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# The Label Complexity of Mixed-Initiative Classifier Training

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## Supplementary Material - Experiment Flow

This document describes the flow and mechanics of the Mechanical Turk experiment along with the screenshots.

### 1. General Instructions

Participants are given identical instructions in all conditions. They must accept the instructions to proceed to the tasks.

#### Instructions

Please read the following instructions carefully.

- You will be teaching a robot.
- Please try your best and answer questions honestly!
- You will receive a confirmation code to submit at the end of the HIT.
- It will probably take you about 5 - 10 minutes to complete this HIT.

To get paid for this HIT...

- Read task instructions carefully and ANSWER ALL QUESTIONS. Incomplete HITs will not be approved.
- You may only complete this study or a study similar to this once (one time per worker for this task title and requester).
- Please complete this HIT in a single session. Interrupted tasks will not be approved.

I accept!

## 2. Task Instructions

All participants are given identical task descriptions for the specific threshold or interval classifier.

### (1) Threshold classifier task

#### Task

Imagine you are looking to buy a car. Car prices go from \$10000 to \$30000, but you will only accept a car priced at **\$19000 or below**.

You have a robot assistant who knows that your acceptable price falls at or below a threshold, but it does not know what your acceptable threshold is.

Your task is to teach your robot what your acceptable threshold is:

- You can only give examples like "\$\_ is acceptable" or "\$\_ is unacceptable."
- You cannot afford any car over \$19000 by even \$1 because you only have \$19000 in your bank account.
- Provide the **fewest number of examples** possible while still making sure your robot has clearly understood your price threshold.

### (2) Interval classifier task

#### Task

Imagine you are looking to buy a car. Car prices go from \$500 to \$1500, but you will only accept a car in the range of **\$1260 to \$1360**.

You have a robot assistant who knows that your acceptable price falls into a range, but it does not know what your acceptable range is.

Your task is to teach your robot what your acceptable price range is:

- You can only give examples like "\$\_ is acceptable" or "\$\_ is unacceptable."
- You believe any car under \$1260 by even \$1 will break down.
- You cannot afford any car over \$1360 by even \$1 because you only have \$1360 in your bank account.
- Provide the **fewest number of examples** possible while still making sure your robot has clearly understood your price range.

## 2.1. Teacher education by analogues

If the participant is in the teacher education by analogues condition, the optimal teaching sets for two other hypothetical problems are displayed below the task instructions.

### (1) Threshold classifier task

#### Hints

- If your price threshold was \$20000 or below, you could show your robot these 2 examples: **\$20000 is acceptable, \$20001 is unacceptable**
- If your price threshold was \$24000 or below, you could show your robot these 2 examples: **\$24000 is acceptable, \$24001 is unacceptable**

### (2) Interval classifier task

#### Hints

- If your price range were \$900 to \$1000, you could show your robot these 4 examples: **\$899 is unacceptable, \$900 is acceptable, \$1000 is acceptable, \$1001 is unacceptable.**
- If your price range were \$600 to \$700, you could show your robot these 4 examples: **\$599 is unacceptable, \$600 is acceptable, \$700 is acceptable, \$701 is unacceptable.**

## 2.2. Teacher education by explanation

If the participant is in the teacher education by explanation condition (only applicable to interval classifier task), before proceeding to the actual task, the participants are shown step-by-step tutorial for a hypothetical problem with three quizzes that they can page through.

### Task Description

You are trying to buy a car with a range of acceptable prices in your mind. You have a robot assistant who knows that your acceptable price falls into a range, but it does not know what your acceptable range is.

Your task is to teach your robot what your acceptable price range is:

- You can only give examples like "\$\_ is acceptable" or "\$\_ is unacceptable."
- You believe any car under the acceptable price range by even \$1 will break down.
- You cannot afford any car over the acceptable price range by even \$1 because you don't have enough money in your bank account.
- Provide the **fewest number of examples** possible while still making sure your robot has clearly understood your price range.

Next, we provide a step by step illustration of how you may teach the robot. Click the buttons to step through the hints.


