

# The AI Revolution in Learning

## Why Edinburgh matters

Kobi Gal











THE UNIVERSITY  
*of* EDINBURGH

**aiai**

Artificial Intelligence  
and its Applications Institute

# Course Forums Yesterday

Homework 3	annoucnements and HW for next class		Kobi Gal
Homework 4			
<b>News forum</b>	optional study worth 1-pt bonus		Kobi Gal
syllabus			
Blackjack MDP	announcements		Kobi Gal
MDP programr assignment			
▶ Class 1	new dates for homework		Kobi Gal
▶ Class 2			
▶ Class 3	homework up on web		Kobi Gal
▶ Class 4			
▶ Class 5	slides updated and homework box		Kobi Gal
▶ Class 6 (May 13)			
▶ Class 7 (May 20)	homework for next class		Kobi Gal
▶ Class 8 (May 28)			
▶ Class 9 (June 3)			
▶ Class 6 (May 1)	welcome and readings for next class		Kobi Gal
▶ Class 10 (June			

# And Today

[Yogev et al., 17]

## Make a note.

*Draw others' attention to something interesting. Click & drag to highlight.*

loaded first getting a boost, even holding constant their over in that a small number of the articles in Wikipedia have a dis ng them (Capocci, et al., 2006), and why a small number of g orks on social networking sites (Backstrom, Huttenlocher, K

le social proof and preferential attachment will often lead to r ibutions and an undersupply of others, these principles can b ntribute in cases where they otherwise would not. For exam e site (espgame.org) announces that it has already labeled ov has been "seen on CNN and newspapers around the world." nvince latecomers to play the game, and the game distribu to be labeled.

gn claim 12: People are more likely to comply with a request e have also complied.

ides of research in psychology and organizational behavior ir g strongly motivate people. Goals are objects or conditions ocke & Kristof, 1996). They can be long term (e.g., create th i term (e.g., fix all bugs by the February software release); va

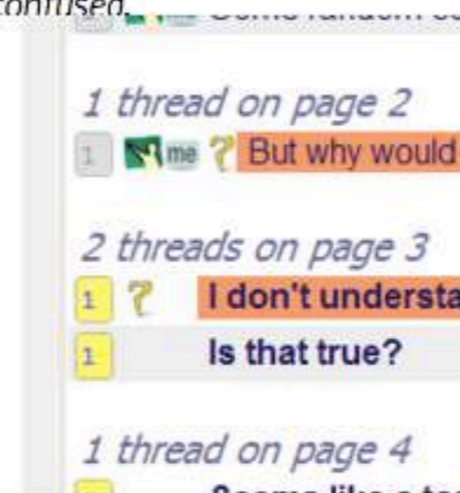
## Ask a question.

*Don't understand something? Highlight the text and ask your class about it.*



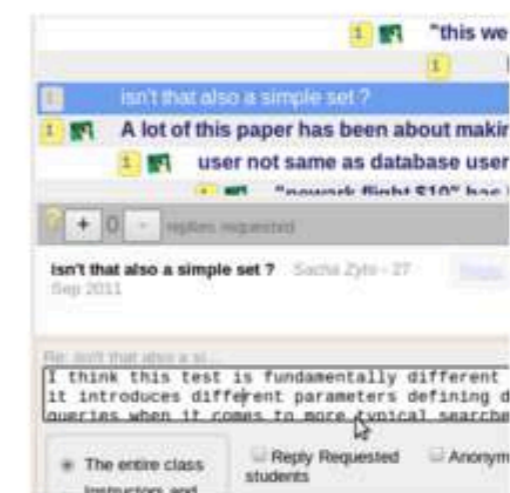
## See trouble spots.

*Know which parts of the material need more attention by seeing where students are confused.*

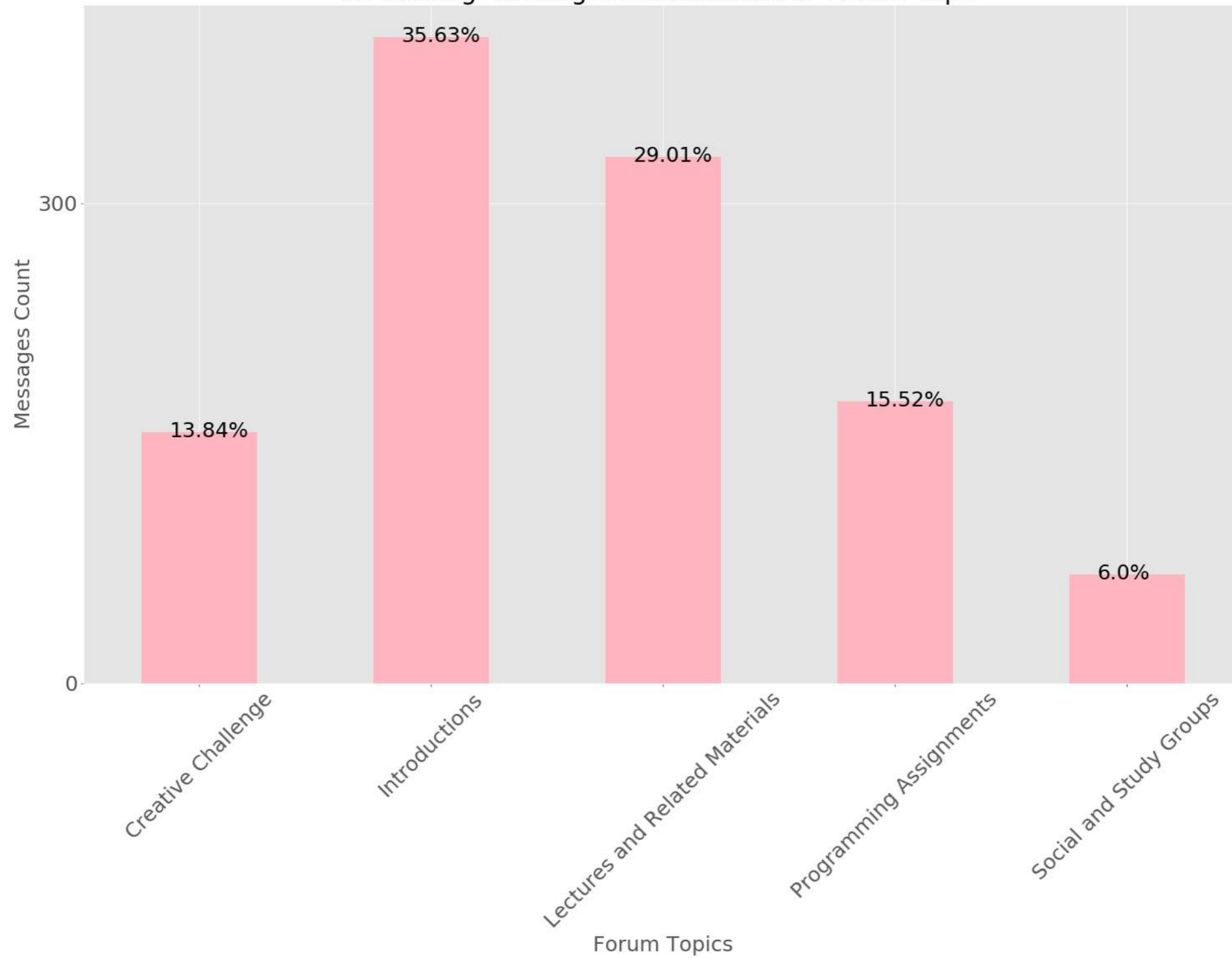


## Answer a question.

*If you see a question and you know the answer, just right click it to answer it.*



AIPlanning: Messages Distribution Per Forum Topic



# Labs yesterday



# Labs today

[Yaron et al. 17]

Stockroom Explorer...

