explanation

The neuron predicts Chester will be happiest when the neuron is full, like when the inputs for rubs on his back, chin, and belly are on :



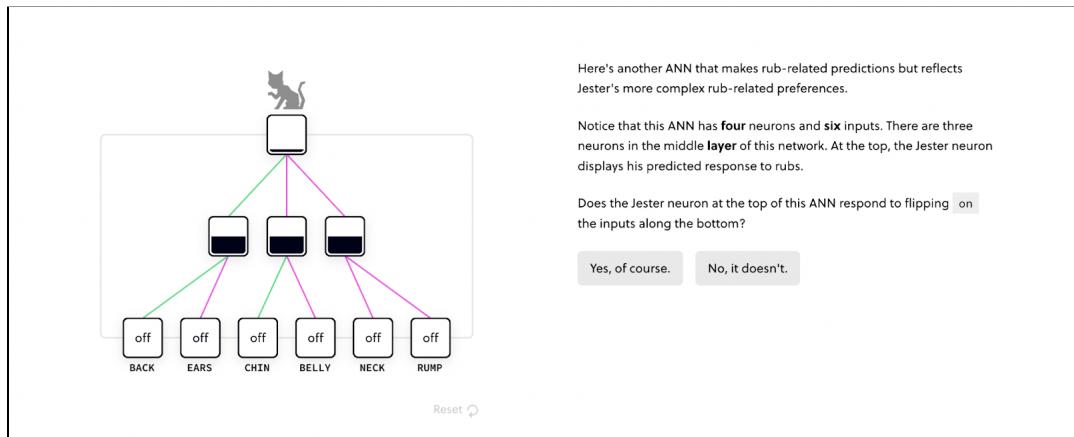
Reset ⌂

However, if you switch on the input for his ears, the activation of the neuron decreases and he stops purring.

No matter which other inputs are on, the neuron predicts that rubbing ears will always make him a little less happy. So don't rub his ears today, please.

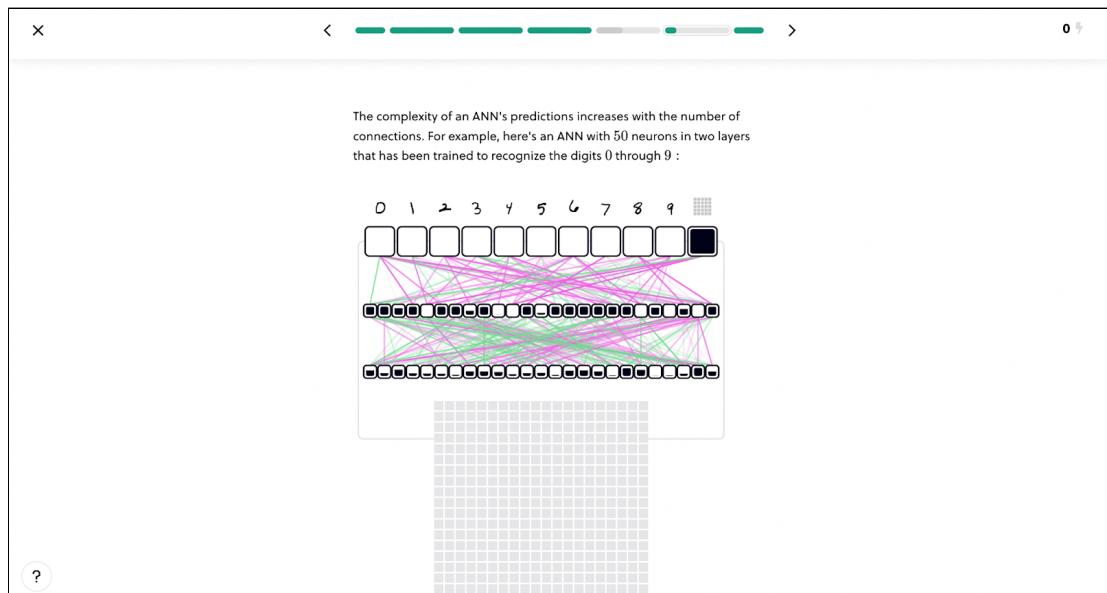
[Back to problem](#)

- c. Frequent prompts to make sure that the learner is engaged in the exercise and understands every part of what is being taught.