[View Hints](#)

### 2.2.1 Detailed Explanation of Optimal Teaching Set

At first, we provide a detailed explanation for a hypothetical problem with acceptable ranges between \$900 and \$1000. We illustrate the effect of providing examples and labels on the robot's hypothesis space with a number line visualization.

#### Step-by-Step Hints


If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:  
**\$900 is acceptable**



500 900 1500 Back Next

#### Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:  
**\$900 is acceptable, \$1000 is acceptable**



500 900 1000 1500 Back Next

## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

\$900 is acceptable, \$1000 is acceptable



Okay, if \$900 and \$1000 are acceptable, all prices **in-between** must also be acceptable!



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## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

\$900 is acceptable, \$1000 is acceptable



But wait... I'm still not completely sure what is unacceptable. Please clarify.



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## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

\$900 is acceptable, \$1000 is acceptable.

To make your unacceptable ranges clear, you could show your robot that:



But wait... I'm still not completely sure what is unacceptable. Please clarify.



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## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

**\$900 is acceptable, \$1000 is acceptable.**

To make your unacceptable ranges clear, you could show your robot that:

**\$899 is unacceptable**



But wait... I'm still not completely sure what is unacceptable. Please clarify.



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## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

**\$900 is acceptable, \$1000 is acceptable.**

To make your unacceptable ranges clear, you could show your robot that:

**\$899 is unacceptable**



Okay, if \$900 to \$1000 is acceptable **and** \$899 is unacceptable, then all prices below \$899 must also be unacceptable!



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## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

**\$900 is acceptable, \$1000 is acceptable.**

To make your unacceptable ranges clear, you could show your robot that:

**\$899 is unacceptable**



But wait... What about prices \$1001 and above?



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## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

**\$900 is acceptable, \$1000 is acceptable.**

To make your unacceptable ranges clear, you could show your robot that:

**\$899 is unacceptable AND \$1001 is unacceptable.**



But wait... What about prices \$1001 and above?



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## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

**\$900 is acceptable, \$1000 is acceptable.**

To make your unacceptable ranges clear, you could show your robot that:

**\$899 is unacceptable AND \$1001 is unacceptable.**



Okay, if \$900 to \$1000 is acceptable and \$1001 is unacceptable, then all prices above \$1001 must also be unacceptable!



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## Step-by-Step Hints

If your acceptable price range were \$900 to \$1000, you could show your robot 2 examples:

**\$900 is acceptable, \$1000 is acceptable.**

To make your unacceptable ranges clear, you could show your robot that:

**\$899 is unacceptable AND \$1001 is unacceptable.**



Ah ha! Now its completely clear that the only acceptable price range is \$900 to \$1000!



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Got it!





## 2.2.2 Quizzes

We then provide 3 short quizzes to probe the participants and provide explanations for answers.

### Step-by-Step Hints

Would it be necessary to provide one more example of '\$950 is acceptable' to train the robot?


- Yes
- No




### Step-by-Step Hints

Would it be necessary to provide one more example of '\$950 is acceptable' to train the robot?

- Yes
- No



That's unnecessary because I already know that **all** prices between \$900 and \$1000 are acceptable. Please select the correct answer.



## Step-by-Step Hints

Would it be necessary to provide one more example of '\$950 is acceptable' to train the robot?

- Yes
- No



Correct! I already know that \$950 is acceptable!



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Got it!

## Step-by-Step Hints

Would it be necessary to provide either '\$500 is unacceptable' or '\$1500 is unacceptable' as additional examples?

- Yes
- No



## Step-by-Step Hints

Would it be necessary to provide either '\$500 is unacceptable' or '\$1500 is unacceptable' as additional examples?

- Yes
- No



I already know that! Please select the correct answer.



## Step-by-Step Hints

Would it be necessary to provide either '\$500 is unacceptable' or '\$1500 is unacceptable' as additional examples?

- Yes
- No



Correct! I already know that \$500 and \$1500 are unacceptable!



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Got it!

## Step-by-Step Hints

If you were to provide the following 3 examples, would the robot arrive at the correct price range of \$900 to \$1000?