- Iridium Solutions
  - Distilled H<sub>2</sub>O
  - Stock Solutions
    - 19M NaOH
    - 11.6M HCl
    - 17.8M H<sub>2</sub>SO<sub>4</sub>
    - 15.4M HNO<sub>3</sub>
    - 15M HClO<sub>4</sub>
    - 14.6M H<sub>3</sub>PO<sub>4</sub>
    - 14.8M NH<sub>3</sub>
  - Strong-acids
  - Weak-acids
  - Conjugate-acids
  - Strong-bases
  - Weak-bases
  - Conjugate-bases
  - Indicators
  - Solids

Workbench 1

Distilled H<sub>2</sub>O

250mL Beaker

19M NaOH

Solution Info...

Name: 19M NaOH  
Volume: 1780.0 mL

Aqueous  Solid  Gas

log( Molarity )

Species	Molarity
H <sup>+</sup>	5.314e-16
OH <sup>-</sup>	1.900e1
Na <sup>+</sup>	1.900e1

25.0°C

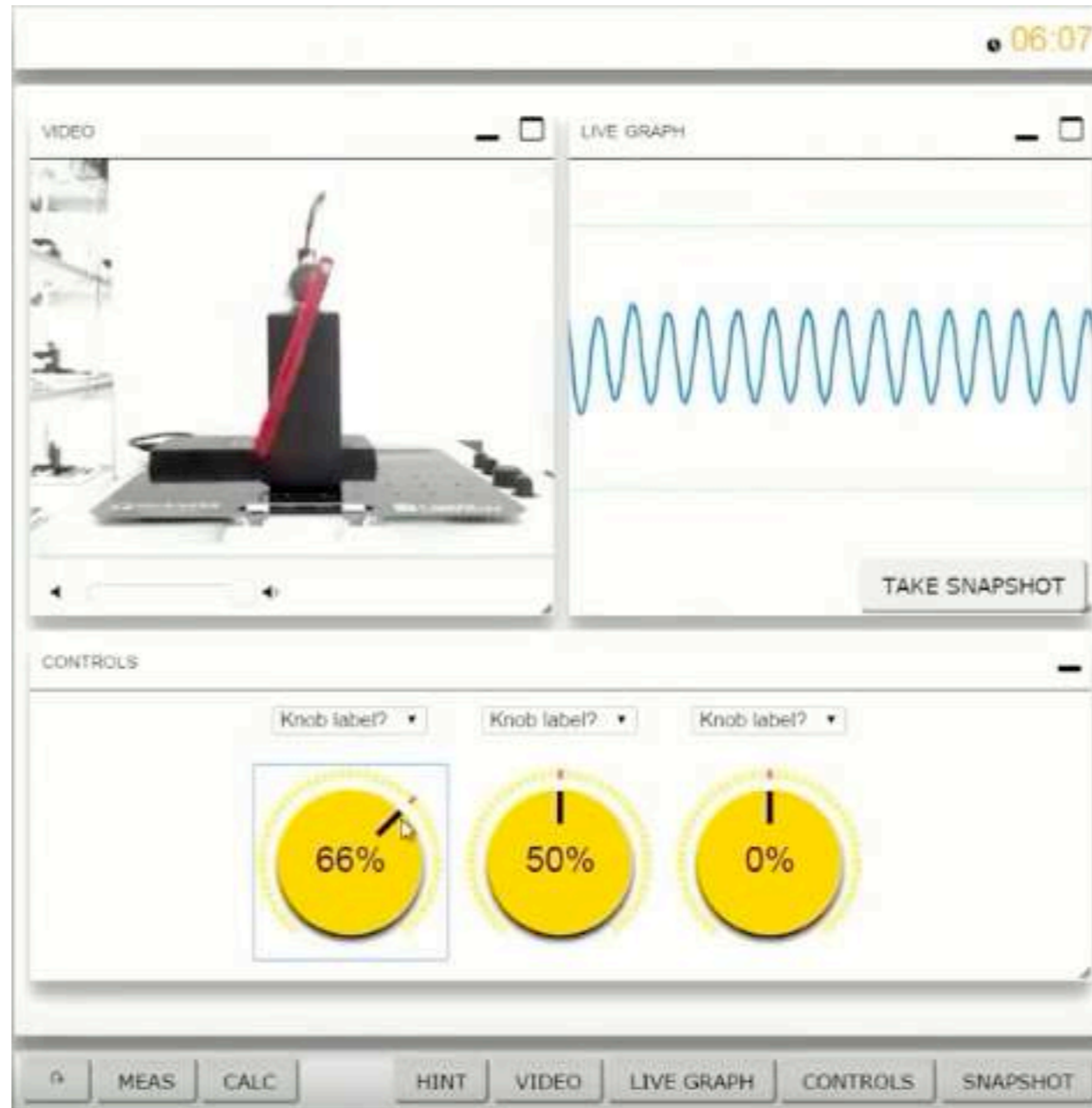
PH Meter

15.27

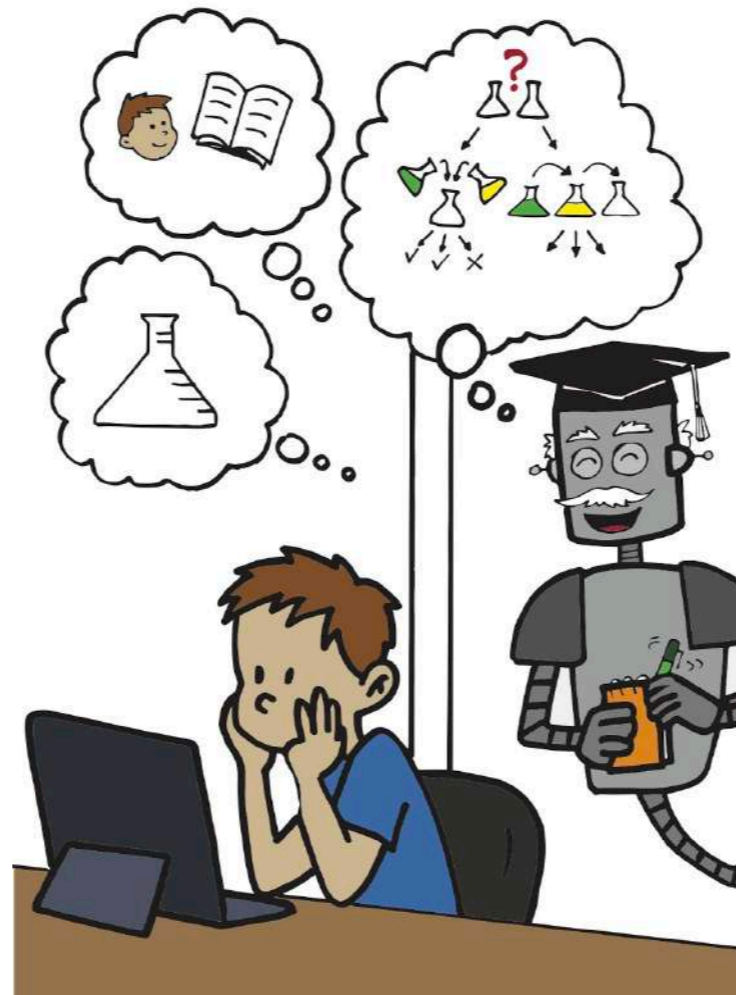
19M Sodium Hydroxide

Transfer amount (mL): 200 Pour from 19M NaOH to 250mL Beaker

{Drysdale et al. 18}



# The Teacher in the Loop



- Inferring Student Engagement
