CMPUT 267
Machine Learning I

Instructor: Vlad Tkachuk

Classes and tutorials will be streamed on Google Meet

Classes Will be Recorded and Made Public

- Classes and tutorials will be recorded
- Recordings will be posted publicly on this Youtube channel
- If you speak (ex: ask a question) in class your voice will be recorded
- If you speak on Google Meet your voice and Google profile picture (or video if you have it on) will be recorded

There is a course website

(vladtkachuk4.github.io/machinelearning1)

These slides (and future) are posted there in the schedule tab

Course is based on the (in progress) course notes

They will be updated throughout the term

Course Details

- Lectures: Tue & Thu 12:30pm - 1:50pm (CCIS 1-440 & Virtual)
  - Will go over course notes
- Tutorial (Optional): Thu 4:00pm - 5:00pm (CCIS 1-160 & Virtual)
  - Will go over examples and assignment solutions
- Instructor: Vlad Tkachuk (email: vtkachuk@ualberta.ca)
- Office Hours: Thu 2:15pm - 3:30pm (CSC 2-15)

TAs

TA email: cmput267@ualberta.ca

Name	Day and Time	Location
Bahar Boroomand Ghahnavieh	Monday 9:00am - 10:00am	Virtual
Abdelrahman Elaraby	Monday 12:00pm - 1:00pm	CAB 313
Mehrshad Tavana	Monday 1:00pm - 2:00pm	CAB 313
Alireza Masoumian	Tuesday 9:00am - 10:00am	CAB 313
Aidan Bush	Tuesday 3:00pm - 4:00pm	Virtual
Guoqing Luo	Wednesday 9:00am - 10:00am	Virtual
Thang Duc Chu	Wednesday 2:00pm - 3:00pm	CAB 313
Jai Riley	Wednesday 3:00pm - 4:00pm	CAB 313
Vlad Tkachuk (Instructor)	Thursday 2:15pm - 3:30pm	CSC 2-15
Alex Ayoub	Friday 9:00am - 10:00am	CSC 2-18
Rohini Das	Friday 1:00 - 2:00pm	CAB 313
Kushagra Chandak	Friday 4:00pm - 5:00pm	Virtual

Asking Questions and Getting Help

1. **Ask an LLM** (ex: ChatGPT). Fast responses and familiarizes you with LLMs.
   - **IMPORTANT:** LLM outputs should not be blindly trusted; students must verify information if unsure of its accuracy.
2. **Ask on Piazza** (Note: you can ask questions anonymously)
   - Any questions that don't reveal assignment solutions
3. **Email the TAs** (cmput267@ualberta.ca)
   - For private assignment questions
4. **Email the instructor** (vtkachuk@ualberta.ca)
   - Missing exams or personal issues

Join Piazza
(Link also on eClass and course website)

Grading

Assessment	Weight	Date
Assignments (8, top 7 counted):	30% (4.29% each)	See the schedule tab on the course website
Midterm exam 1:	20%	Oct 8, 2024 in class (12:30pm - 1:50pm in CCIS 1-440)
Midterm exam 2:	20%	Nov 19, 2024 in class (12:30pm - 1:50pm in CCIS 1-440)
Final exam	30%	Dec 18, 2024 (8:30am), date and time are tentative

- At least 3 of the assignments will be coding assignments. We will be using Python in Google Colab.
- To do the assignments you will need: An internet connection, and a modern web browser (Chrome, Firefox, or Safari recommended).

Course Policies

- We will not accept late assignments
- If you are granted an excused absence for a midterm exam its weight will be transferred to the final exam
- All assignments must be written by you in your own words
- You can use AI (ex: LLMs) to **help you** with assignments
  - At the end of the assignment you must mention what you used AI for
  - You will not lose marks for using AI, unless you used AI to generate a complete solution for you
- No cheating, plagiarism, harassment, physical assault, etc.
  - Can result in suspension or expulsion from the University
  - Familiarize yourself with the new Student Academic Integrity Policy

Refer to the syllabus for detailed official course policies

Advice: If you can do the assignment questions and examples in the course notes,

then you are likely to succeed on the midterms and final exam

Disclaimer: This course is math heavy, and we do not cover neural networks

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However: Course notes are mostly self contained and I will try to motivate things as much as possible

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Necessary background: Can take derivatives (Calculus)

Useful background: Probability and statistics, familiar with vectors and matrices (Lin Alg)

Please ask questions!

Especially: “Why are we doing this?”

Course Outline

1. Math and probability review
2. Define supervised learning formally (splitting it into regression or classification)
3. Design some learning programs to solve regression problems

   Midterm Exam 1
4. Evaluate our learning programs
5. Present some new ways to design learning programs for regression

   Midterm Exam 2
6. Repeat the above for classification problems
7. Brief intro to language models (if time permits)

   Final Exam (Cumulative)

What is Machine Learning?

What is Machine Learning?

Remaining slides are inspired by: Shai Ben-David (Lecture 1 - CS 485/685)

Raise your hand if you think you know what Machine Learning is

Raise your hand if you learned about machine learning before

(ex: taken a course, watched videos, etc.)

Raise your hand if you've heard of:

Raise your hand if you use:

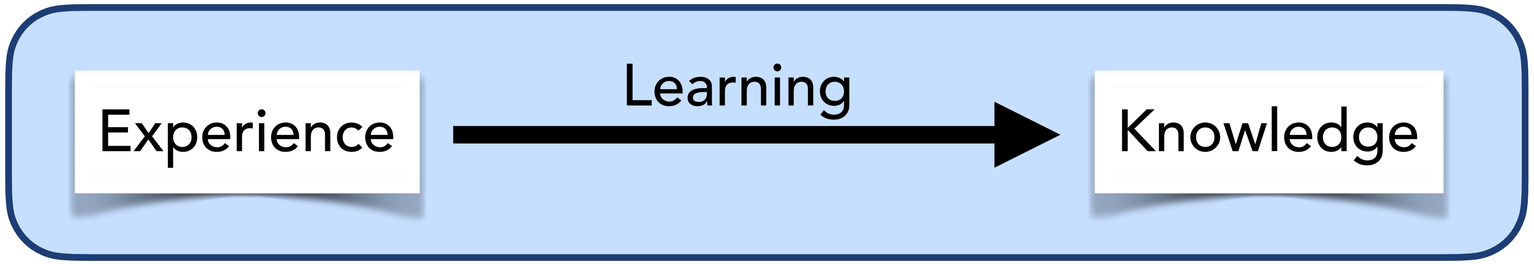
Raise your hand if you think Machine Learning is exciting

What is Machine Learning?

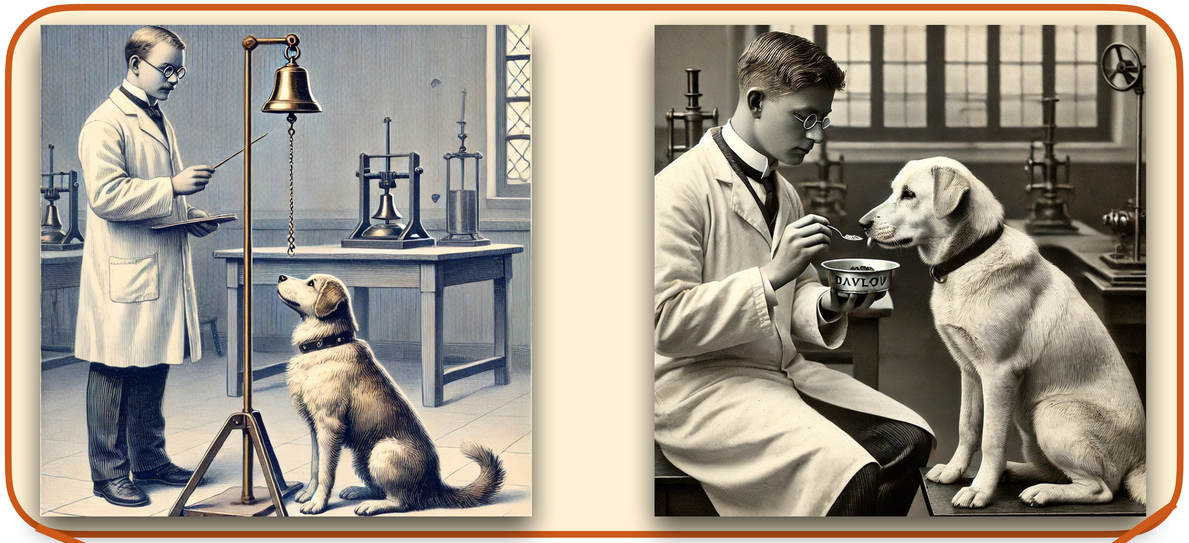
What is Machine Learning?

Answer: A program/algorithm that is learning

What is Learning?


Experience
Learning
Knowledge

Example: Pavlov's Dog



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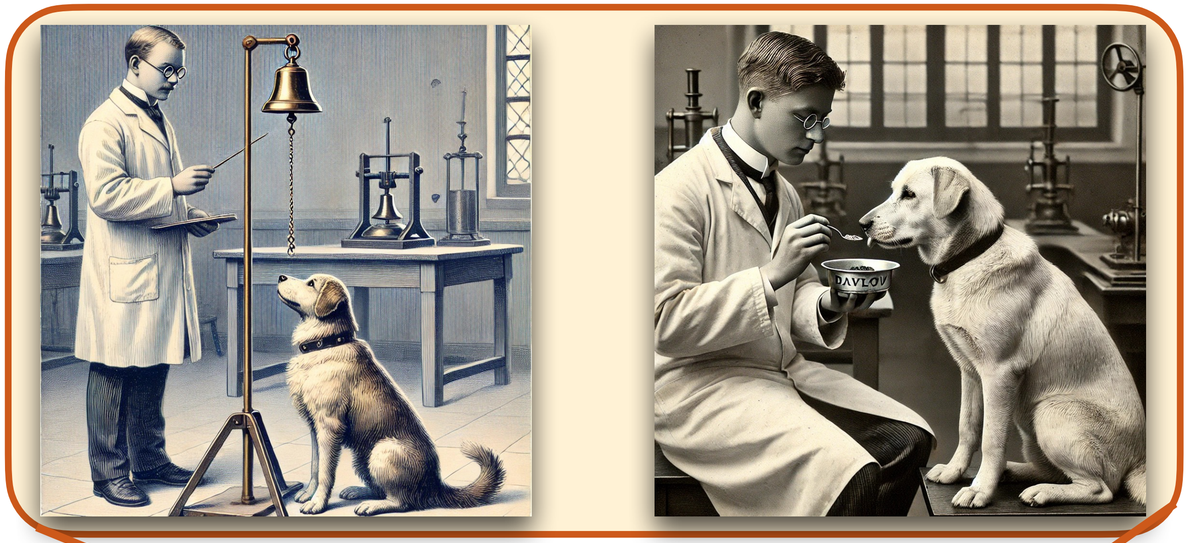
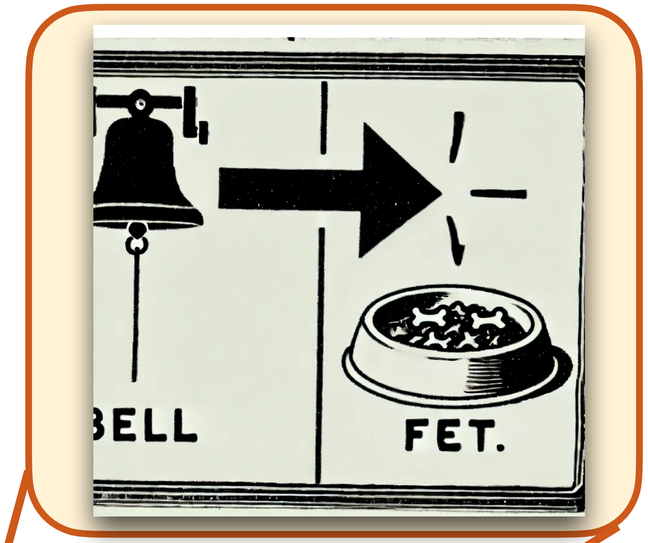
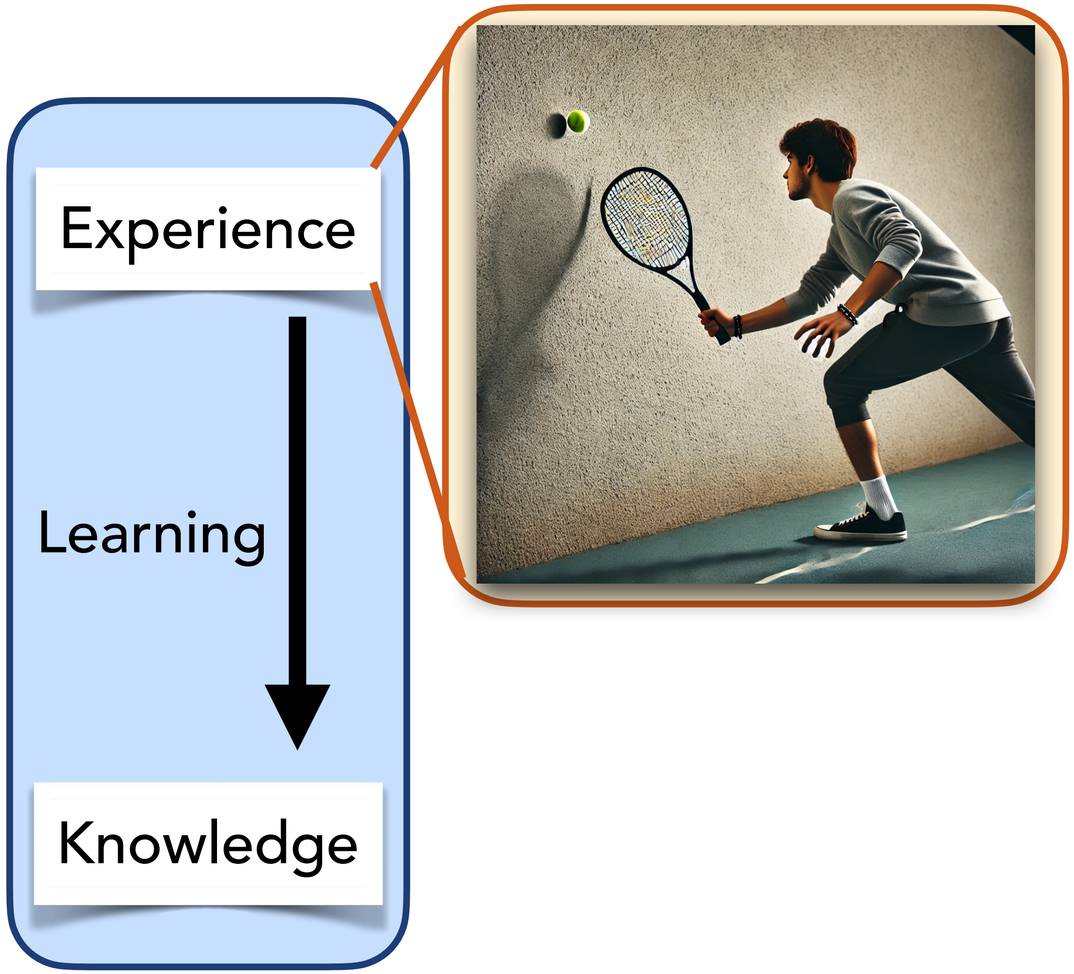