\$950 is acceptable, \$899 is unacceptable, \$1001 is unacceptable.

- Yes
- No



\* Note: We displayed the incorrect font color for “\$1001 is unacceptable”.

## Step-by-Step Hints

If you were to provide the following 3 examples, would the robot arrive at the correct price range of \$900 to \$1000?

\$950 is acceptable, \$899 is unacceptable, \$1001 is unacceptable.

- Yes
- No



Correct! Those 3 examples are not enough for me to know where the acceptable price range starts and ends.



## Step-by-Step Hints

If you were to provide the following 3 examples, would the robot arrive at the correct price range of \$900 to \$1000?

\$950 is acceptable, \$899 is unacceptable, \$1001 is unacceptable.

- Yes
- No



Correct! Those 3 examples are not enough for me to know where the acceptable price range starts and ends.



Now you are ready to begin the task!

Start

### 3. Task Input

Once the participants start their task, they are asked to provide example-label set in the human-initiated and mixed-initiative condition with an option to terminate teaching and to provide only labels in the computer-initiated condition until the active learning algorithm is able to converge.

#### 3.1. Human-Initiated Input

The participant is reminded of their allowed input ranges and target threshold or ranges and is asked to provide the example value and its label (acceptable or unacceptable).

Again, car prices go from \$500 to \$1500, but you will only accept a car in the range of **\$1260 to \$1360**.

\$  is

#### 3.2 Input Validation Feedback

In the conditions where example-label set is requested, we provide feedback to the user such that only valid examples and labels can be submitted.

(1) Input textbox only accepts only numerical keys 0 through 9. All other keys will be ignored.

(2) Any value outside of the input range is not allowed.

Again, car prices go from \$10000 to \$30000, but you will only accept a car priced at **\$19000 or below**.

\$  is    **The number must be between \$10000 and \$30000.**

Again, car prices go from \$500 to \$1500, but you will only accept a car in the range of **\$1260 to \$1360**.

\$  is    **The number must be between \$500 and \$1500.**

(3) An example must be submitted with a label.

Again, car prices go from \$10000 to \$30000, but you will only accept a car priced at **\$19000 or below**.

\$  is    **Select either "Acceptable" or "Unacceptable".**

Again, car prices go from \$500 to \$1500, but you will only accept a car in the range of **\$1260 to \$1360**.

\$  is    **Select either "Acceptable" or "Unacceptable".**

### 3.3. Teaching Termination

On every example-label set submission in human-initiated condition or on the first TD example-label set submissions in mixed-initiative condition, the participant can opt to continue teaching or to terminate teaching.

That is enough for the robot

Let me provide another example

### 3.4. Mixed-Initiative Input

If the participant terminates their teaching before TD example-label sets are provided or the algorithm cannot determine the threshold or interval based on the provided example-label sets in the mixed-initiative condition, the active learning takes over and asks the participant to provide labels until it can reach a conclusion.

Your robot is still confused. Please continue by answering the following questions:

Is \$630

Acceptable

Unacceptable

Submit Example

### 3.5. Computer-Initiated Input

In the computer-initiated condition, the participant is asked to provide the label for examples provided by the active learning algorithm until the algorithm is able to reach a conclusion.

Again, car prices go from \$500 to \$1500, but you will only accept a car in the range of **\$1260 to \$1360**.

Is \$1001

Acceptable

Unacceptable

Submit Example

#### 4. Survey

All participants were asked to fill out a survey, and the survey is displayed in a single page.

##### 4.1. Mistakes and Difficulty

Participants are asked to recall if they had made any mistakes and to rate the difficulty of the task.

**Survey**

You're almost done! Please answer the following questions to complete your task.

**Did you make any mistakes during your task?**

- Yes
- No
- Unsure

**Overall, how difficult or easy did you find this task?**

- Very difficult
- Difficult
- Neither difficult nor easy
- Easy
- Very Easy

## 4.2. Teaching Confidence and Experience

Participants are asked to rate their confidence in teaching, their confidence in the robot's understanding of their teaching, and their teaching experience.