- Collaborative Group learning



# ICAP framework

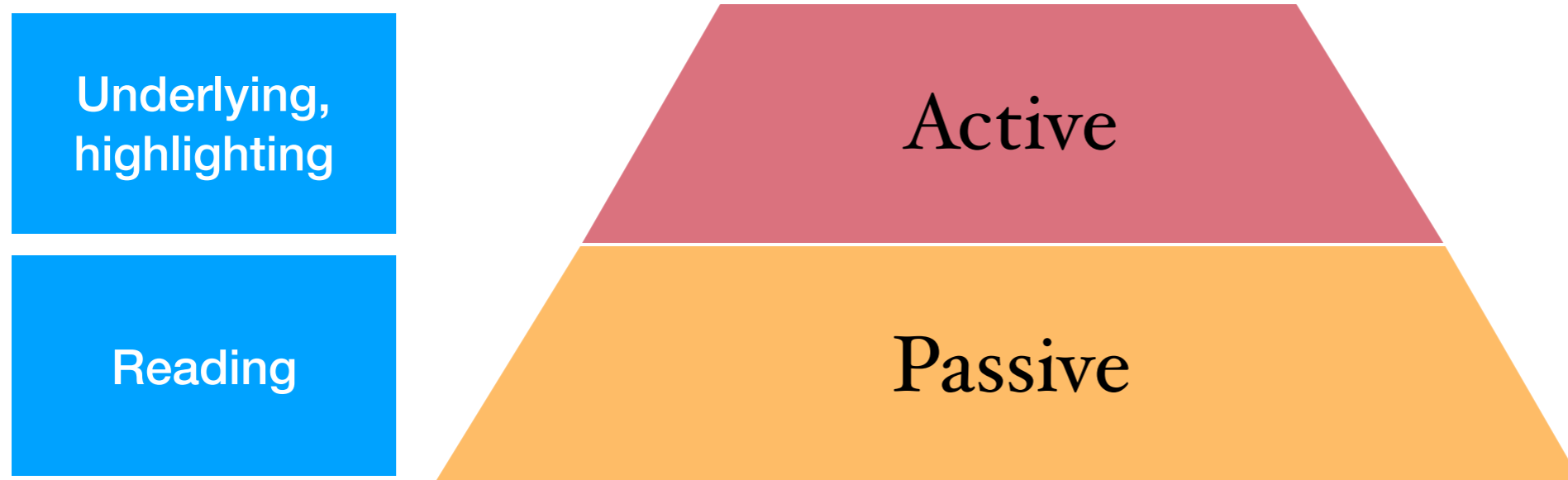
{Chi and Wylie 16}

Reading

Passive

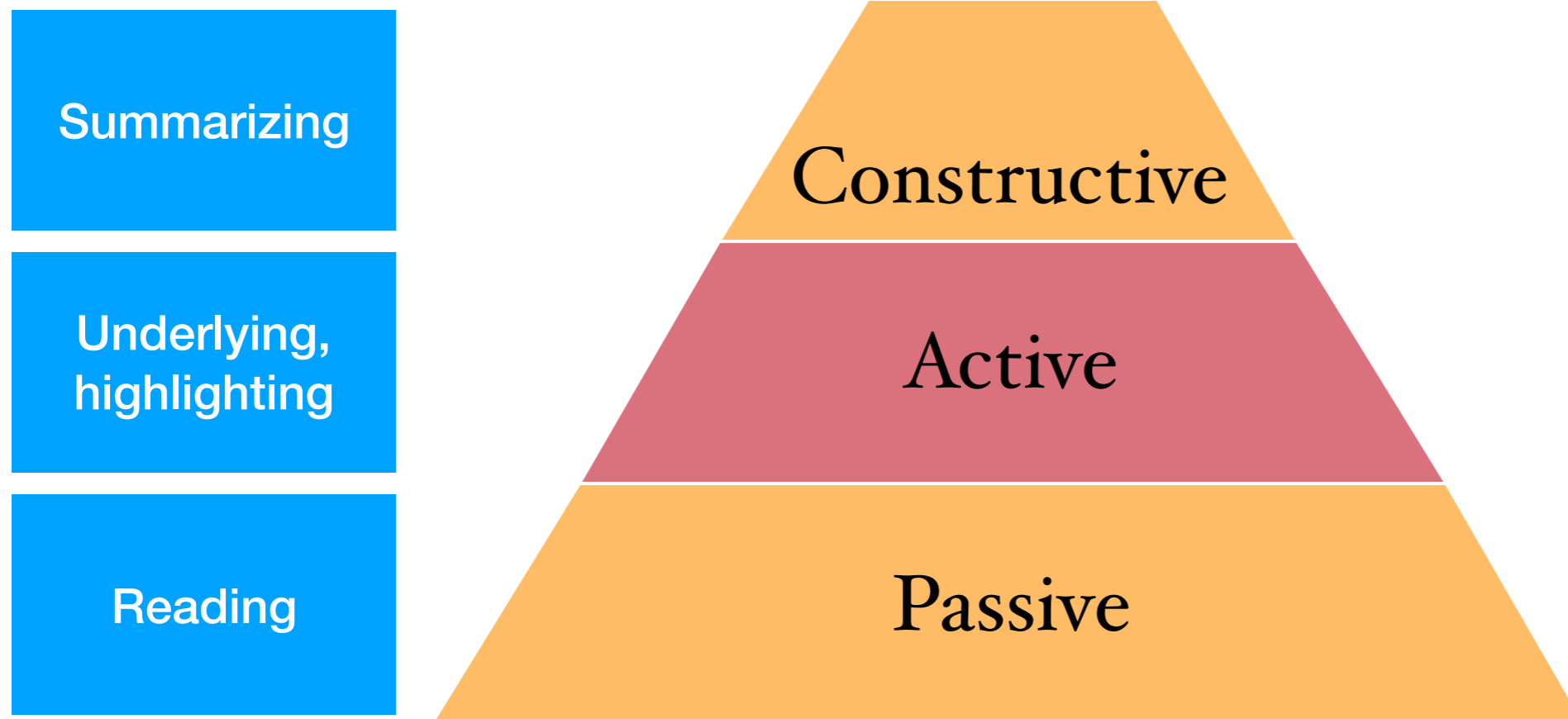
# ICAP framework

{Chi and Wylie 16}



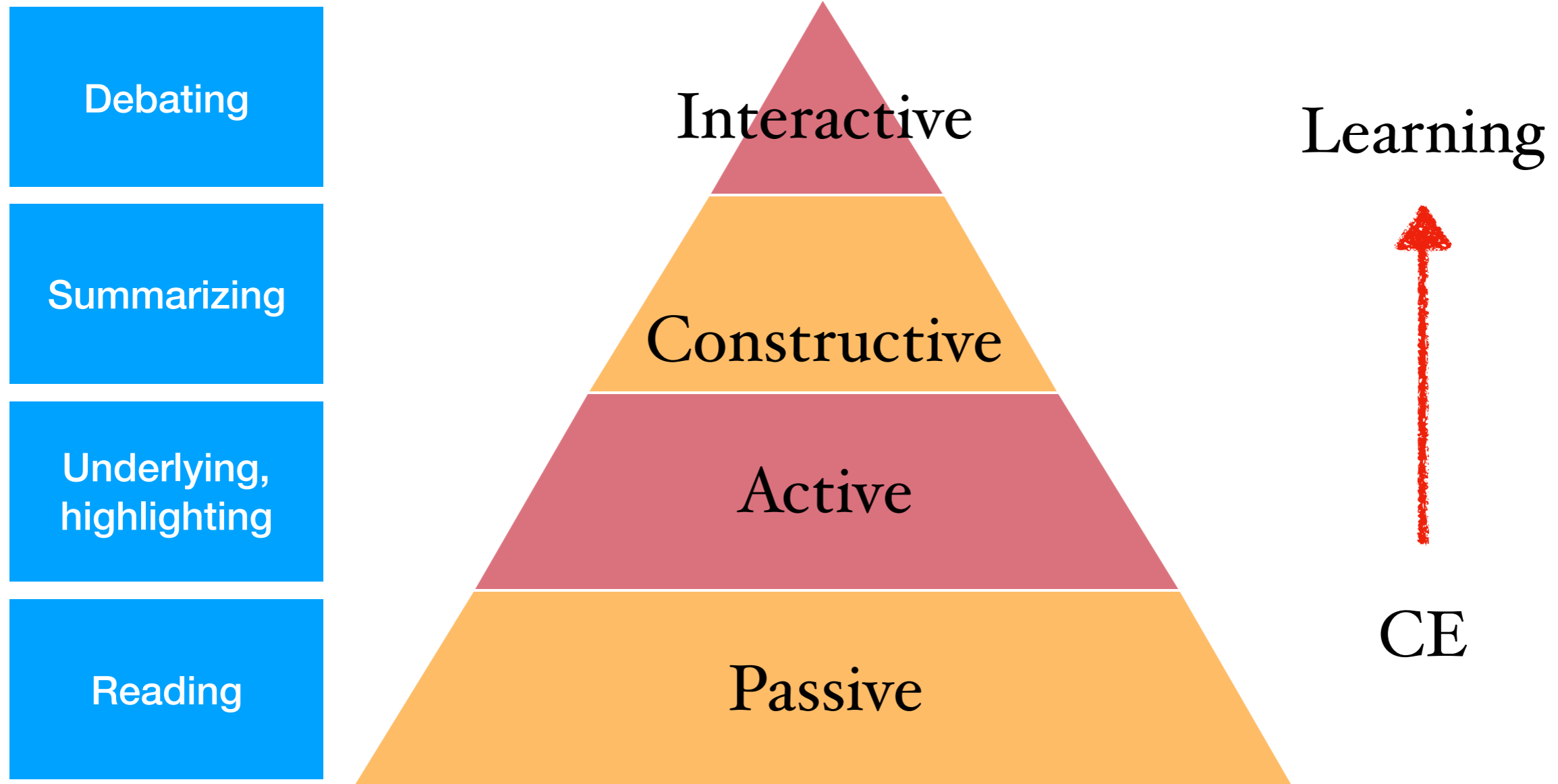
# ICAP framework

{Chi and Wylie 16}



# ICAP framework

{Chi and Wylie 16}



# Research Question

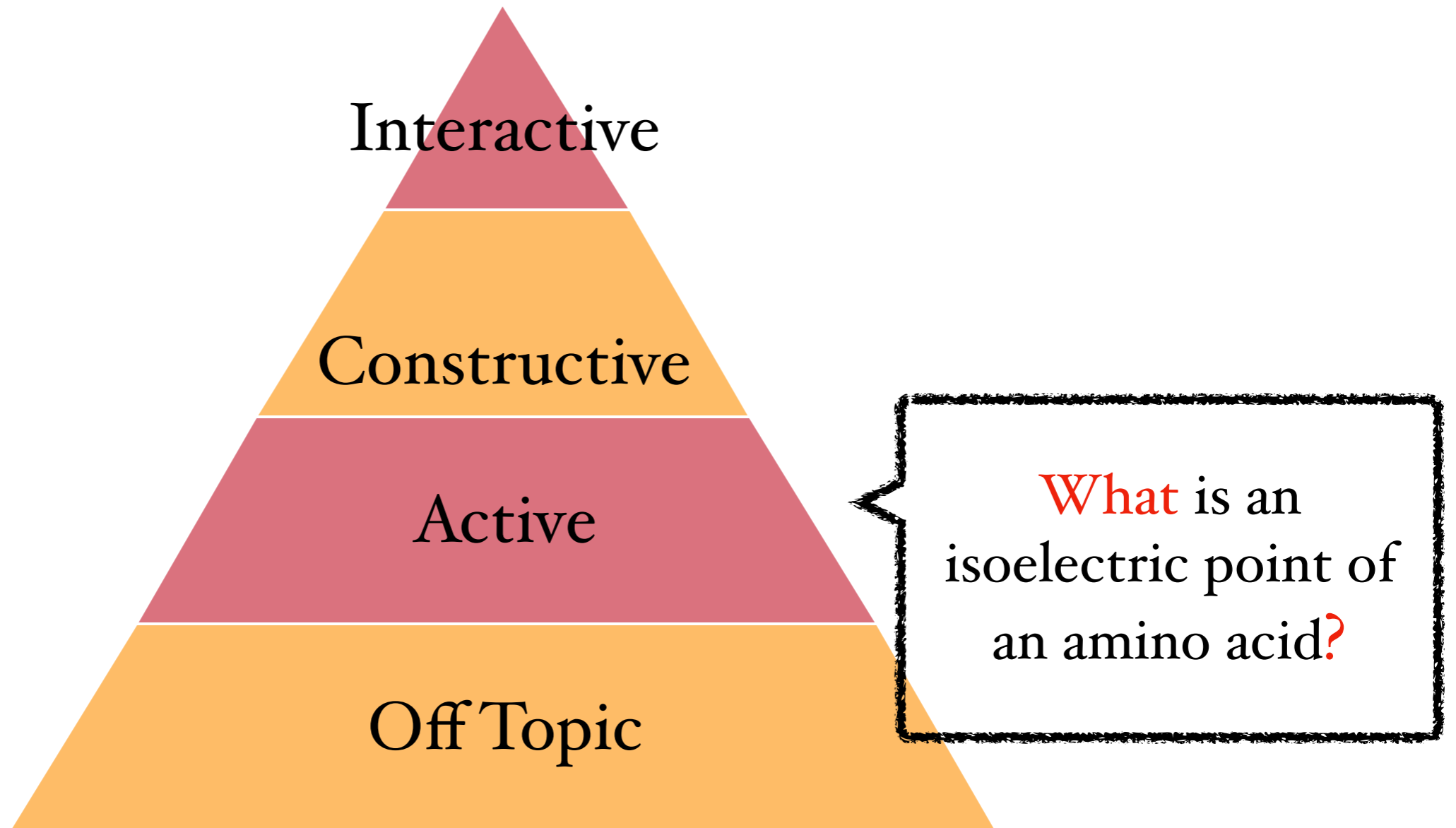
Cognitive Engagement can be a useful tool for teachers.