Experience → Learning → Knowledge

Example: Learning to Play Tennis



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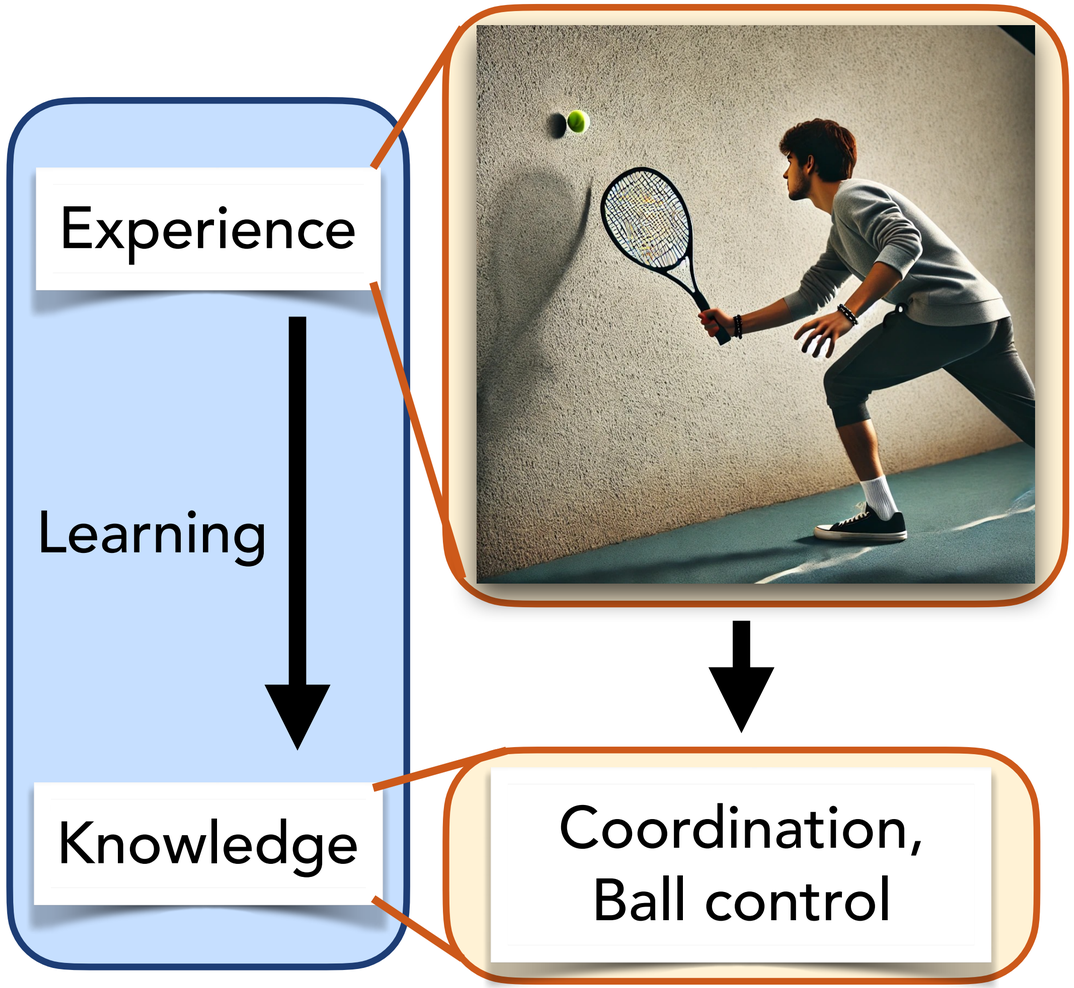

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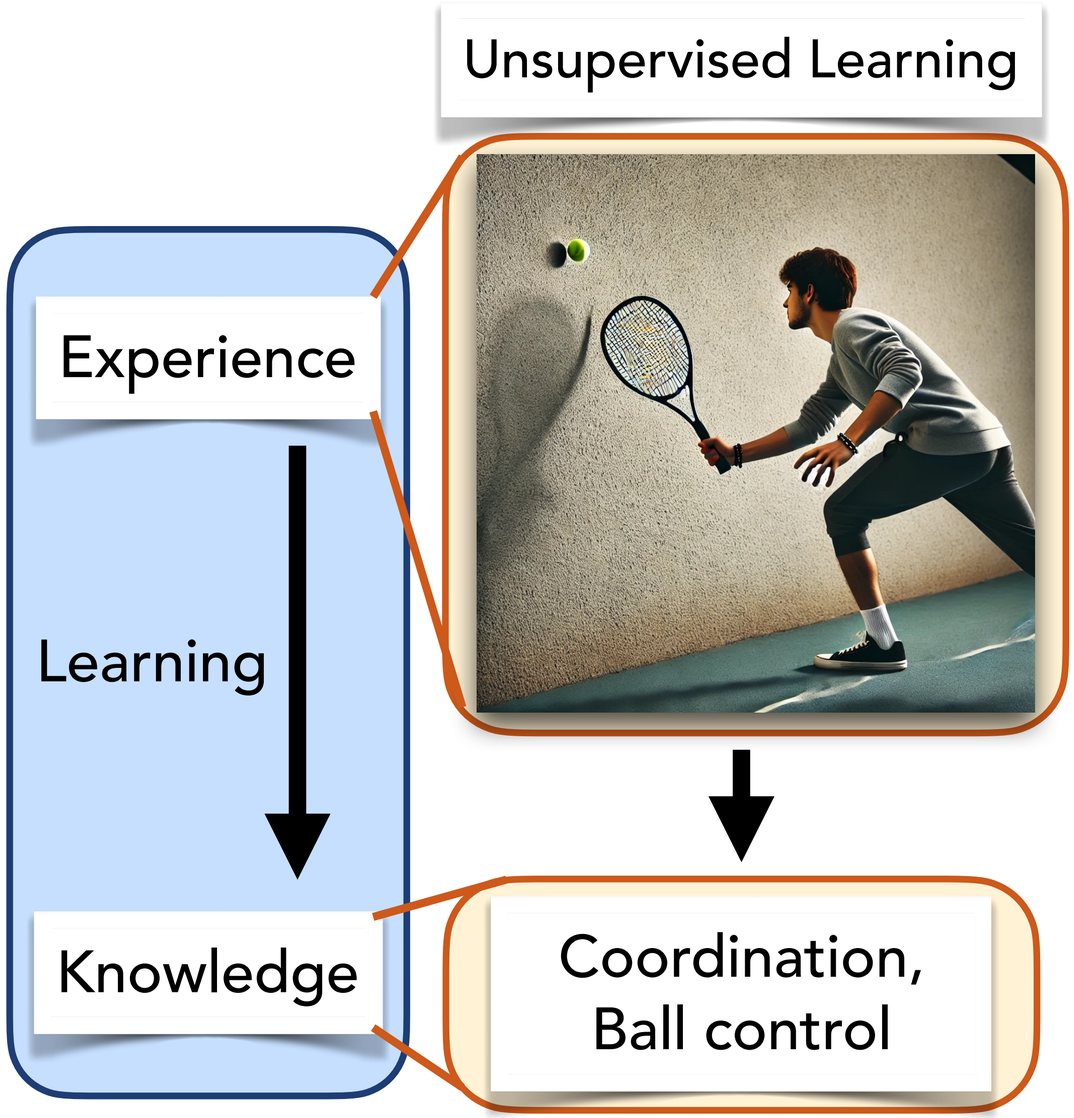

Example: Learning to Play Tennis

Unsupervised Learning

Experience

Learning

Knowledge

Coordination,
Ball control

Example: Learning to Play Tennis

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How to play

Reinforcement Learning

How to play

Example: Learning Language

Experience

Learning

Knowledge

Example: Learning Language

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ChatGPT

Example: Learning Language

Offline (Batch) Learning

Experience

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Knowledge

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Example: Learning Language

Offline (Batch) Learning

Online Learning

Experience

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Knowledge

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Example: Games

Experience

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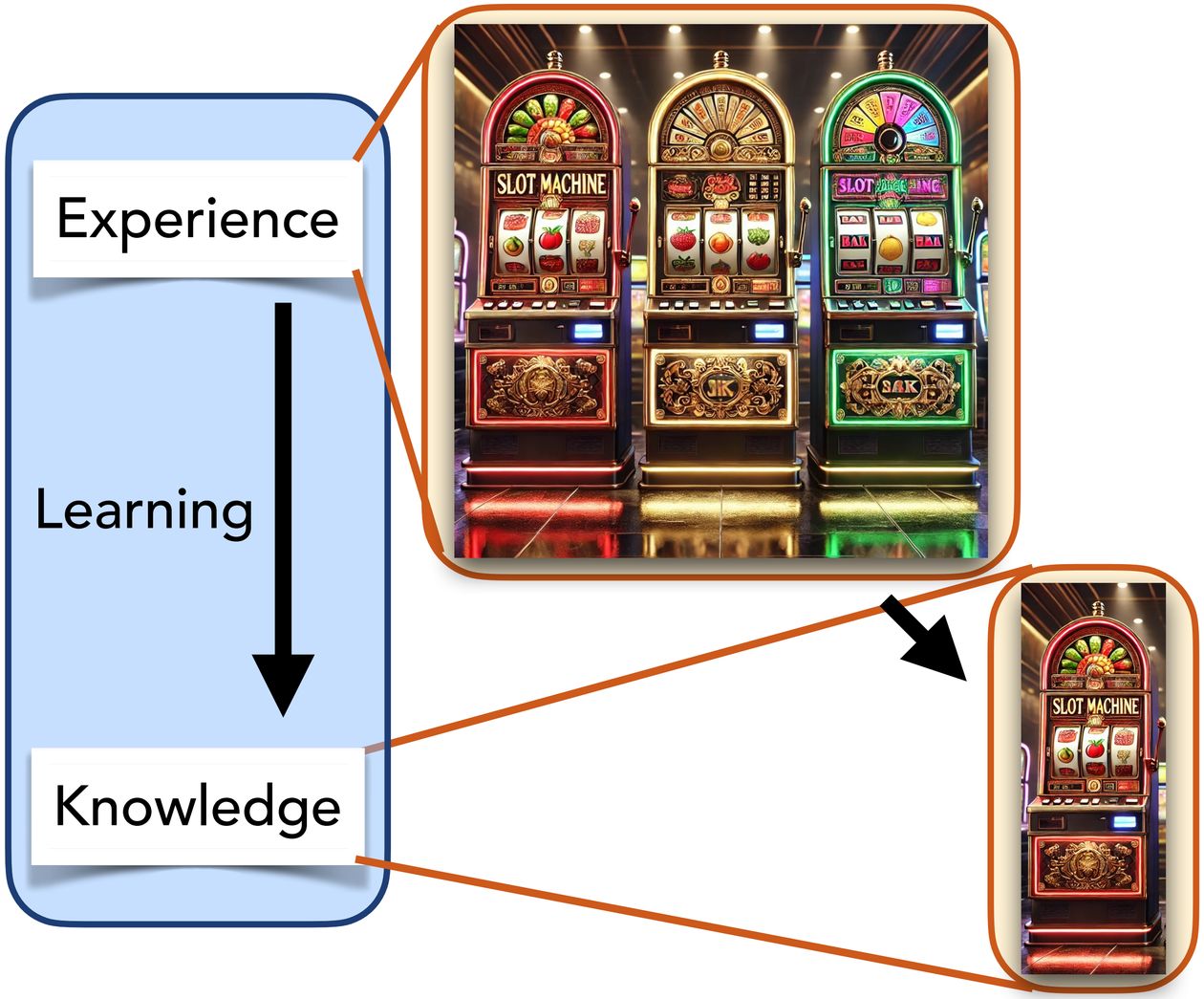
Example: Games



Example: Games

Stochastic Learning

Experience

Learning

Knowledge

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Experience

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Stochastic Learning

Experience

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Example: Games

Stochastic Learning

Adversarial Learning

Experience

Learning

Knowledge

Different Kinds of Learning

Unsupervised Learning

Supervised Learning

Reinforcement Learning

Offline (Batch) Learning

Online Learning

Stochastic Learning

Adversarial Learning

What we Will Cover

Unsupervised Learning

Supervised Learning

Reinforcement Learning

Offline (Batch) Learning

Online Learning

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Adversarial Learning

Supervised, Offline, Stochastic Learning

What we Will Cover

Unsupervised Learning

Supervised Learning

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Supervised Learning = Supervised, Offline, Stochastic Learning

What we Will Cover

Unsupervised Learning

Supervised Learning

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Online Learning

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Adversarial Learning

Supervised Learning = Learning from a **batch** of **labeled** randomly **selected** experience

Example: Spam Detector

Spam Detector

Experience → Learning → Knowledge

Supervised Learning = Learning from a **batch** of **labeled** randomly selected experience

Why are machines (programs) that learn useful?

(instead of just having humans)

Why are Programs Useful?

Programs can perform computations much more efficiently than humans

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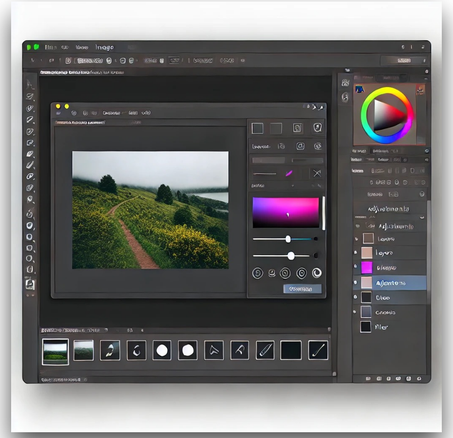

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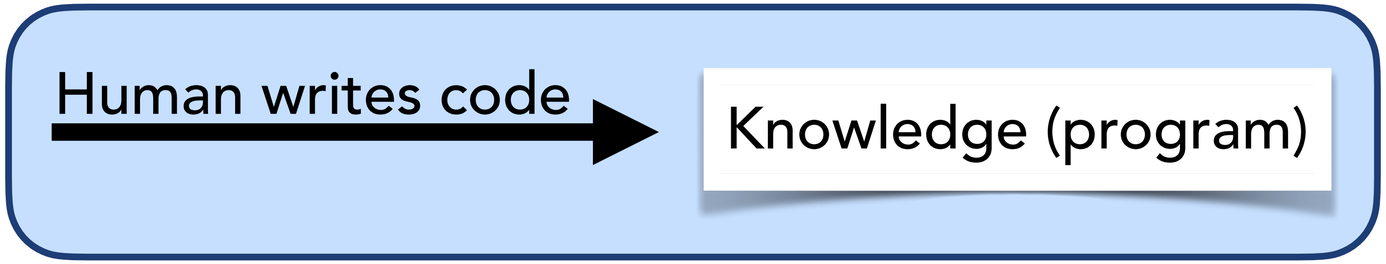
- etc.

Classic Programs



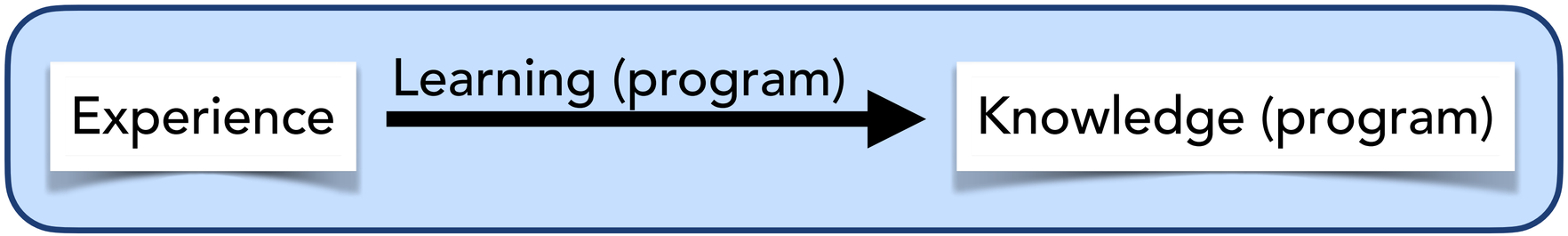
Classic Programs

Example: A human writes a calculator program.