**Overall, how confident are you that you taught the price range correctly?**

- Not confident at all
- Slightly confident
- Somewhat confident
- Quite confident
- Extremely confident

**Overall, how confident are you that your price range was correctly understood?**

- Not confident at all
- Slightly confident
- Somewhat confident
- Quite confident
- Extremely confident

**How much experience do you have teaching, tutoring, coaching, parenting, etc?**

- Very much
- Quite a bit
- Some
- Very little
- None



### 4.3. Attention and Numeracy

Two questions were specifically added to test for the participant's attention to detail and to see if the participant understood the concept of thresholds or ranges.

#### (1) Threshold classifier task

Please select **ALL** correct statements from the instructions that we provided at the beginning of the task.

- Provide the most number of examples possible.
- You cannot afford any car over \$19000 by even \$1 because you only have \$19000 in your bank account.
- Your task is to teach a dinosaur what your acceptable price range is.
- Car prices go from \$10000 to \$30000.

Imagine you are looking to buy a car. You will only accept a car priced at \$24000 or below.

Please select **ALL** acceptable prices.

- 10000
- 15000
- 19000
- 20000
- 22000
- 23999
- 24000
- 24001
- 25000
- 30000

(2) Interval classifier task

Please select **ALL** correct statements from the instructions that we provided at the beginning of the task.

- Provide the most number of examples possible.
- You cannot afford any car over \$1360 by even \$1 because you only have \$1360 in your bank account.
- Your task is to teach a dinosaur what your acceptable price range is.
- You believe any car under \$1260 by even \$1 will break down.

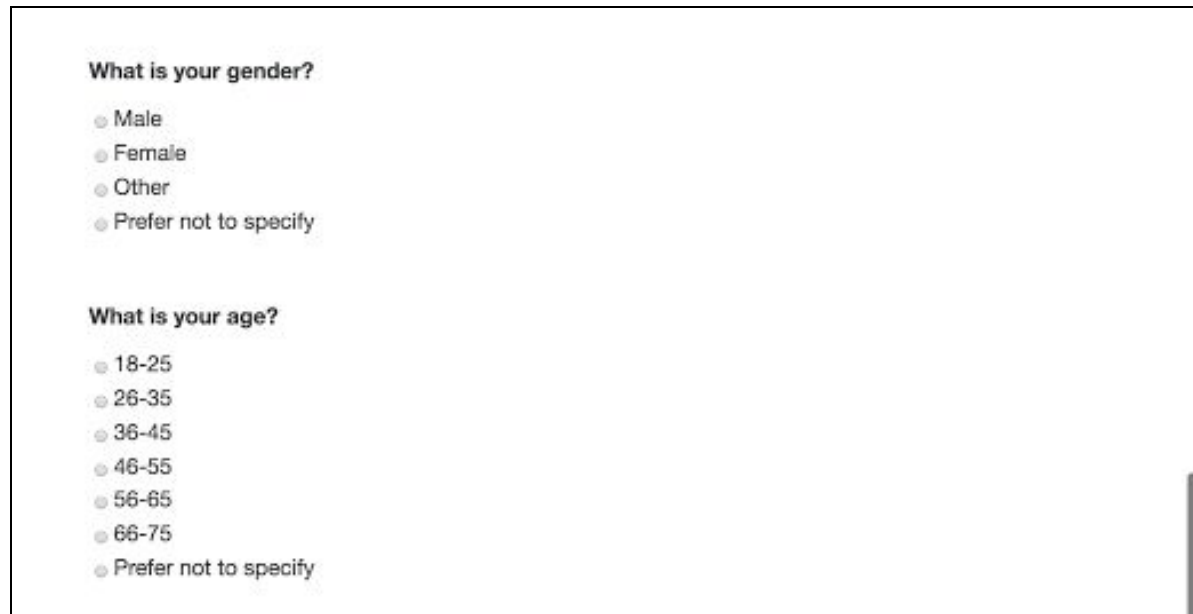
Imagine you are looking to buy a car. Car prices go from \$1000 to \$3000, but you will only accept a car in the price range of \$1500 to \$2500.

Please select **ALL** acceptable prices.