Approach: Combining **automatic classification** with **visualization** and **interacting with stakeholders**.

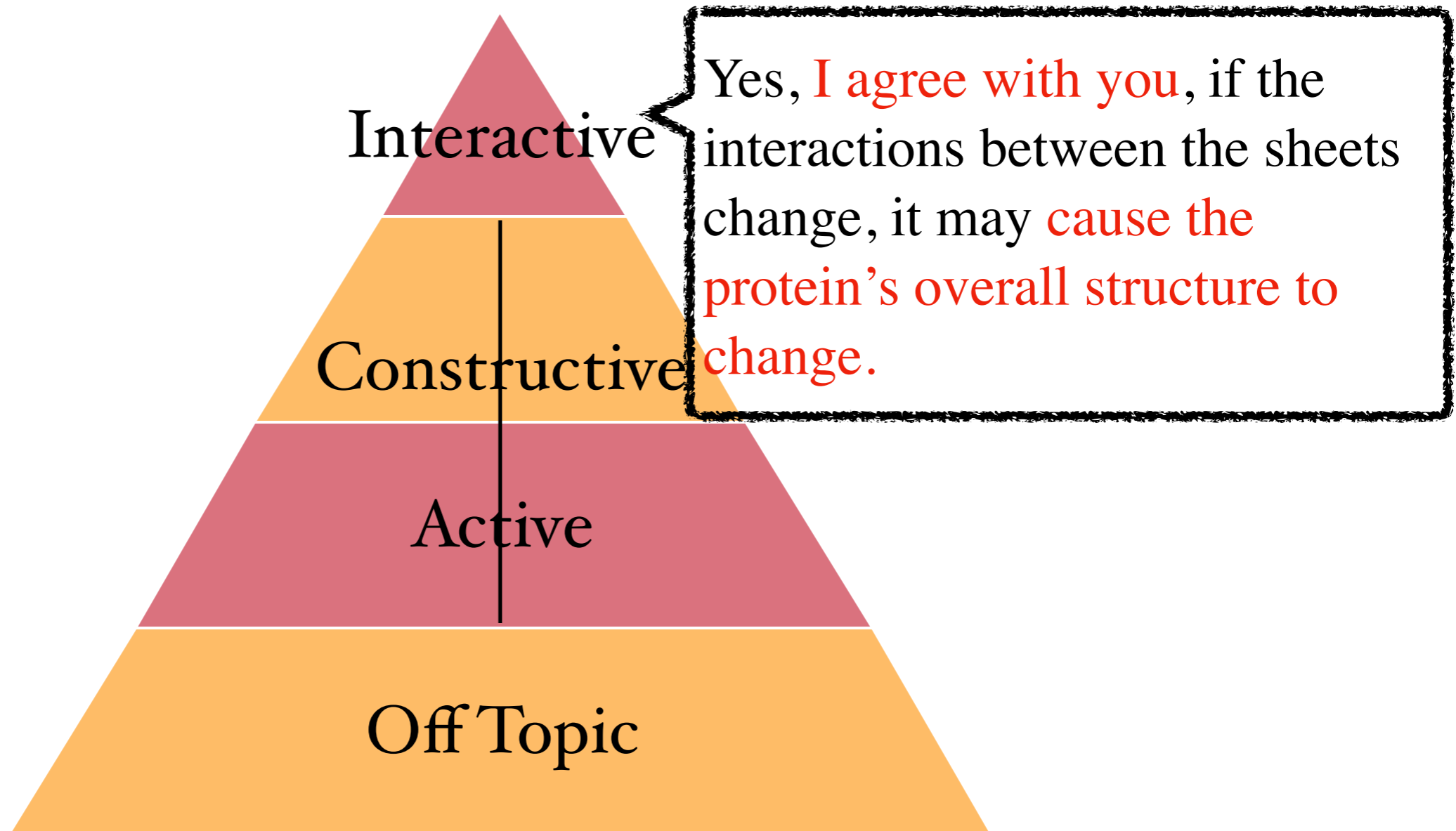
Contribution:

- Classifying CE (Manual and Automatic),
- Visualization Tool

# Example Active Reasoning



# Example Interactive Reasoning (I)



# The Power of Context

## Cell division in the bacteria and archaea

### Bacteria and Archaea

Like all other life forms, bacteria and archaea have one key evolutionary driver: to make more of themselves. Typically, bacterial and archaeal cells grow, duplicate all major cellular constituents, like DNA, ribosomes, etc., distribute this content and then divide into two nearly identical daughter cells. This process is called **binary fission** and is shown mid-process in the figure below. While some bacterial species are known to use several alternative reproductive strategies including making multiple offspring or budding - and all alternative mechanisms still meet the requirements for cell division stipulated above - binary fission is the most commonly laboratory-observed mechanisms for cell division the bacteria and archaea so we limit our discussion to this mechanisms alone.

(Aside: Those who want to read more about alternatives to binary fission in bacteria should check [this link](#) out.)