Human writes code

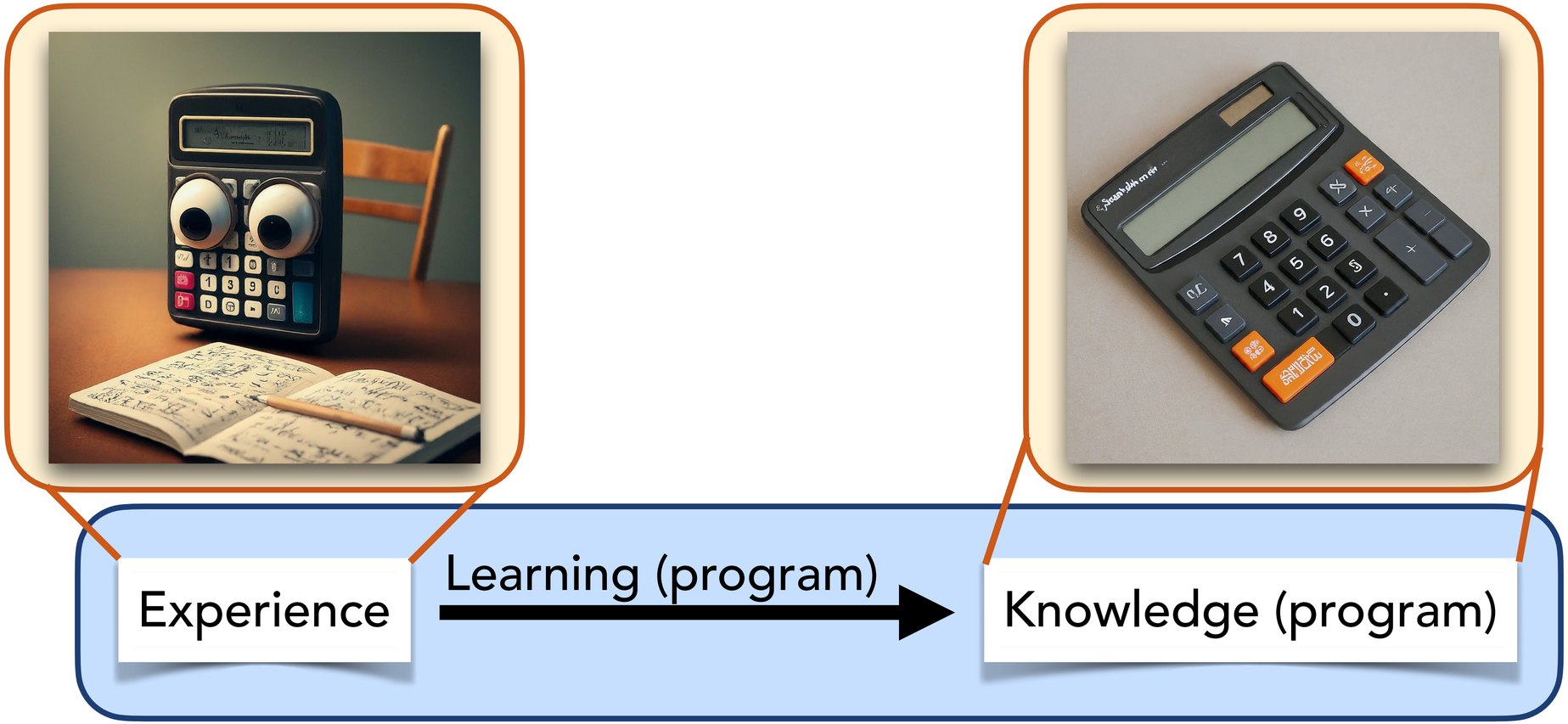
Knowledge (program)

Programs that Learn



Programs that Learn

Example: A calculator learns addition by seeing examples of numbers being added together.



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All of the images in this presentation were generated by

ChatGPT

hat Learn Useful?

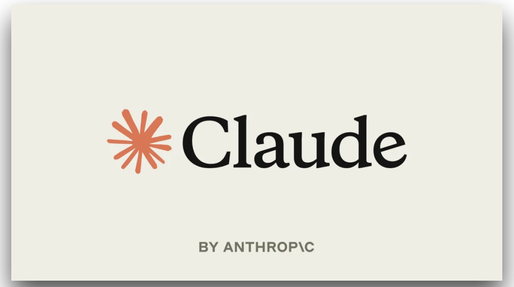
1. 

:”

- Object detection: stop sign, pedestrian, red light, green light, etc.

Why are Programs that Learn Useful?

More examples:



- Chatbot (LLMs: ChatGPT, Claude, Gemini, etc.)

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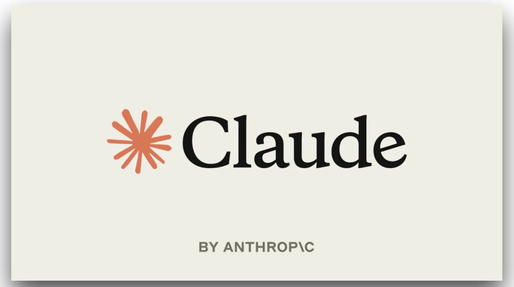
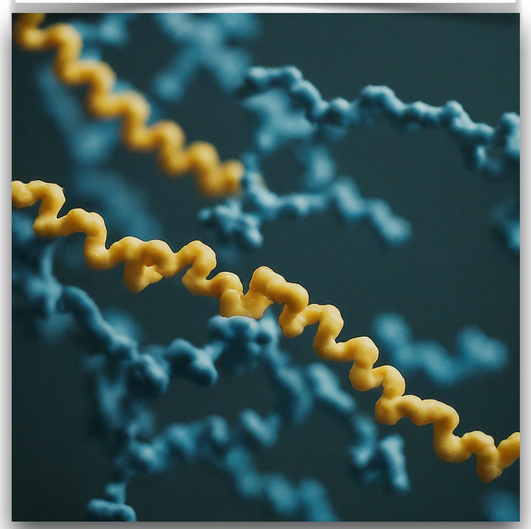
More examples:

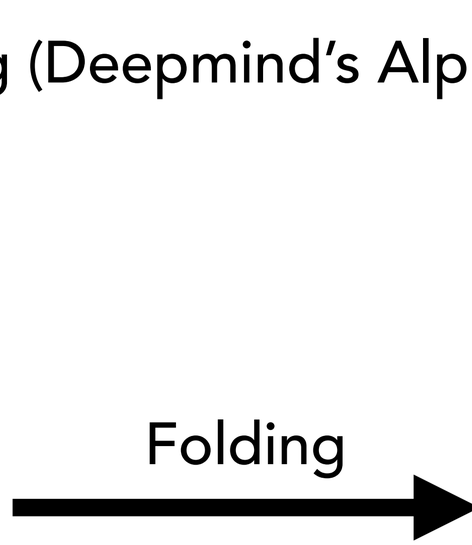


- Chatbot (LLMs: ChatGPT, Claude, Gemini, etc.)
- Discovery: Predicting protein folding (Deepmind's Alphafold).

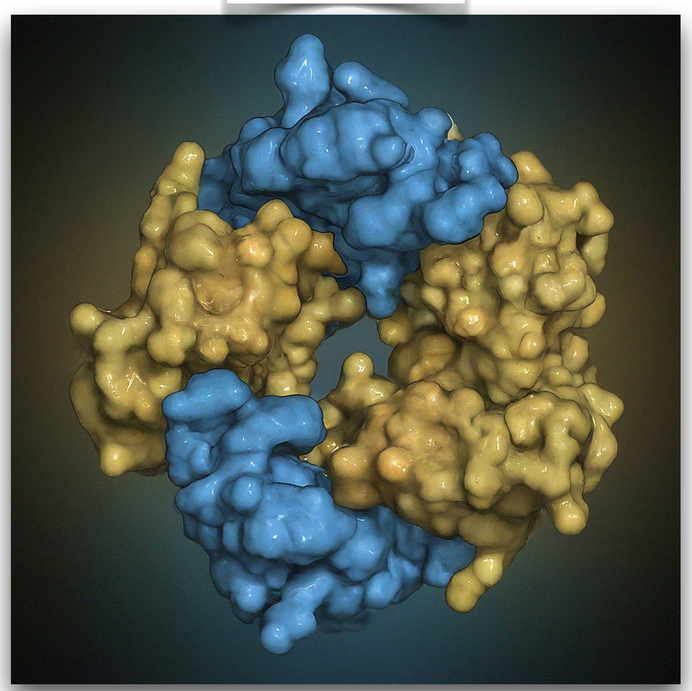
Amino acid chain



Folding



Protein



Why are Programs that Learn Useful?

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   Example:

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Day time

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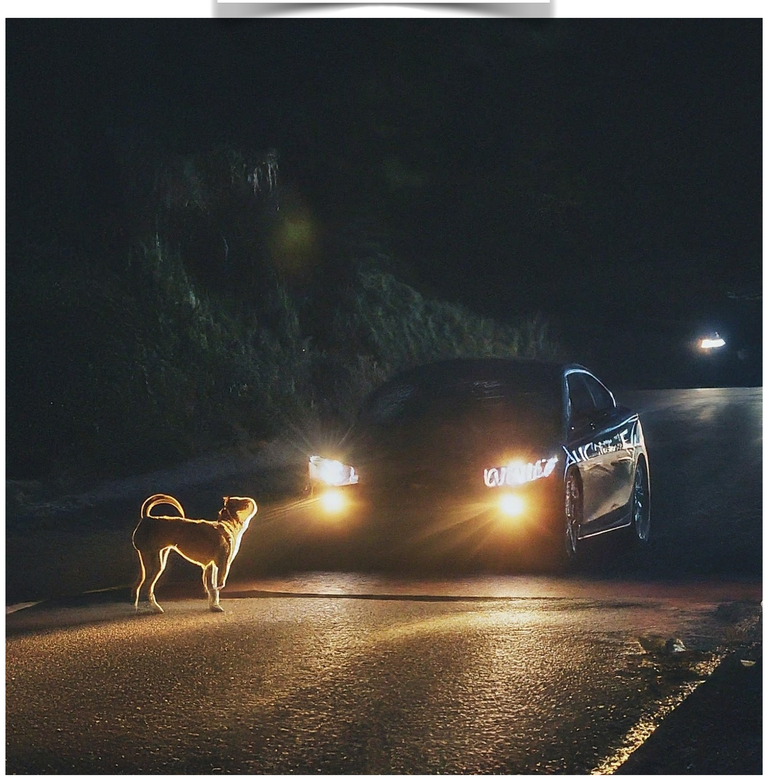


What will you learn in this course?

What we Will Cover

Unsupervised Learning

Supervised Learning

Reinforcement Learning

Offline (Batch) Learning

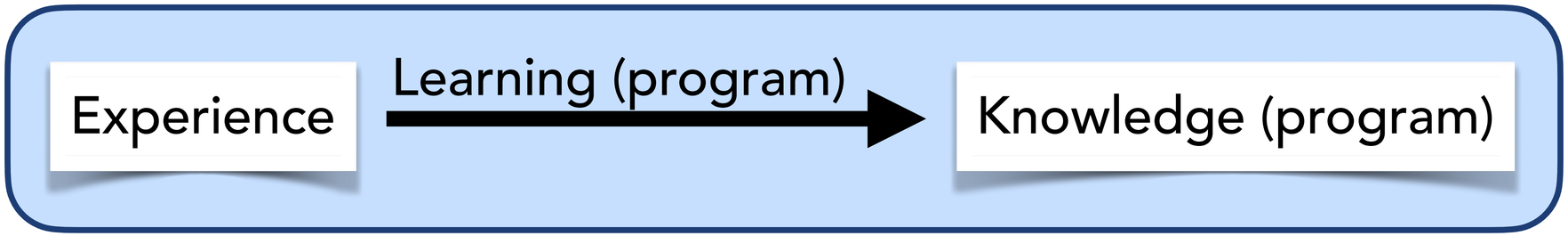
Online Learning

Stochastic Learning

Adversarial Learning

Supervised Learning = Learning from a **batch** of **labeled** randomly **selected** experience

You will learn to write a program that learns



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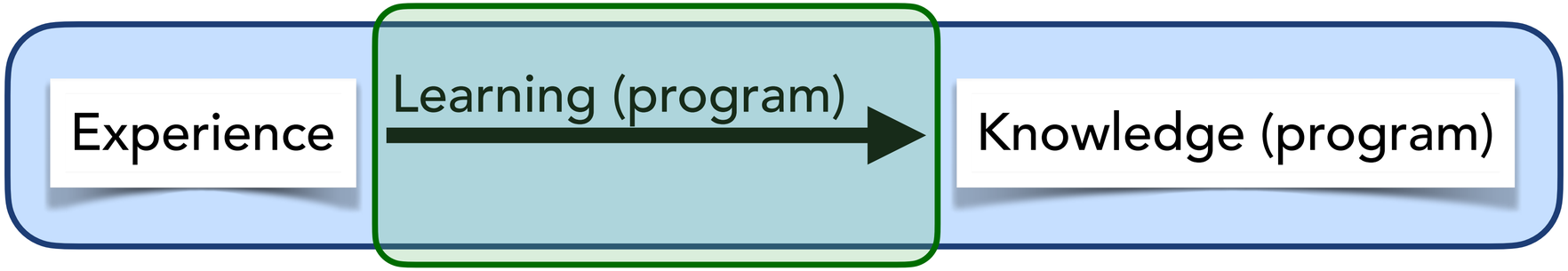

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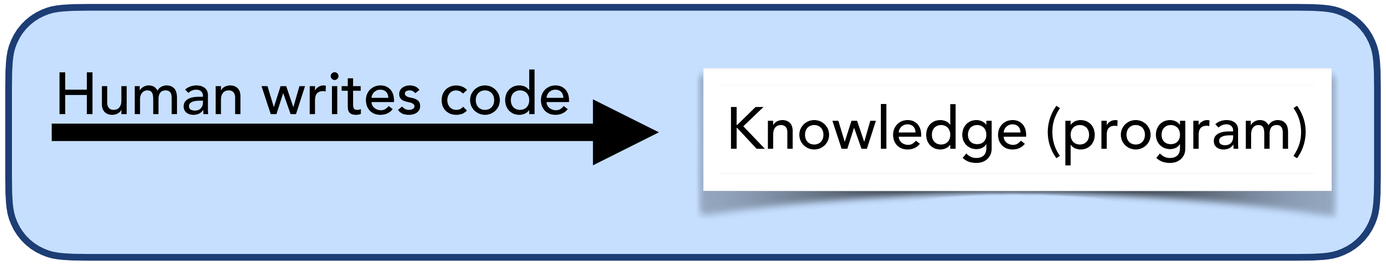