- 800
- 999
- 1000
- 1001
- 1499
- 1500
- 1501
- 2499
- 2500
- 2501
- 2999
- 3000
- 3500

#### 4.4. Demographic Information and Strategy

Basic demographic information is captured.



**What is your gender?**

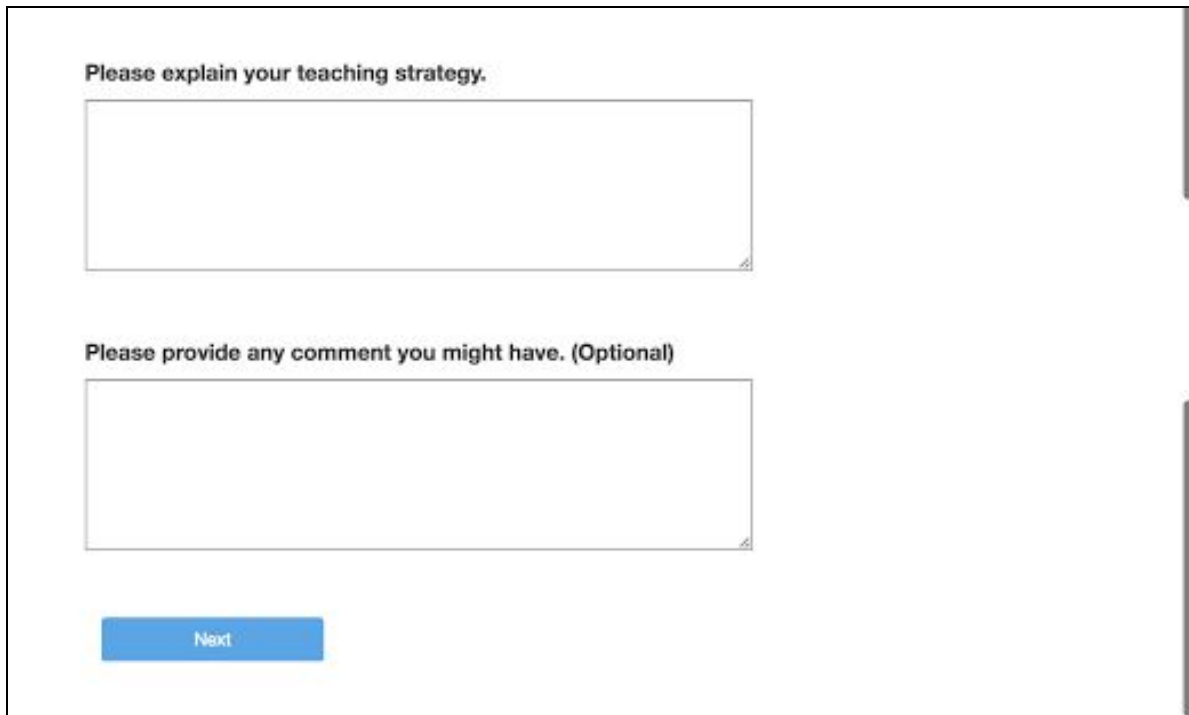
- Male
- Female
- Other
- Prefer not to specify

**What is your age?**

- 18-25
- 26-35
- 36-45
- 46-55
- 56-65
- 66-75
- Prefer not to specify

#### 4.5. Teaching Strategy

Participants were required to provide an explanation for their teaching strategy.



The image shows a screenshot of a survey form. It contains two text input fields and a 'Next' button. The first field is labeled 'Please explain your teaching strategy.' and the second is labeled 'Please provide any comment you might have. (Optional)'. The 'Next' button is blue and located at the bottom left of the form area.

Please explain your teaching strategy.

Please provide any comment you might have. (Optional)

Next

## 5. Completion

When the participant completes the task and the survey, they are provided a completion code used for submitting the task to Mechanical Turk.

**Thanks for teaching your robot!**

Please copy the following completion code and paste it into the HIT page on Mechanical Turk to submit your HIT.

**60501140-6fa0-1493-8190-1d3213431e5e**

You may close this browser window.