Interactive

Constructive

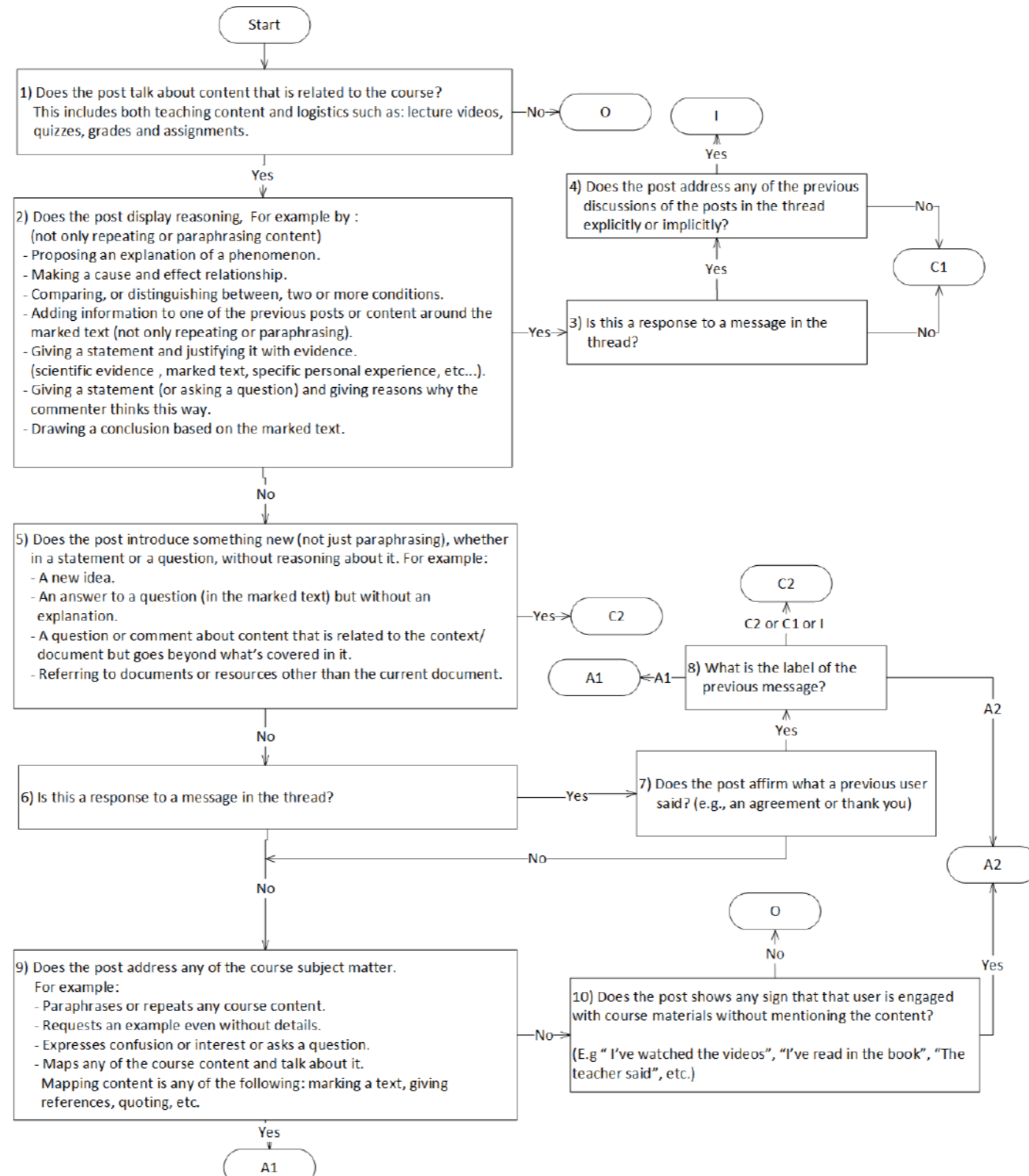
Active

Off Topic

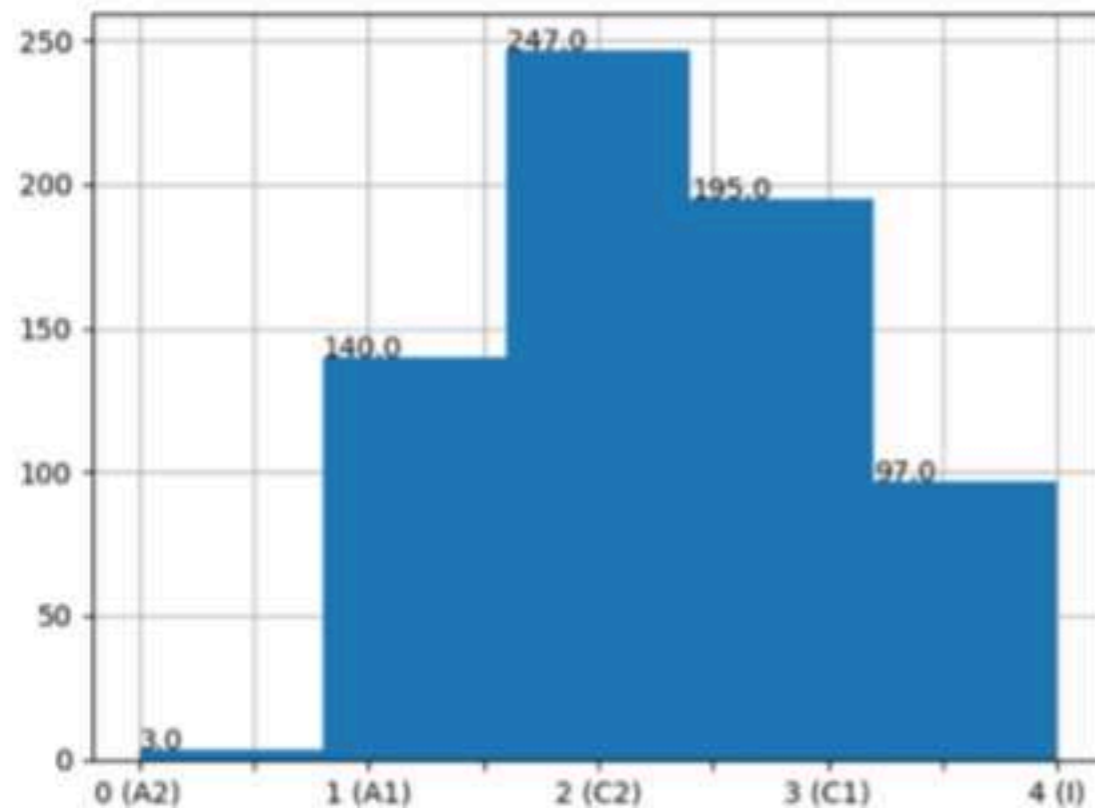
Wild Type is genes of an organism is a type of mutation that can either provide a good or bad trait...