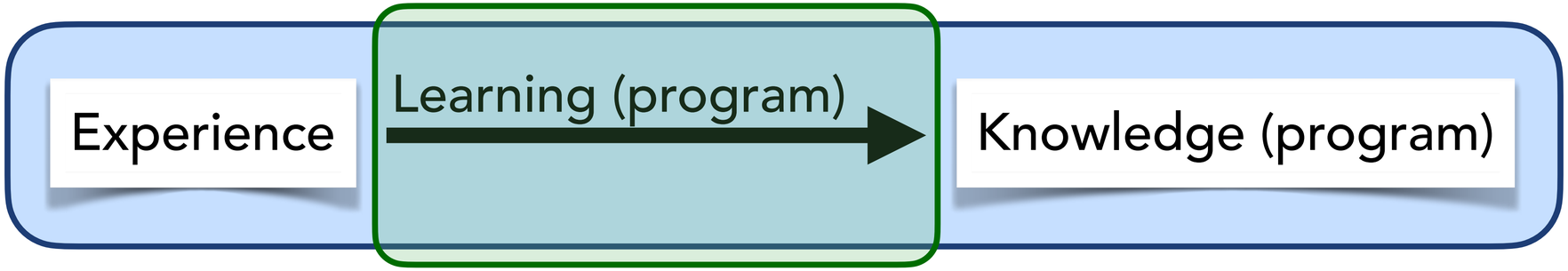

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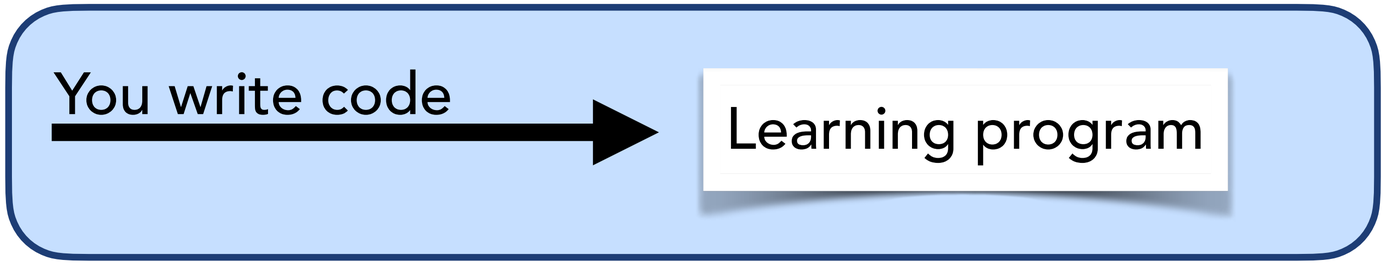

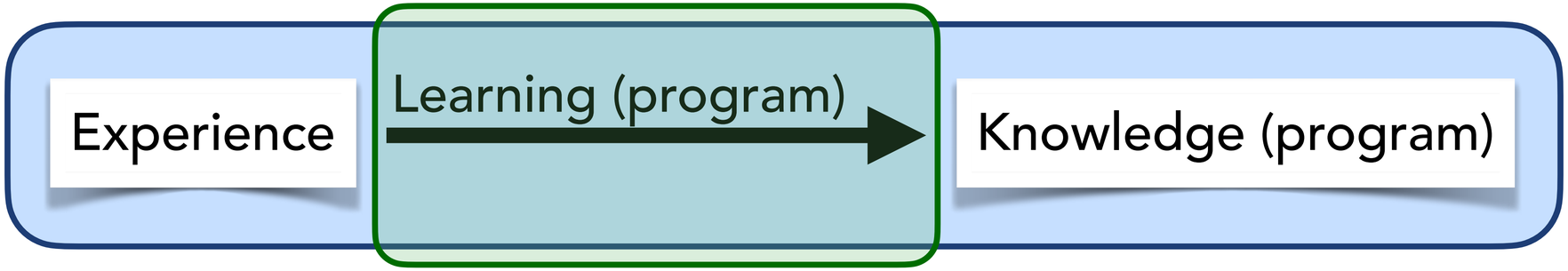

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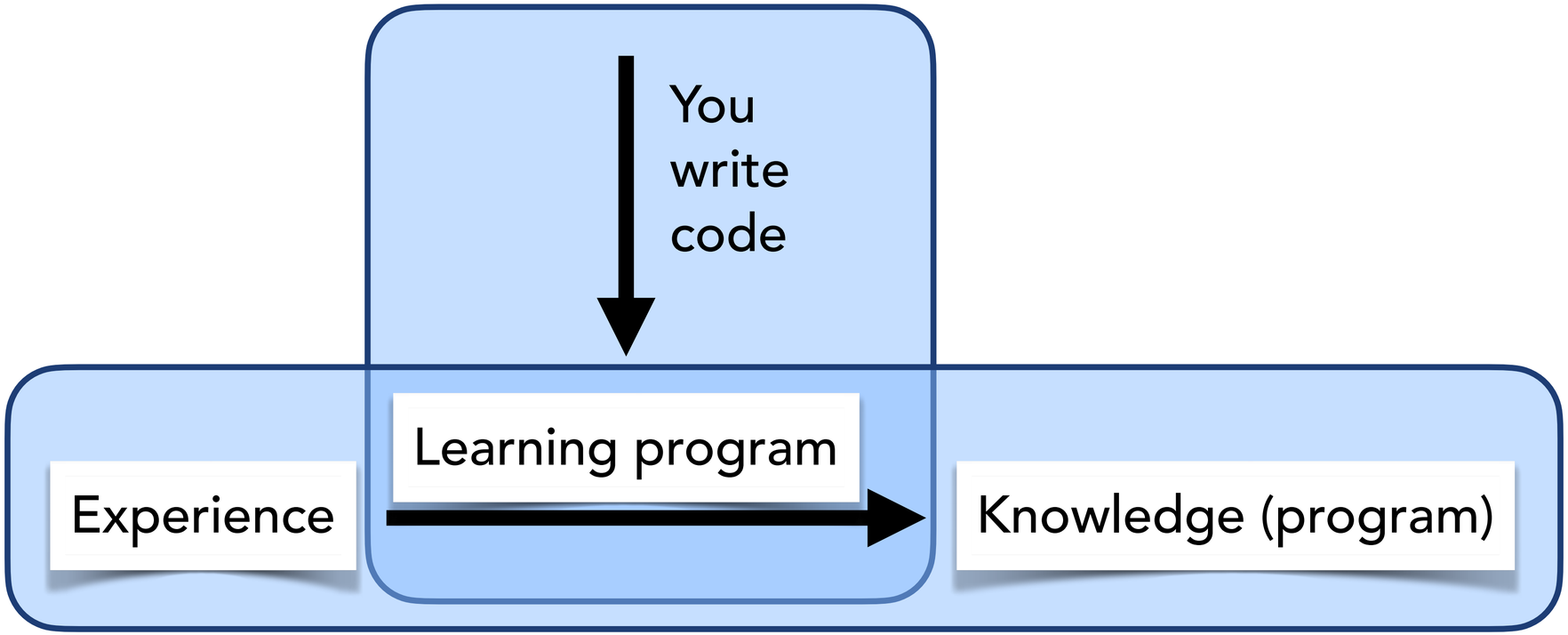

Examples of what that looks like

Example: Predicting House Prices Based on # of Rooms

# Of Rooms	Price
2	$200k
4	$590k
3	$350k
7	$970k

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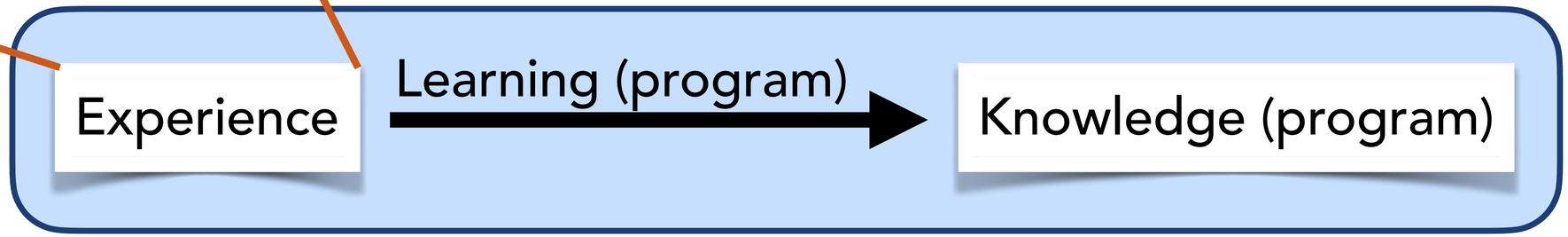

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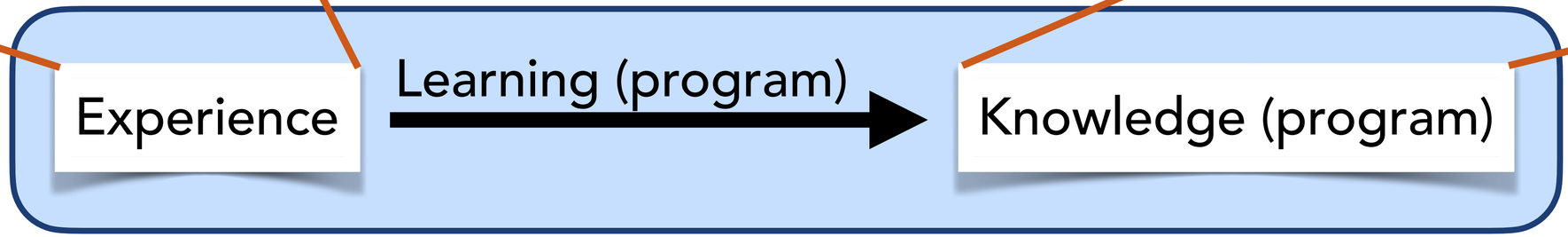
Prediction function f :

Input: # of rooms

Output: price

Example: $f(5) = \$700k$



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Write a Learning program that outputs a predictor f,

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Supervised Learning = Learning from a batch of labeled randomly selected experience

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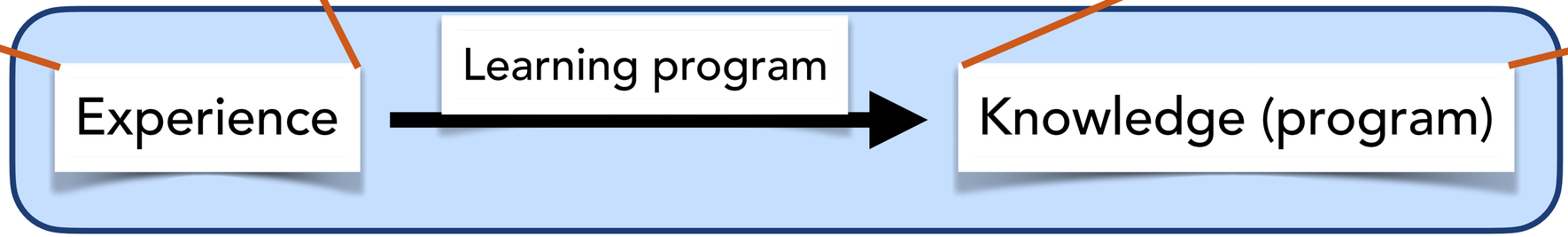

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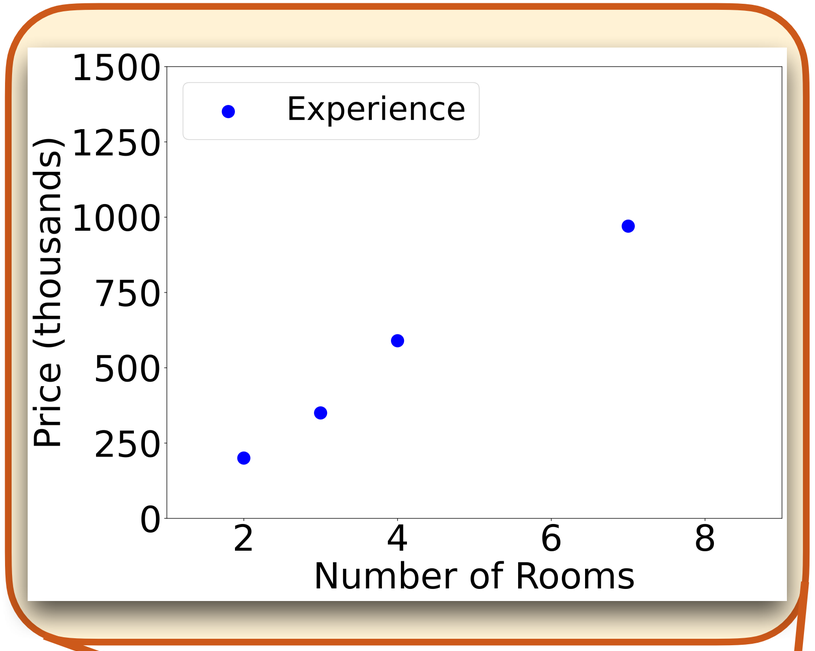