## 6. Things that could be different:

- a. Video explanations would help to understand the concepts faster.
- b. There should be an end of lesson quiz in addition to exercises within the lesson which would test the user's ability to remember what was taught.
- c. Better usage of whitespace, especially on the side. The content should cover the most of the width of the page to better make use of the whitespace.



## Competitor 5 - Codecademy (Javascript)

1. It teaches programming fundamentals in javascript from a basic level.
2. Target audience - beginners in javascript.
3. Media used - text and code (IDE). The question and the required information is given in the left column. The code must be written on the middle column and the output is seen

on the right column.

The screenshot shows a dark-themed IDE interface. On the left, there's a sidebar with a 'Learn' section containing text about semicolons and code examples. The main area has a code editor with 'app.js' containing the following code:

```
1 console.log(23);
2 console.log(3);
```

Below the code editor are buttons for 'Run', 'Save', and 'Reset'. At the bottom, there are navigation buttons for 'Back' and 'Next'.

- Interaction - the user must type the code in the IDE and click on Run. Other ways of interaction include clicking to see the Hints on the left panel and resetting the editor.

The screenshot shows a similar dark-themed IDE interface. The left sidebar now includes a 'Hint' section with a tip about semicolons, a 'Concept Review' section with a link to a cheatsheet, and a 'Community Forums' section listing top questions. The code editor remains the same as in the previous screenshot.

- Things I like about interaction / media usage:

- a. Effective formatting and clear headings in the text question.

## Learn

You'll see later on that we can use `console.log()` to print different kinds of data.

### Instructions

-  1. Use the `console.log` code in the editor to log your age to the console.

Run your code when you are ready to see the result.

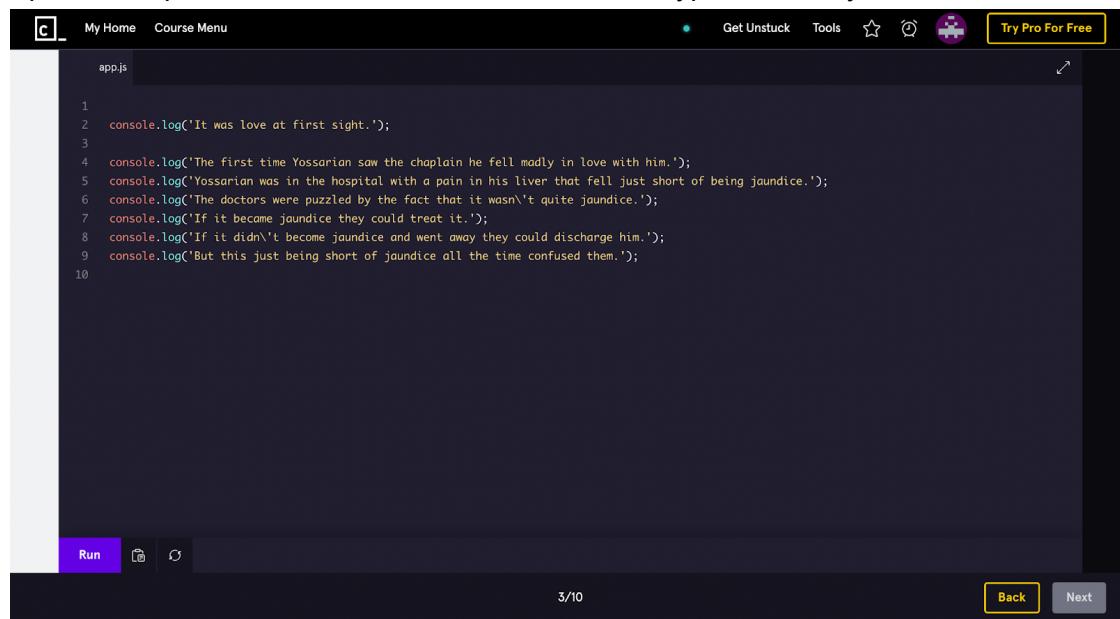
Stuck? Get a hint 

-  2. On the next line, write another `console.log` to print out a different number representing the number of weeks you've been programming.