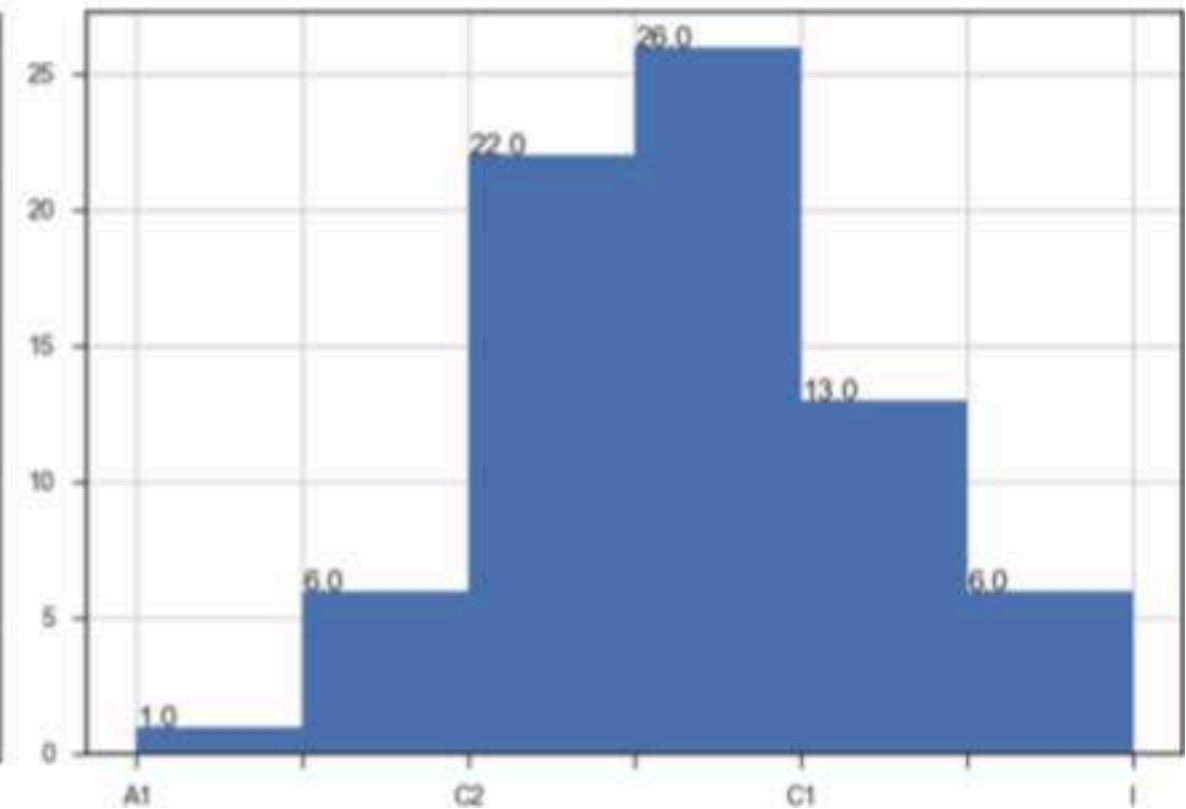
# Manual CE Classification



# CE behavior



Biology

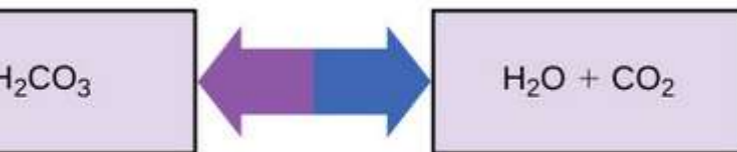


Physics

# Insights

## Low CEs

- Definitions, questions, short comments, first posts,



shows the body's buffering of  
arrows show the process of  
 $\text{CO}_2$  is made. The purple

are antacids used to combat  
y of these over-the-counter  
me way as blood buffers,  
n capable of absorbing  
pH, bringing relief to those  
r eating. The unique  
ntribute to this capacity to

1 While the buffer system is effective, if to...

? + 0 - replies requested Section\_38

While the buffer system is effective, if too much base or acid -- that is particularly strong -- is introduced it will overpower the buffer and equilibrium will be thrown off. That is presumably why it is so dangerous to consume cleaning supplies or strong acids since they are so high and low, respectively, in pH

# Amino Acid Structure

3 2.52  
 Amino acids are the monomers that make up proteins. Each amino acid has the same fundamental structure of a central carbon atom, also known as the alpha ( $\alpha$ ) carbon, bonded to an amino group, a carboxyl group (COOH), and to a hydrogen atom. Every amino acid also has another atom or group of atoms bonded to the central atom known as the R group (Figure). For an introduction on amino acids, click [here](#) for a short (4 minute) video.

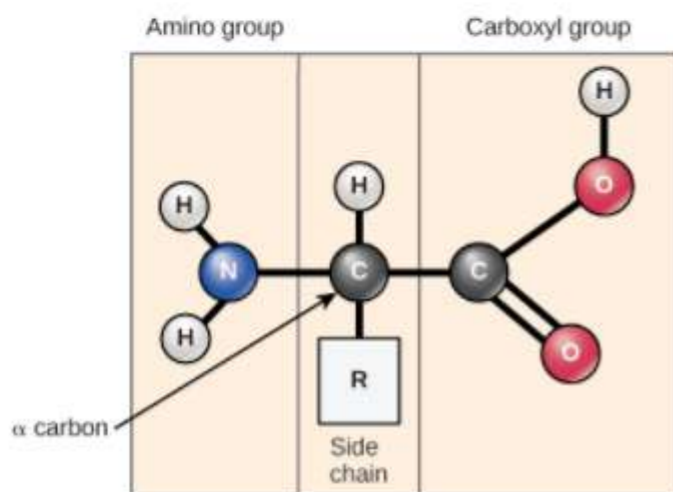


Figure 2. Amino acids have a central asymmetric carbon to which an amino group, a carboxyl group, a hydrogen atom, and a side chain (R group) are attached.

## Possible Discussion:

Recall that one of the learning goals for this class is that you (a) be able to recognize in a molecular diagram the backbone of an amino acid and its side chain (R-group) and (b) that you be able to draw a generic amino acid. Make sure that you practice both. You should be able to recreate something like Figure 2 from memory.

Using figure 2, which of the following is true about amino acids:

- amino acids contain polar functional groups
- amino acids contain basic functional groups
- amino acids contain acidic functional groups
- amino acids contain a variable group that can be either polar or nonpolar
- all of the above

Heatmap info Toggle Heat map  
 Heatmap info Toggle Heat map  
 me 0 2 2 ? 12 1 more filters tags filter  
 2109 threads  
 1 to denature is to "unbind/uncoil" the proteins. I his brea...  
 1 Denature would destroy protein's characteristic pro...  
 1 Off Task: 0  
 1 Active - General: 1  
 1 Active - Targeted: 2  
 1 Constructive - Extending: 3  
 1 Constructive - Reasoning: 4  
 1 Interactive: 5  
 1 A large proportion of our cells are made up of amino ac...  
 1 Amino acids are the monomers that make up proteins. ...

? + 0 - replies requested Section\_39

In order to understand the formation of thousands of proteins from only 20 amino acids, I like to see each amino acid as being a letter of the alphabet. With our 26 letters, we are able to make thousands of words with different lengths and different letters. Some words contain the same letters such as top and pot. Although they have the same letters, they are arranged differently, and therefore could be two different amino acids! I hope this helps.

- 4 Alice - Constructive Reasoning - 01/01/2017
- 4 This is a really good analogy! It also can allow students to see chains of amino acids as mental models and imagine the proteins the same way they would imagine words.
- 4 Bob - Constructive Extending - 02/01/2017

# User Study Findings

## CE heat map

- 1) helps instructors make sense of student's interaction with the material.
- 2) facilitates class design.
- 3) saves instructors time and effort.

# Facilitating Group Work

[Segal et al. 17, Shwarz et al. 19]



Dillenbourg (2013)



# VMT [Stahl 2012]

The screenshot displays the VMT interface. At the top, there are tabs for 'none' and 'control'. Below is a toolbar with various geometric tools like a compass, straightedge, and eraser. The main workspace shows a complex geometric diagram with several triangles and lines in different colors (blue, green, red). The diagram includes points labeled with Greek letters:  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ ,  $\epsilon$ ,  $\zeta$ ,  $\eta$ ,  $\theta$ ,  $\iota$ ,  $\kappa$ ,  $\lambda$ ,  $\mu$ ,  $\nu$ ,  $\xi$ ,  $\omicron$ ,  $\pi$ ,  $\rho$ ,  $\sigma$ , and  $\tau$ . On the right side, there is a chat window titled 'Users in session:' with the user 'avis'. The chat log shows a series of messages in Hebrew and English, including timestamps, user names, and server messages. The messages include questions about geometry, session join/leave notifications, and task instructions.