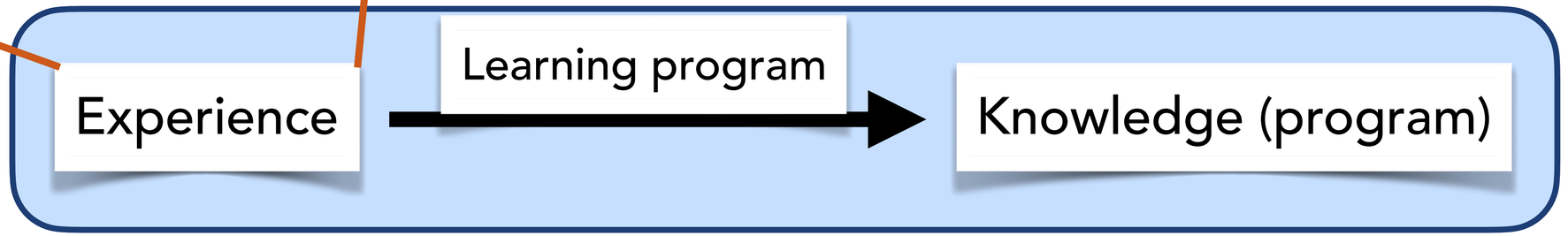

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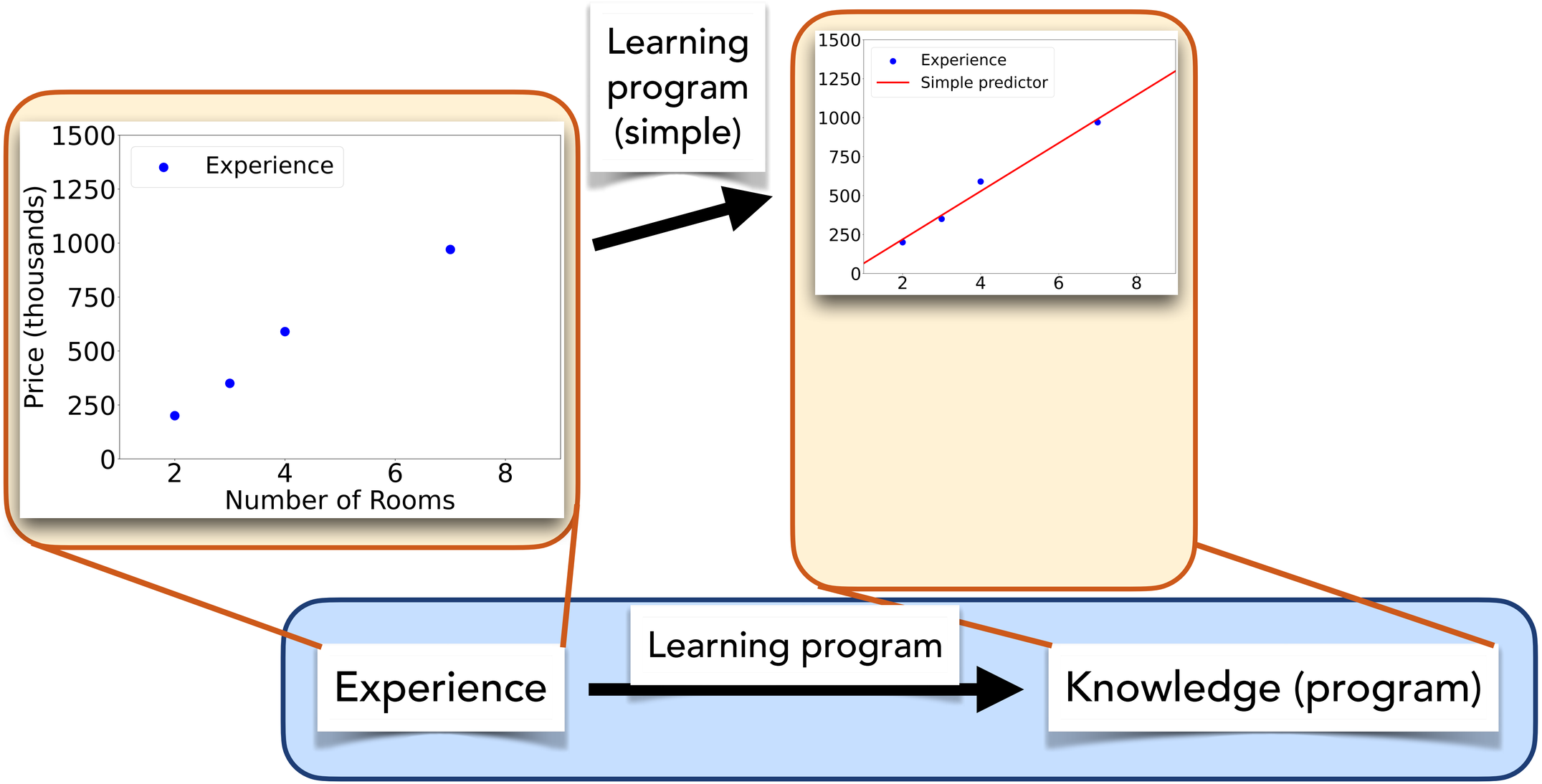

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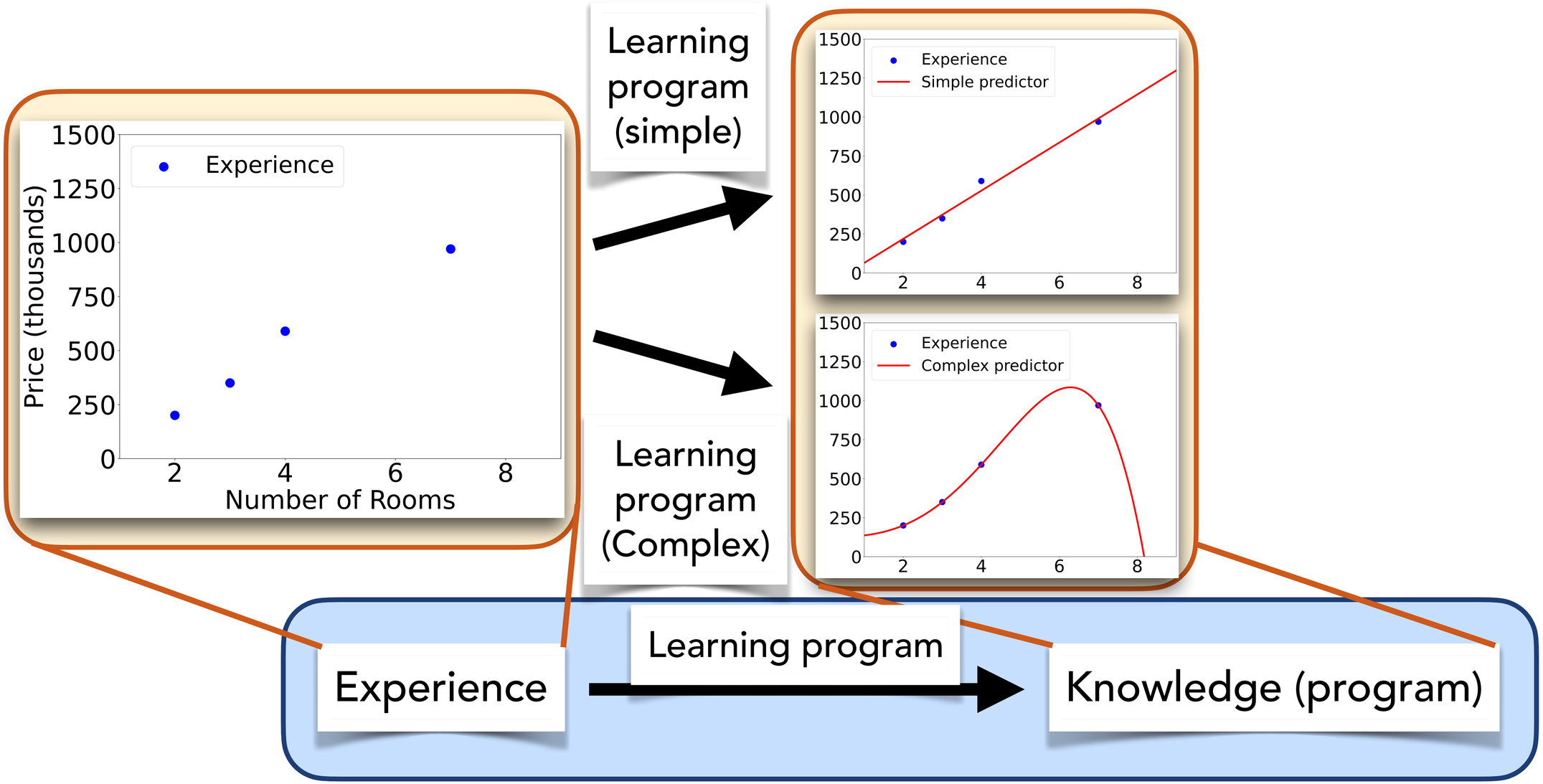

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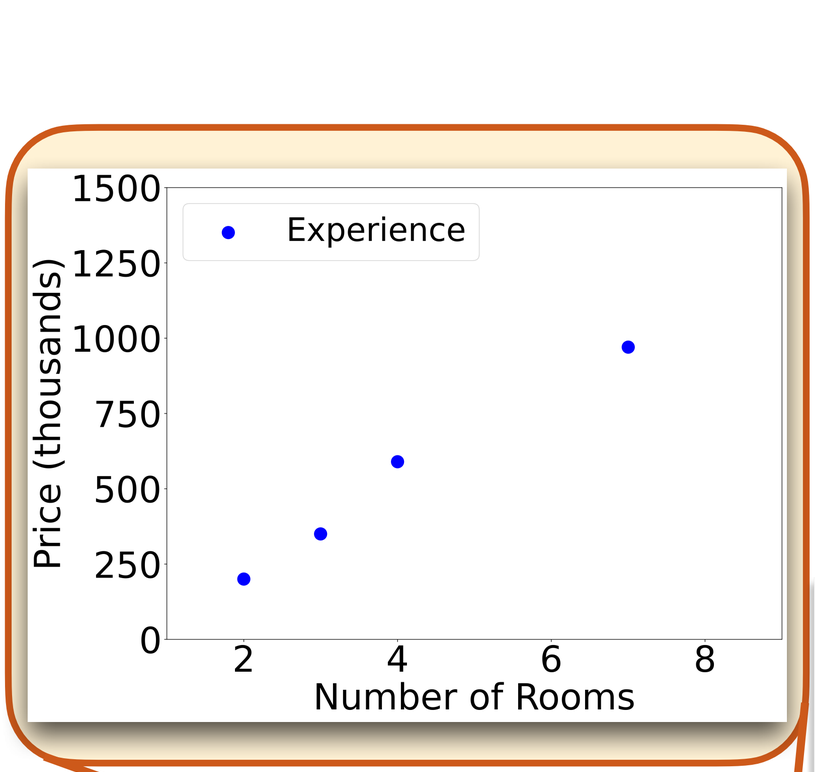
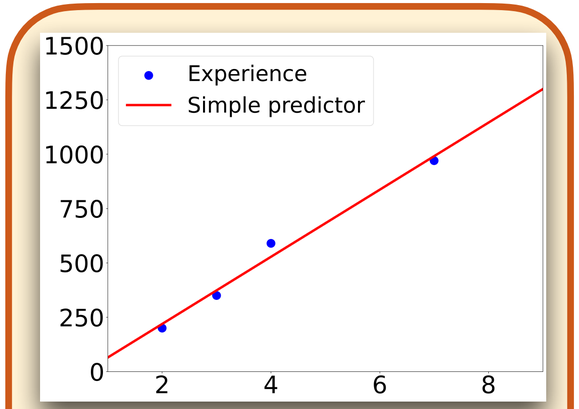
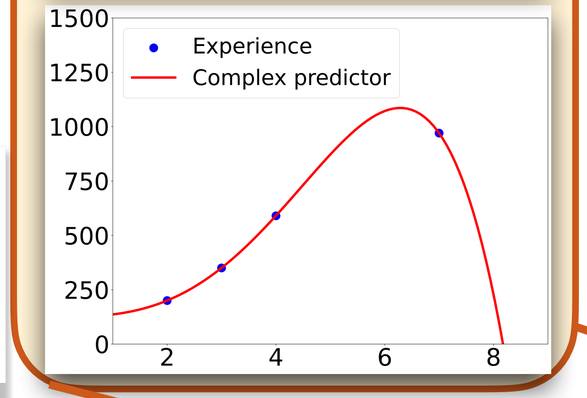


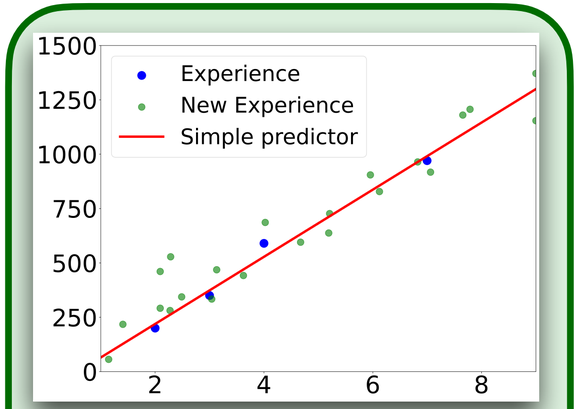
Learning program (simple)



Learning program (Complex)



New Experience

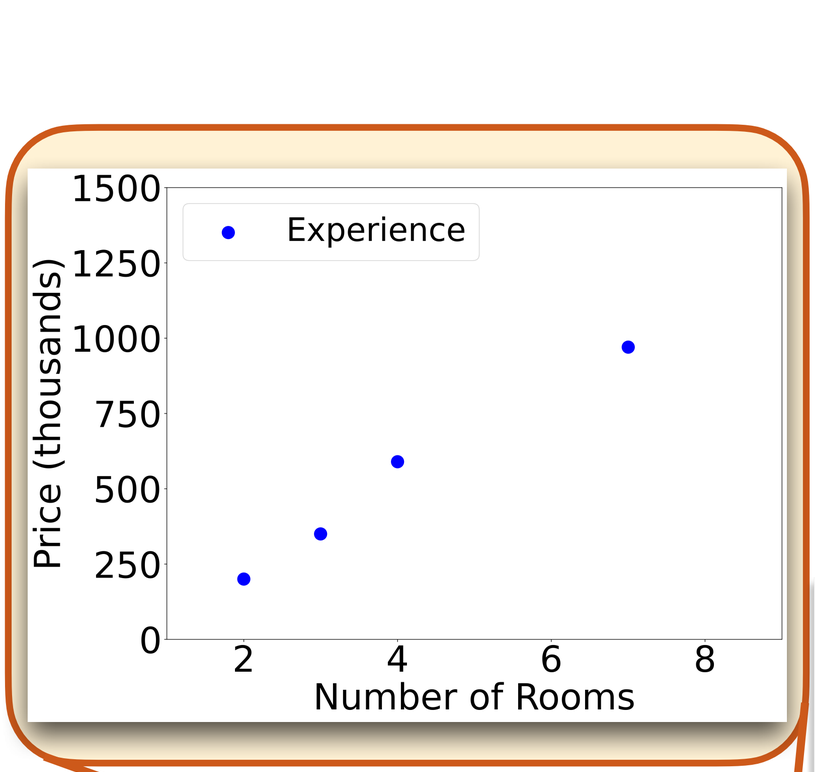


Experience

Learning program

Knowledge (program)

Example: Predicting House Prices Based on # of Rooms



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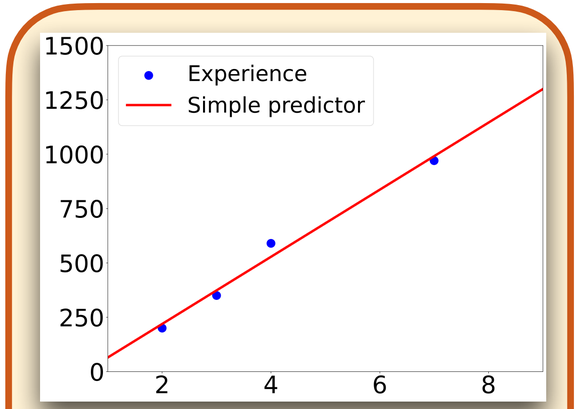
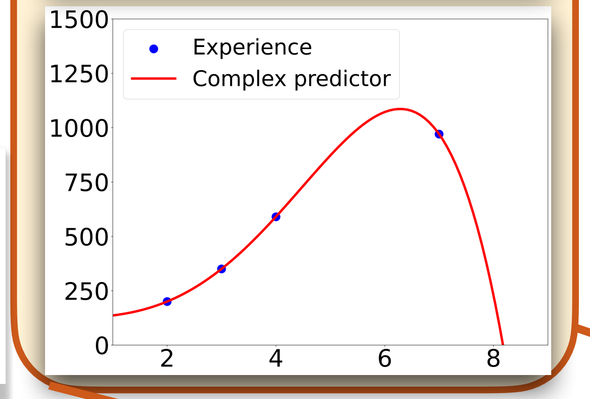


Learning program (Complex)



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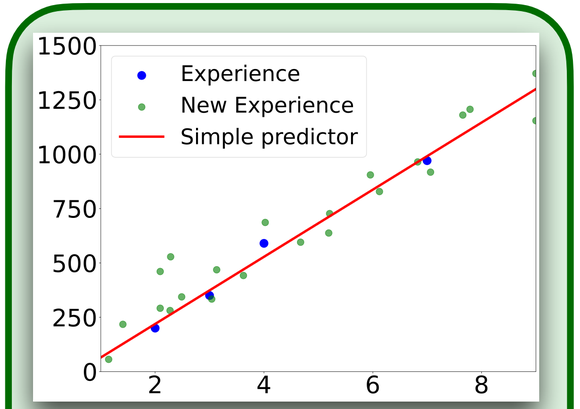
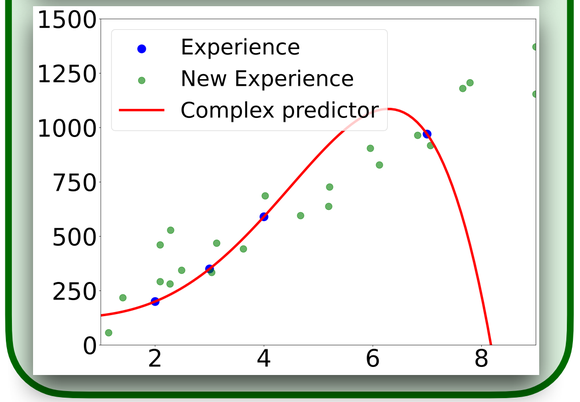