Stuck? Get a hint 

## Concept Review

- b. Option to expand the code window, so that we can type effectively.



```
app.js
1 console.log('It was love at first sight.');
2
3
4 console.log('The first time Yossarian saw the chaplain he fell madly in love with him.');
5 console.log('Yossarian was in the hospital with a pain in his liver that fell just short of being jaundice.');
6 console.log('The doctors were puzzled by the fact that it wasn\'t quite jaundice.');
7 console.log('If it became jaundice they could treat it.');
8 console.log('If it didn\'t become jaundice and went away they could discharge him.');
9 console.log('But this just being short of jaundice all the time confused them.');
10
```

Run Back Next

- c. Links to the cheatsheet and forum available in every lesson.

### ☰ Concept Review

Want to quickly review some of the concepts you've been learning? Take a look at this material's [cheatsheet!](#)

### 💬 Community Forums

Here are some helpful links to the top questions asked by coders about this exercise:

1. Why would you want to prevent code lines from running by using comments? >

Still have questions? View this exercise's thread in the [Codecademy Forums](#).

# User Interview

2. I interviewed my cousin Anshul, a sophomore undergraduate student in Computer Science. He has been learning about algorithms and working on computational projects and is interested in learning more about machine learning and AI, especially in the areas of deep learning and neural networks.

3. The three topics I could teach are:

## **Topic 1**

1. Domain: Neural networks and Deep learning
2. Topic: Backpropagation
3. He is interested in learning about machine learning and said "I started to explore neural networks in machine learning. But, I didn't fully understand the training process, mainly backprop." Backpropagation is the fundamental concept that must be understood to train neural networks and is the basis of deep learning and all its applications.
4. He told me that he finds this topic difficult to understand. He said "I'm not getting the intuition for backprop and I am lost in the math which is very complicated. But, I like how in some places, it is explained easily like a pipeline. They show arrows going to and from different layers of the network and using that to calculate the derivatives." This topic is considered to be difficult from a mathematical point of view since it relies on vector calculus and chain rule and involves finding gradients of loss functions with respect to the weights of the neural network. However, this process is well suited to explain in a visual format, since the propagation of gradients and the chain rule can be explained well in a computation graph formulation where we can get an intuition on how this works.

## **Topic 2**

1. Domain: Neural networks and Deep learning
2. Topic: Optimization algorithms
3. He is interested in understanding more about optimization algorithms used in training neural networks like gradient descent and its many variants. He said "I heard about some optimization algorithms to train neural networks, like gradient descent, momentum, etc. I want to understand how they work and which approach is better."
4. What's hard about this topic? - He said "There are so many optimization algorithms, so it's confusing when to apply which one. The logic of some optimizers is also hard to understand."  
Reasoning - The logic behind the different optimizers is difficult to understand using only equations, which makes it confusing. This is where visualization will help.

## **Topic 3**

1. Domain: Neural networks and Deep learning
2. Topic: Convolutional Neural Networks
3. He is interested in the computer vision field and wants to learn how to apply machine learning techniques to these problems. For computer vision, since we are dealing with images, convolutional neural networks are most commonly used. He said "I want to explore applications of deep learning in computer vision problems like self-driving cars and facial recognition."

4. What's hard about this topic? - He said "For images, convolutional neural networks are complicated for me to understand because I need to think about it in multiple dimensions. It also has many different layers / parameters which makes it more difficult." Reasoning - In CNNs, he is right that we need to think in 3D how the convolutions affect the filters, channels and the depth of the input image. A good visualization will go a long way to help explain this process clearly.
4. In the interview, he mentioned that he used the Visualgo website (first one in the competitor analysis) while learning algorithms. He said he liked how the website had a dynamic visualization and code which highlights as it is executed and a quiz for every concept. This gives me an idea to relate this with the backpropagation topic. Specifically, I want to show the backprop approach on an example in an animation and display the equations on the side and highlight which part of the equation is being implemented at which time and is leading to what effect in the computation graph. This will help to understand this concept from both an intuitive as well as a mathematical perspective.

## Group Slides

<https://docs.google.com/presentation/d/1Qi9Tp6dZ1o8lc6ZUDYFsFlluHJWmBj60NgwXEZ2Jw4/edit?usp=sharing>