Users in session:  
**avis**

Nov 20th 16, 6:25:07 pm  
**naomiprusak:** ?  
Nov 20th 16, 6:26:13 pm  
**server:** osama-swidan joined the session  
Nov 20th 16, 6:26:49 pm  
**naomiprusak:** למה אין תיגים במערכת.  
Nov 20th 16, 6:28:42 pm  
**naomiprusak:** ?  
Nov 20th 16, 6:28:43 pm  
[Task 1: 2](#)  
**server:** neta left the session  
Nov 20th 16, 6:30:24 pm  
[Task 1: 3](#)  
**naomiprusak:** מה קורה האם יש תיגים עכשיו  
Nov 20th 16, 6:33:51 pm  
**naomiprusak:** או קיי אני רוצה לבדוק קצת שיח לא מתמטי  
Nov 20th 16, 6:34:57 pm  
**server:** no-name left the session  
Nov 20th 16, 6:35:26 pm  
**server:** neta joined the session  
Nov 20th 16, 6:35:34 pm  
**neta:** הי ניעמי  
Nov 20th 16, 6:35:43 pm  
האם את בטוחה שזו התשובה הנכונה?

# To use student group learning, a teacher needs to...

“Temporarily clone myself”

“Have eyes in the back of my head”

“Help me to intervene where, when, and with what I’m most needed”



# SAGLET

**Table 1.** Examples of communication message categories

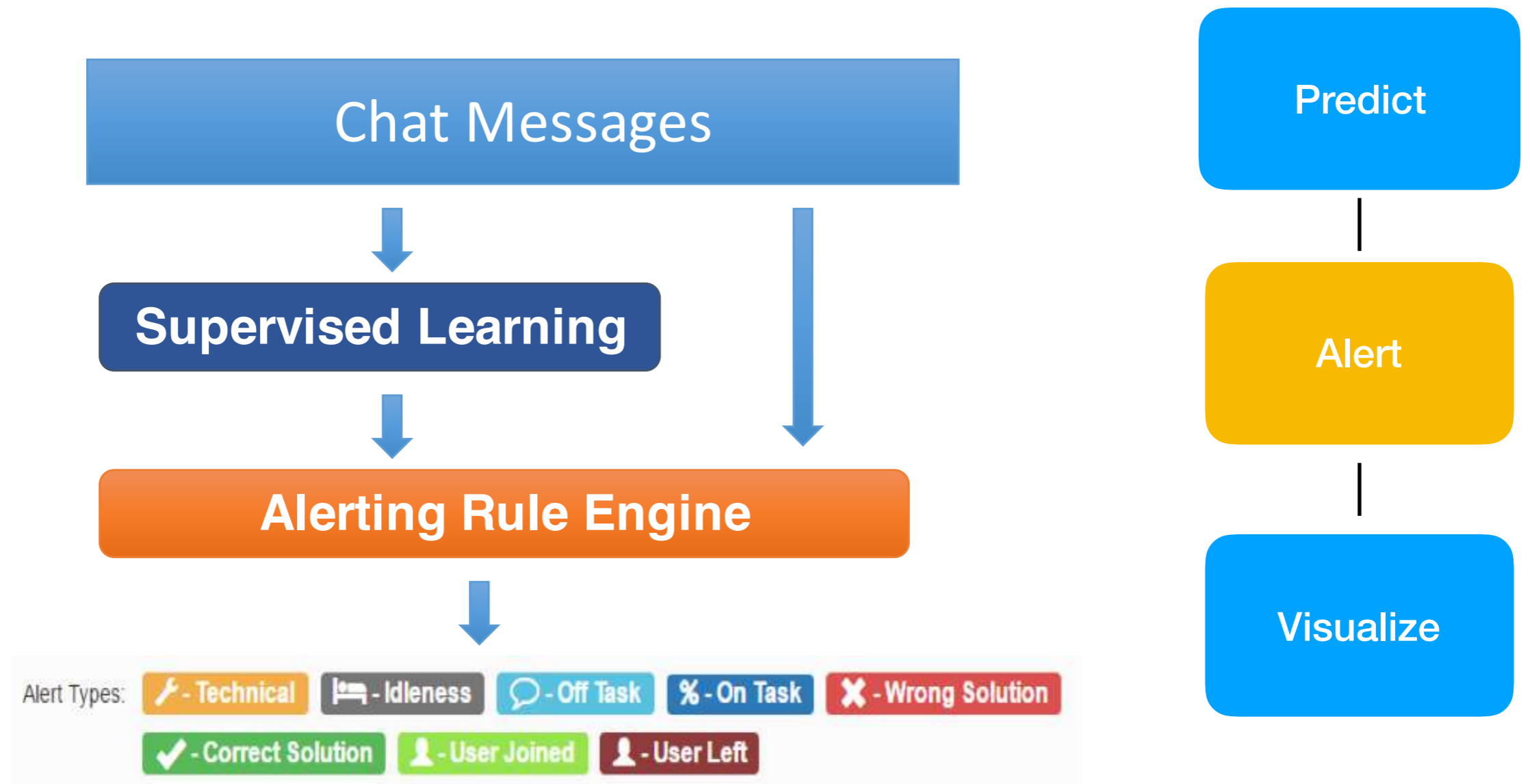
On-task	“Do we all agree that the answer is a parallelogram?”, “We also have to justify the answer”, “You are correct, I did not pay attention to the third item in the question.”
Technical	“Please release the control”, “Where is the diagram?”, “The Drawing Tool is not operating”
Off-task	“How are you?”, “I am finding it hard to focus”, “I have to leave”

Predict

Alert

Visualize

# SAGLET Pipeline



# Supporting the group

The screenshot displays the SAGLET interface. At the top, there is a navigation bar with a home icon, the text 'SAGLET Rooms', a green 'Online' button, the text 'Hello shaken!', and a 'Log out' button. Below this, three panels are shown, each representing a different room: '782 - Room 1', '783 - Room 2', and '785 - Room 4'. Each panel contains a geometric diagram with various colored lines and shapes. At the bottom of the interface, there is a legend for 'Alert Types' with the following items: a wrench icon for 'Technical', a bed icon for 'Idleness', a speech bubble icon for 'Off Task', a percentage icon for 'On Task', a red X icon for 'Wrong Solution', a green checkmark icon for 'Correct Solution', a person icon for 'User Joined', and a person icon with a red slash for 'User Left'.

Predict

Alert

Visualize

# Teacher's Testimony

## Without SAGLET:

- unable to visit groups more than once
- unable to remember state of each group



## With SAGLET

- Able to track 5 groups with minimal burden
- Able to quickly decide on appropriate intervention
- Able to identify “group reached solution” & verify

# Future directions

Invest in instructional design

Student support

Engage faculty

Ethical reasoning