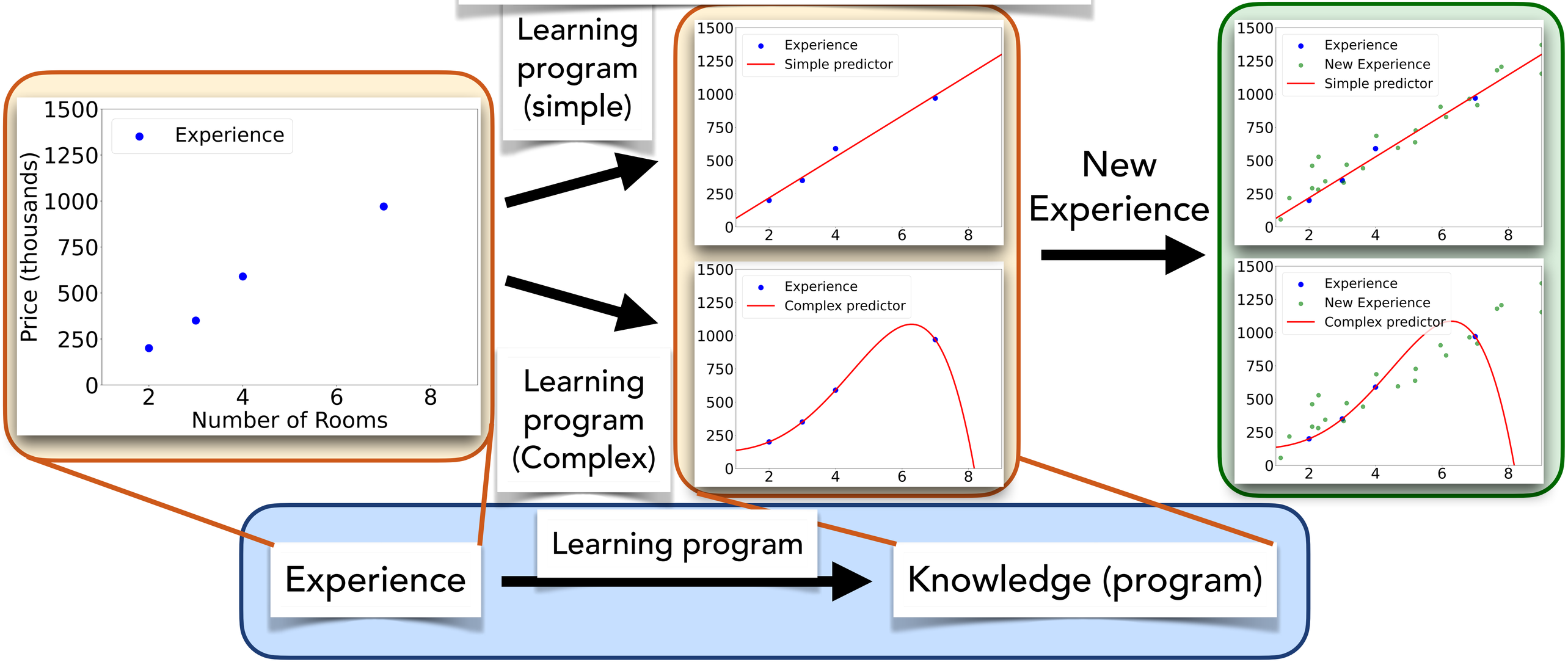
Experience

Learning program

Knowledge (program)

Example: Pred … on # of Rooms

Complex predictor is a Neural Network



Example: Classifying Wine Based on Chemical Properties

Proline	Flavanoid	Type
2.3	3.4	Barolo
1.6	0.8	Not Barolo
⋮	⋮	⋮
2.8	3.5	Barolo

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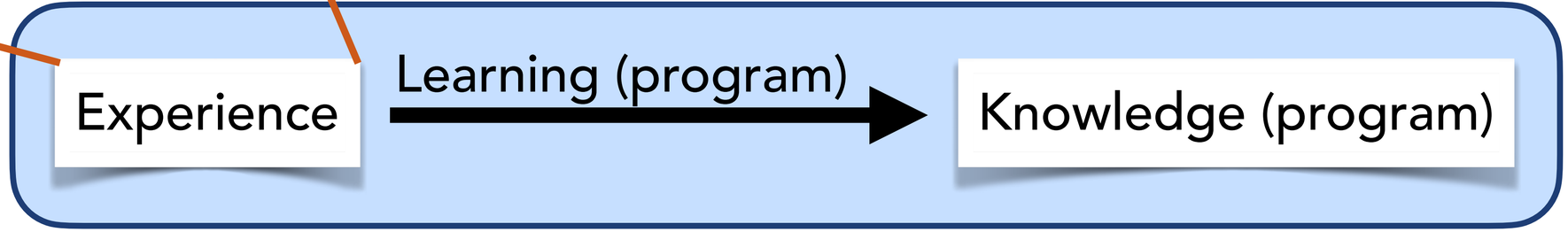

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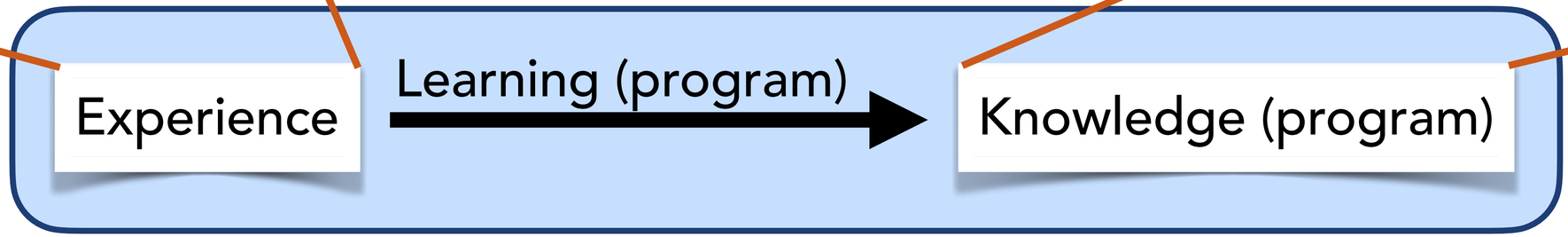
Prediction function f :

Input: Proline, Flavanoid

Output: Type of wine

Example: $f(3,3) =$ Barolo



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Objective:

Write a Learning program that outputs a predictor f,

such that, f can predict the type of any unseen wine

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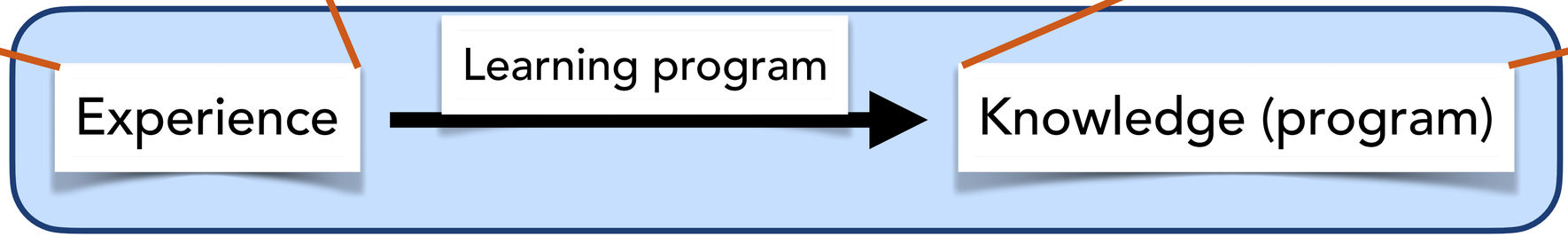

Supervised Learning = Learning from a **batch** of **labeled** randomly **selected** experience

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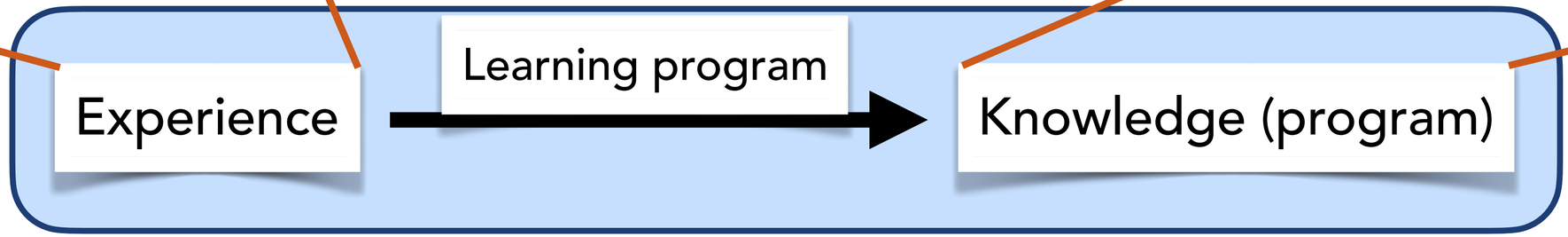

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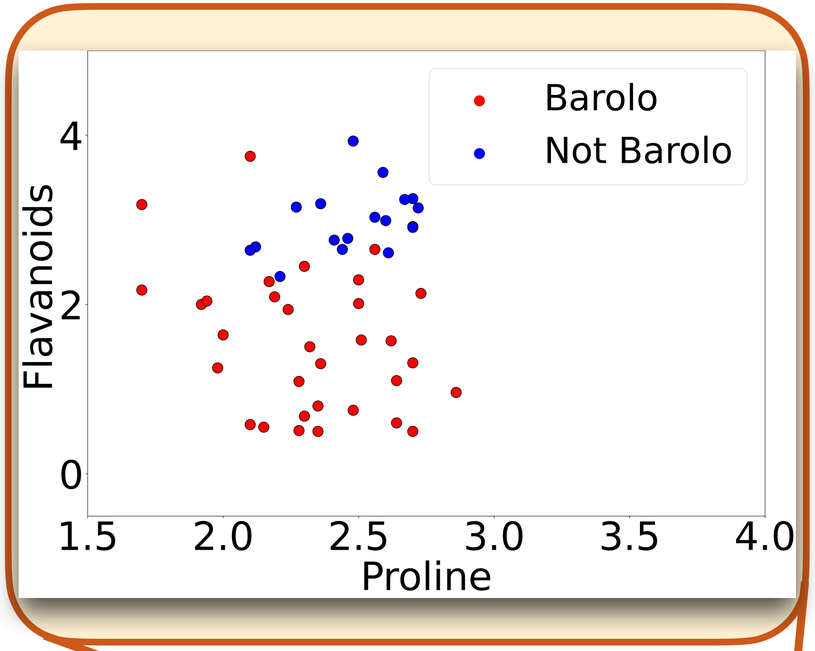

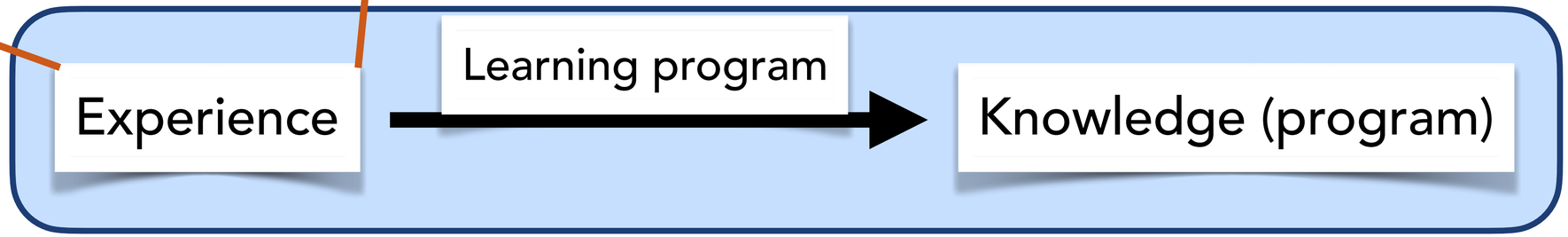

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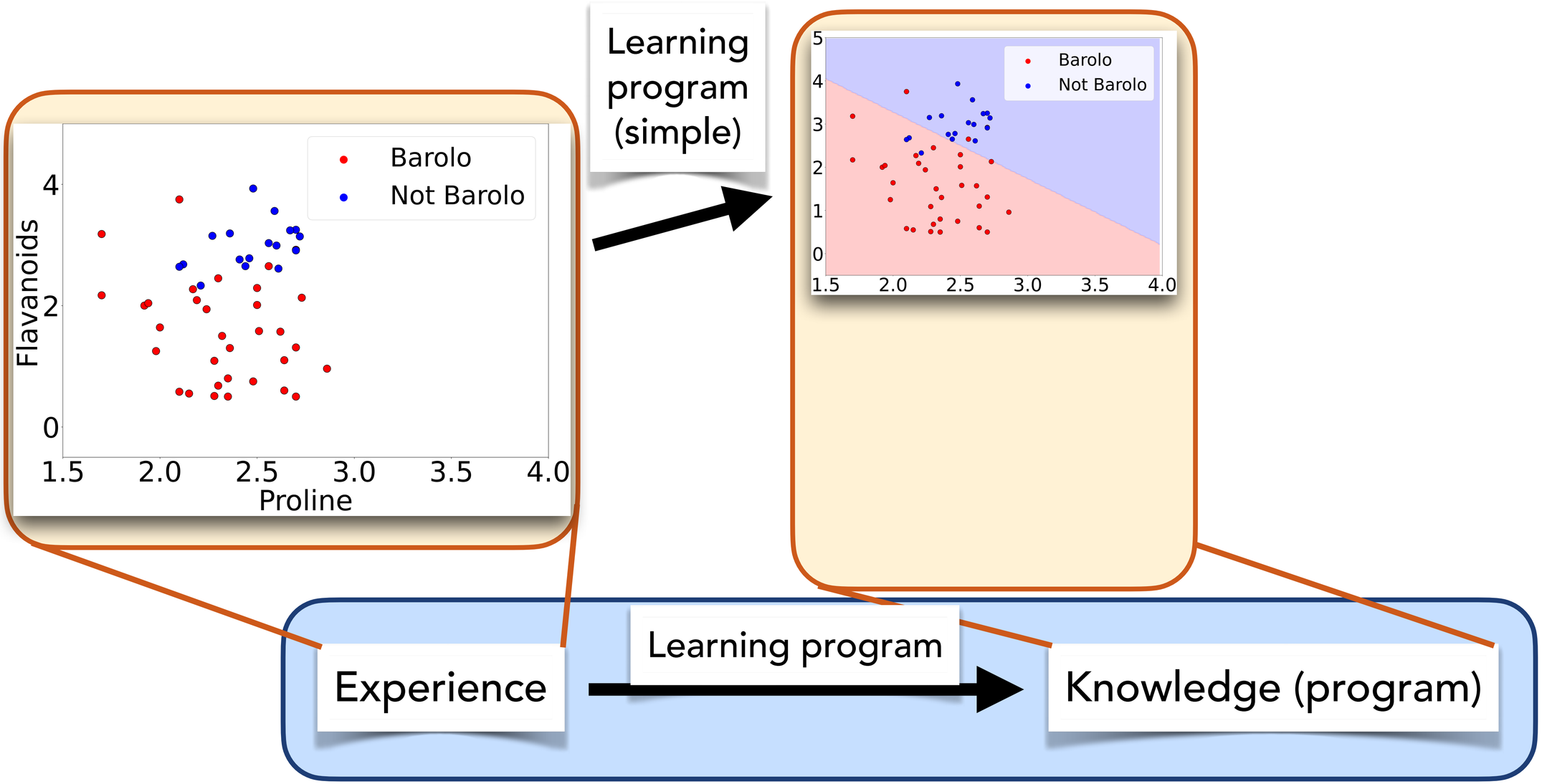

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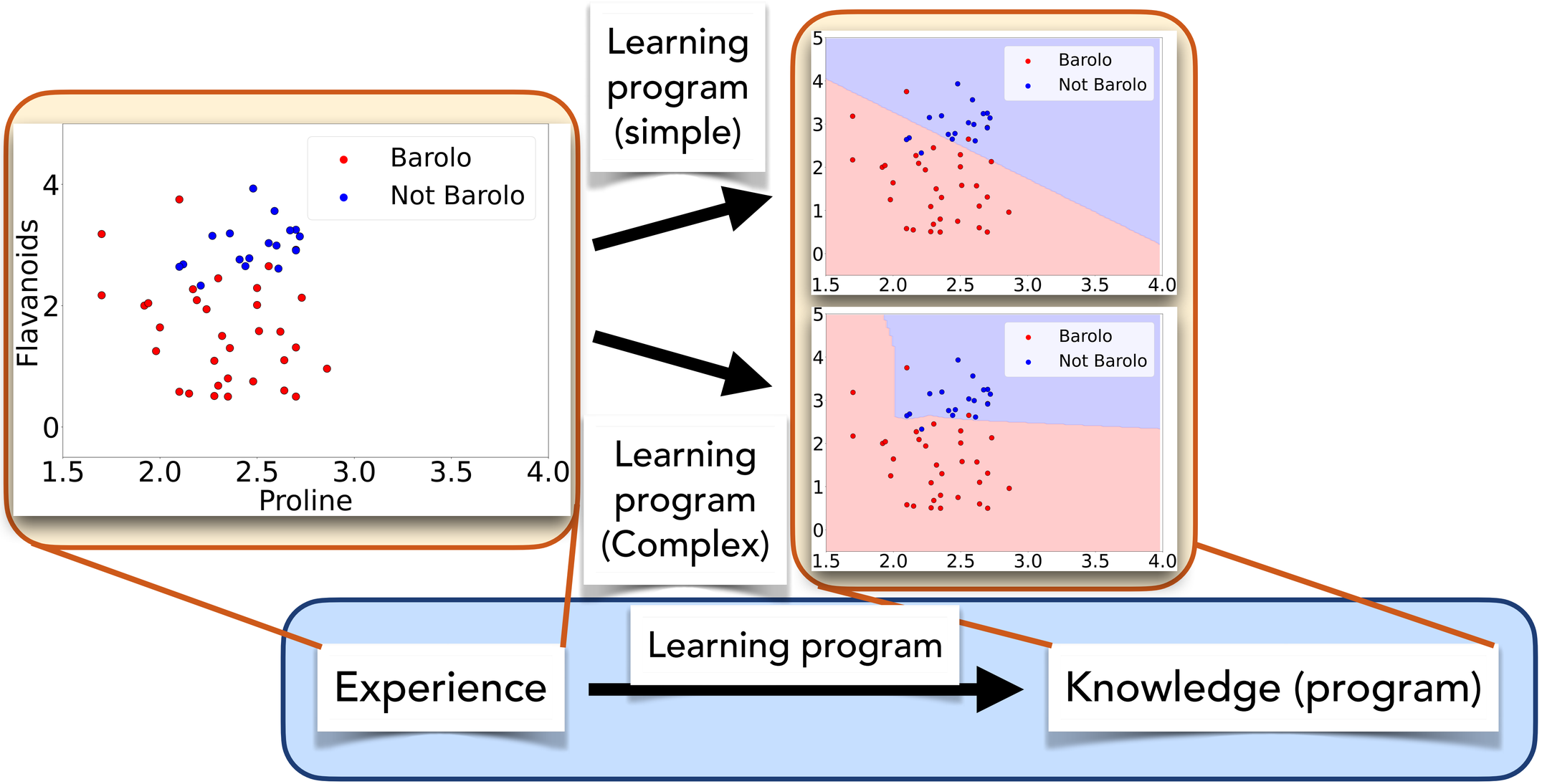
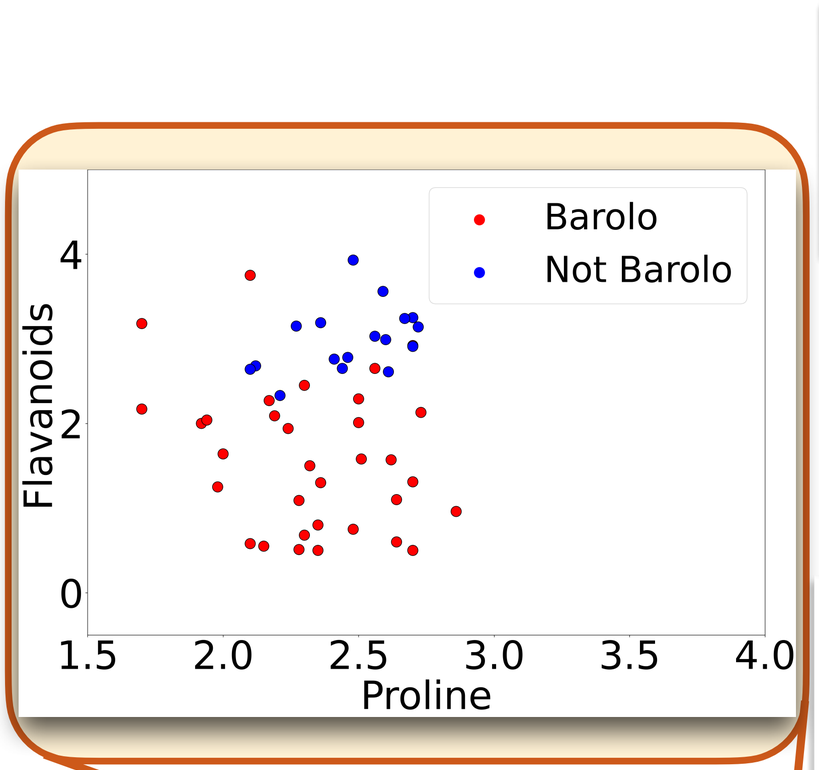
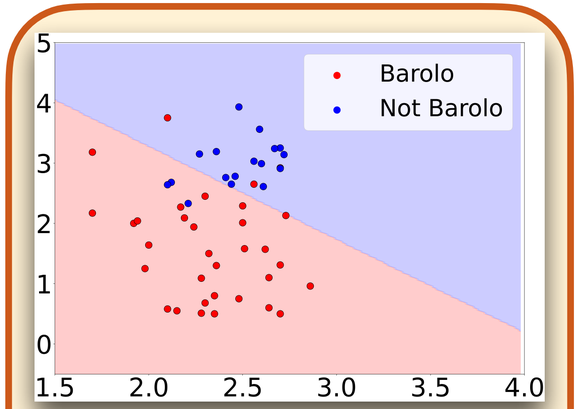


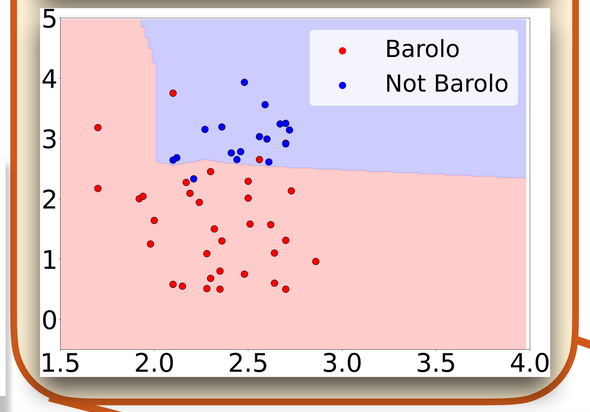
Example: Classifying Wine Based on Chemical Properties



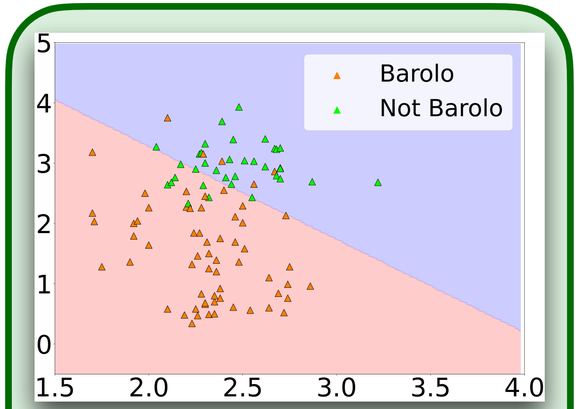
Learning program (simple)



Learning program (Complex)



New Experience

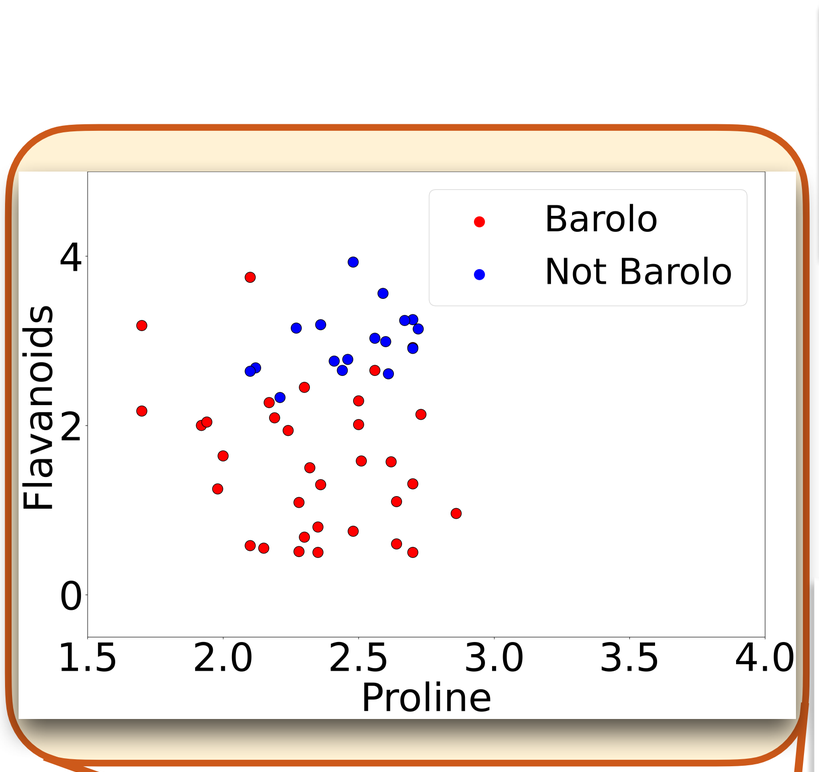


Experience

Learning program

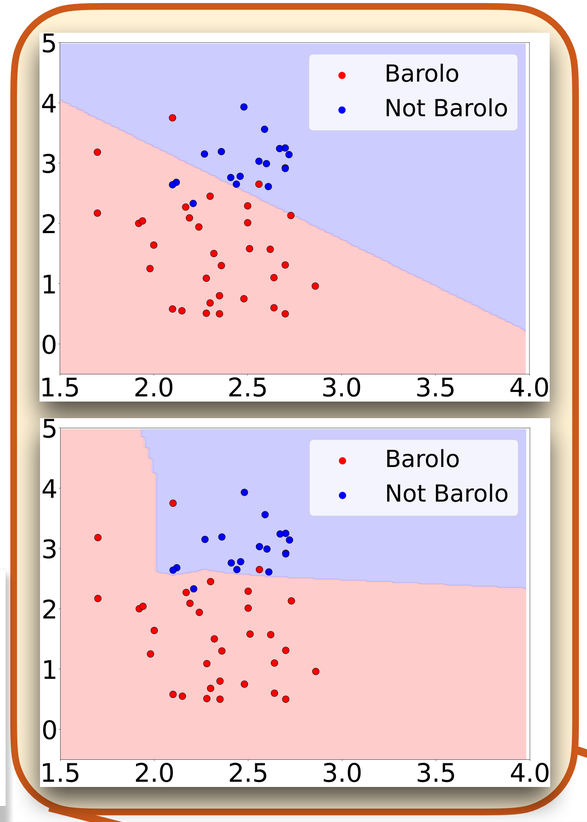
Knowledge (program)

Example: Classifying Wine Based on Chemical Properties



Learning program (simple)

Learning program (Complex)



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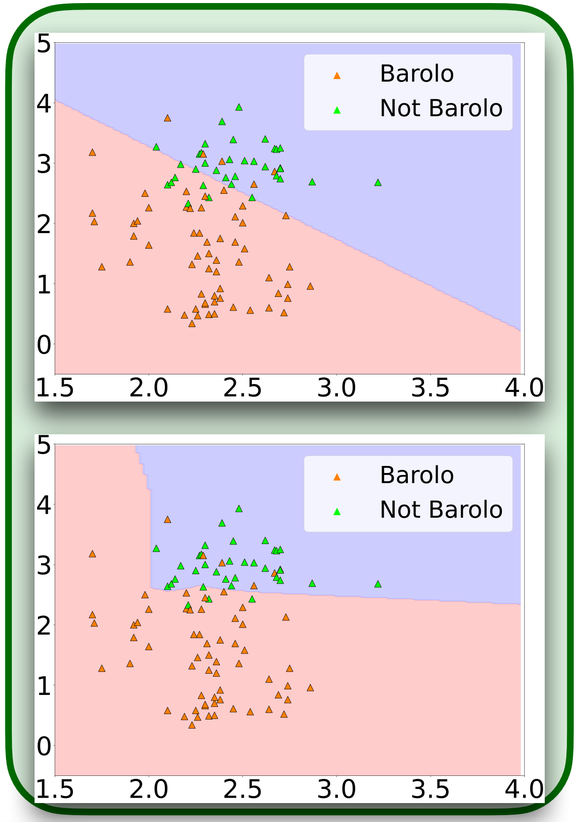


Experience

Learning program

Knowledge (program)

Regression vs Classification

Regression: Labels are continuous values (ex: house prices)

Classification: Labels are discrete and unordered (ex: type of wine)

Course Outline

1. Math and probability review
2. Define supervised learning formally (splitting it into regression or classification)
3. Design some learning programs to solve regression problems

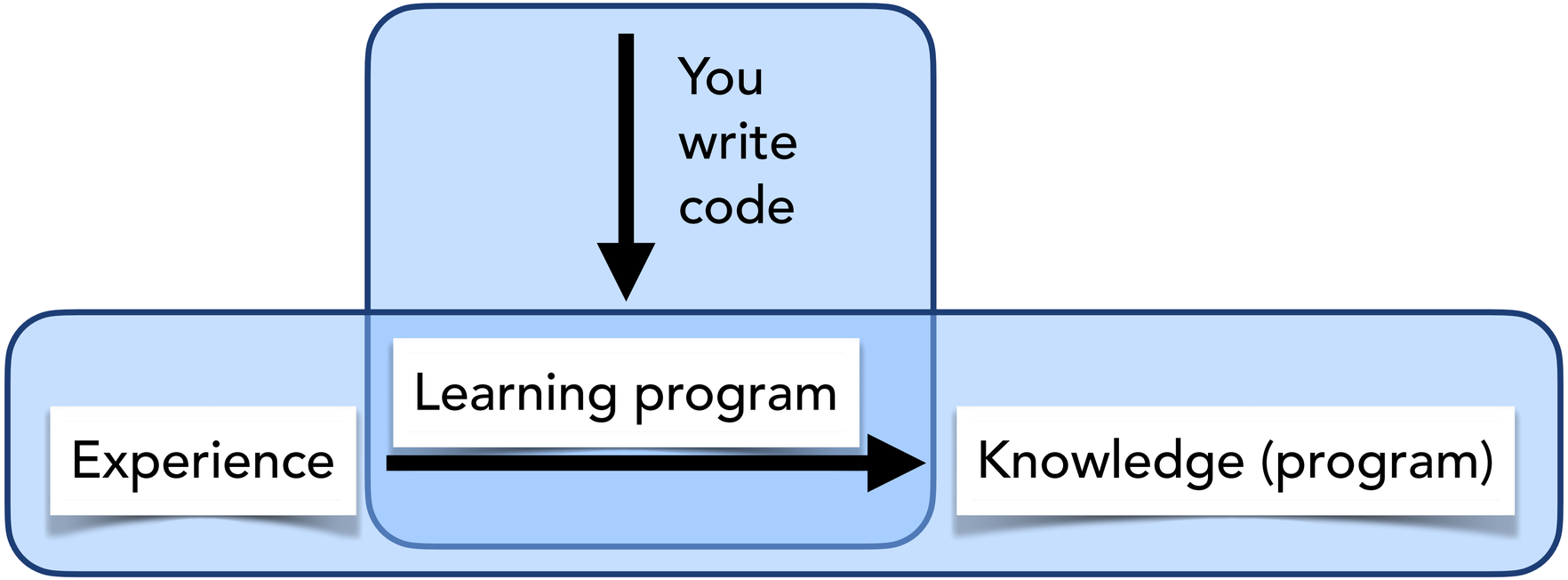
   Midterm Exam 1
4. Evaluate our learning programs
5. Present some new ways to design learning programs for regression

   Midterm Exam 2
6. Repeat the above for classification problems
7. Brief intro to language models (if time permits)

   Final Exam (Cumulative)

The code for all of the plots was generated by

Wait a Minute…



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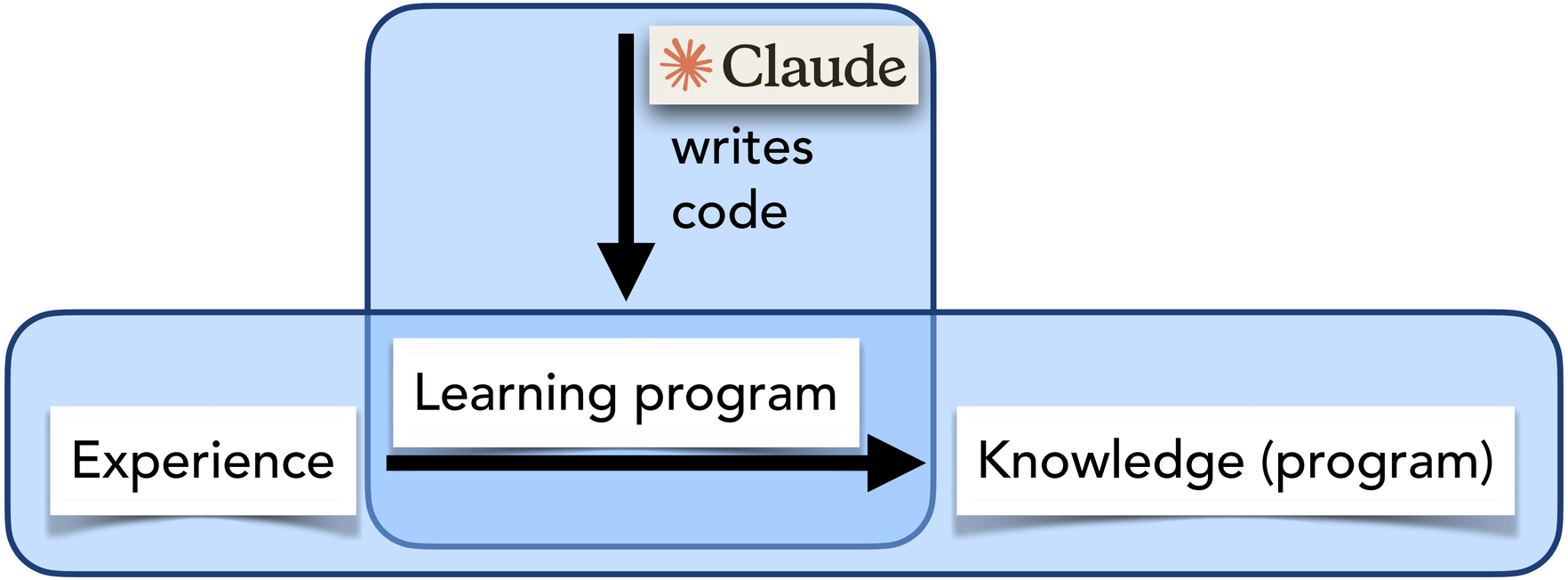

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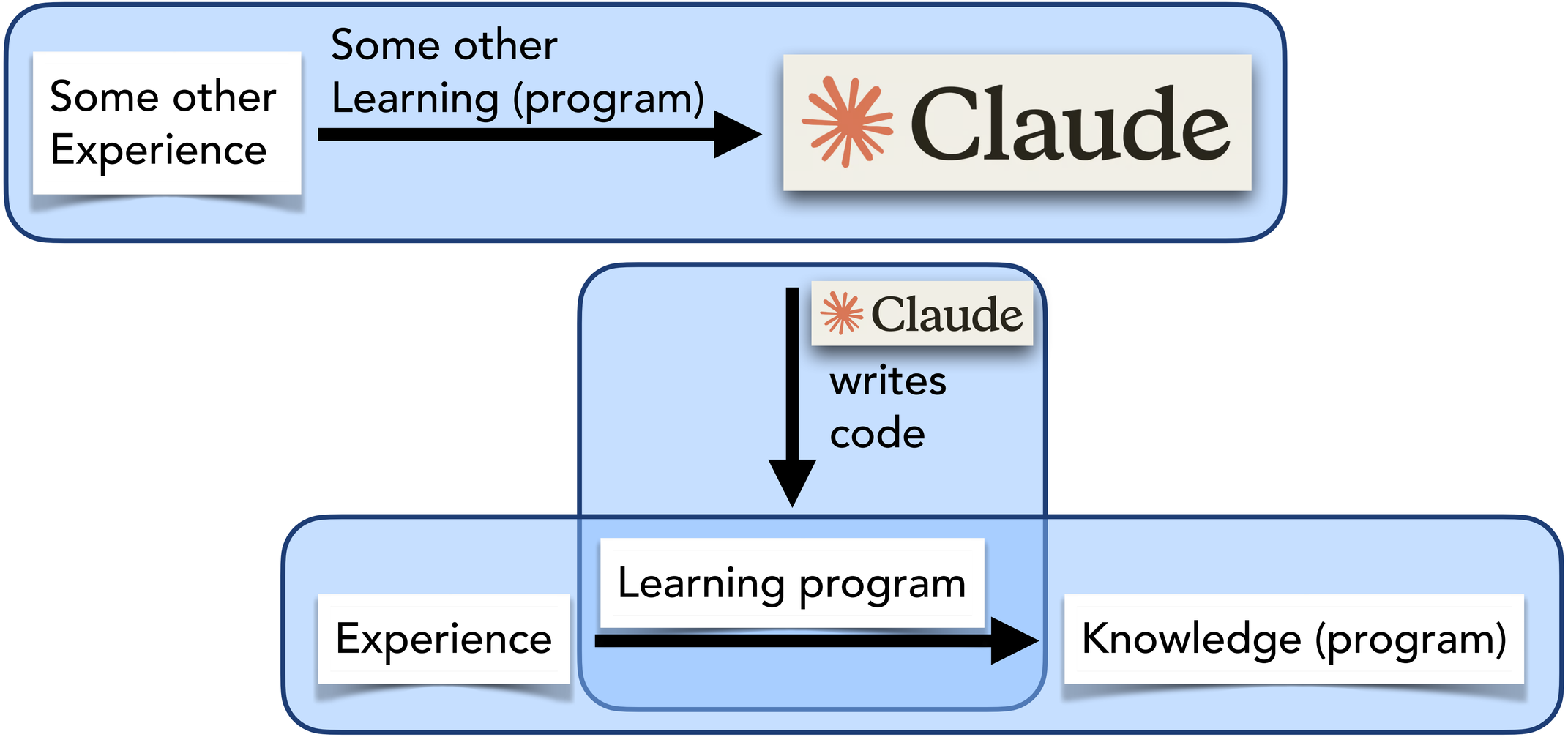

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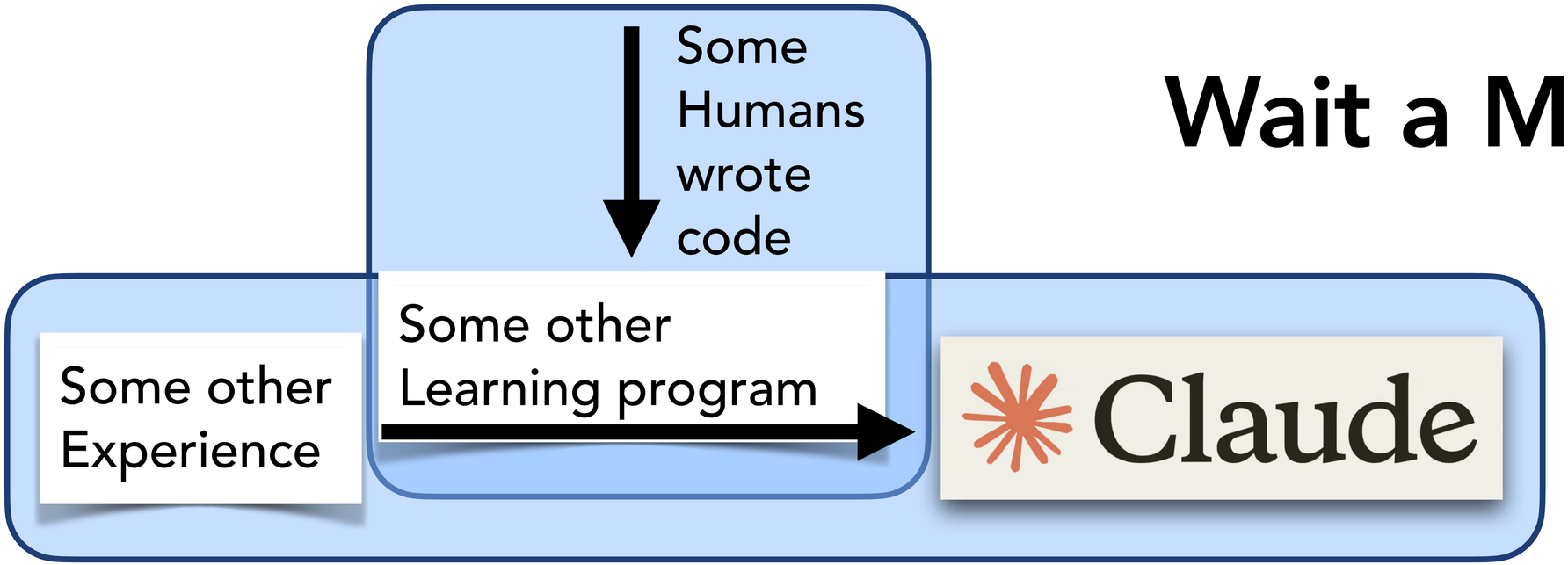

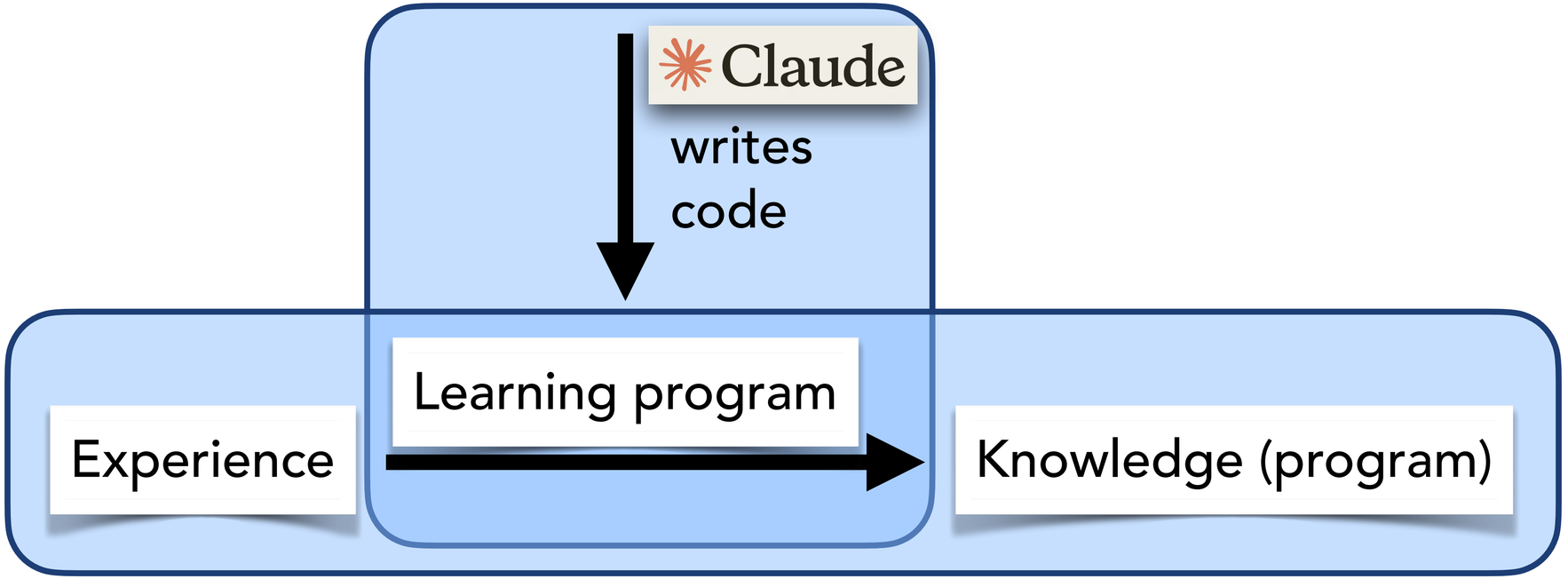

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My Answer:

1. If something doesn't work, then you can fix it

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My Answer:

1. If something doesn't work, then you can fix it
2. Its fun and feels like magic :)