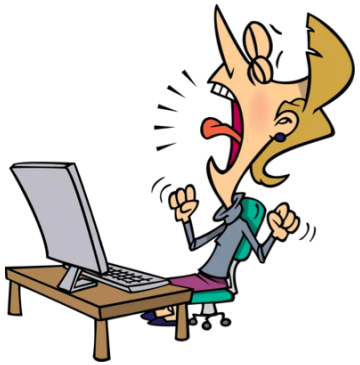
#8 Human-Computer Interaction



Test & Pop Quiz

- I have added 5 marks (i.e., 25%) to everyone's score for Test #2
- Also, rather than having the 3rd pop quiz today, I will also give you 2 free marks for it—that is, there will not be a pop quiz
  - But there will be a 4th pop quiz still
- There will also be a Test #3

Interactivity

Interactivity: What is it?

- Interactivity
  - Noun
  - '-ity': forms nouns denoting quality or condition
  - The interactive quality of a system or of an individual interaction
  - It is about the structure or anatomy of interaction
- Interactivity is related to the 'operational' aspect of interaction

Continuum of Interactivity

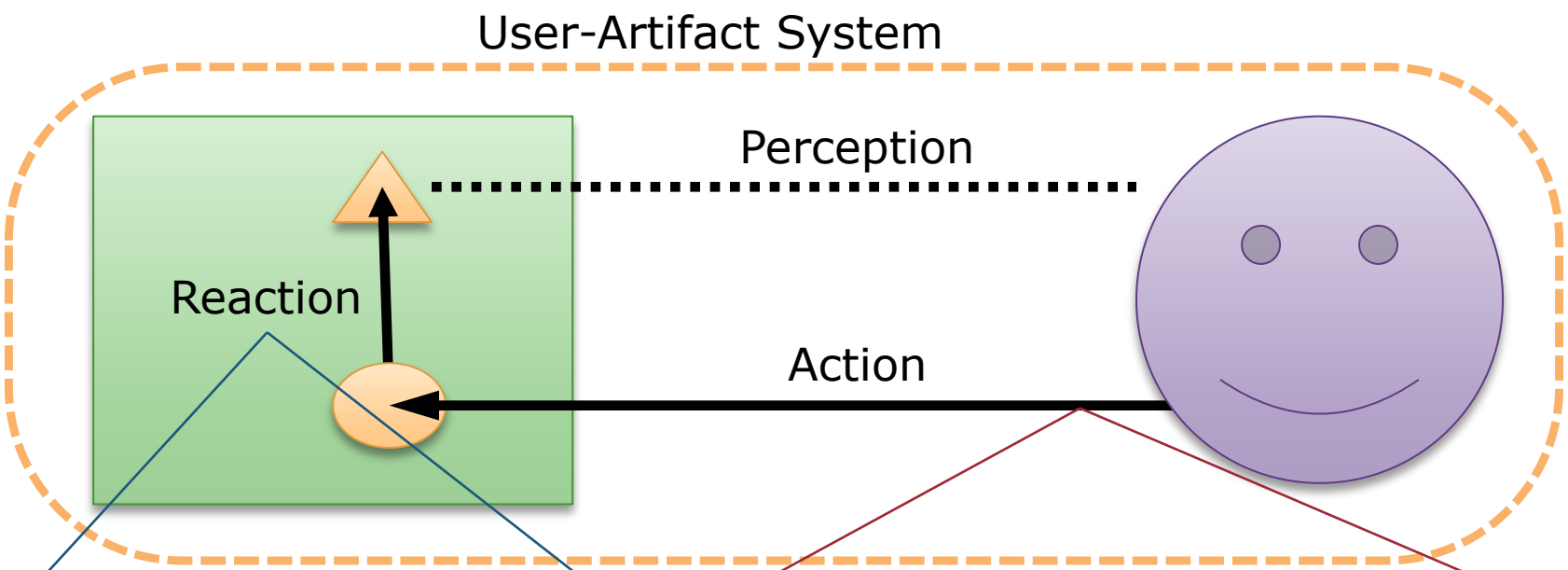
- Interactivity is a continuum
  - Applies to all life experiences, not only digital media
- Two ends of the spectrum:
- Highly interactive
  - What does this mean?
- Highly passive or non-interactive
  - Users observing and interpreting

Continuum of Interactivity

- What is the right level and/or form of interactivity?
  - No right answer
- Need to consider:

Is the level and/or form of interactivity appropriate for the context, task, and users?

Interactivity: What is it?



Components of the reaction
- How many elements change?
- In what order?

Properties of the reaction
- Timing, continuous/discrete…
- Any invisible changes?

Components of the action
- How many steps involved?
- Are they sequenced?

Properties of the action
- Is it timed? In real-time? Is it direct?
- Is it continuous / discrete?
- Does it depend on system state?

Interactivity

- Interactivity at the micro level **depends on** the structural elements of individual interactions

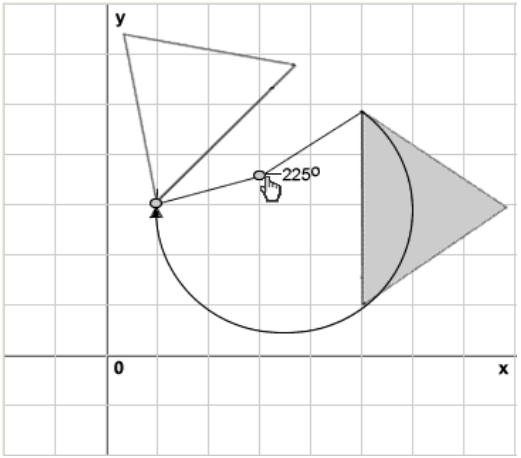
- Interactivity at the macro level **depends on** the combination, sequencing, and aggregate properties and relationships of interactions as a user performs activities

Micro-Level Interactivity: Analysis of the Anatomical Structure of each Interaction

Anatomy of interaction: Action

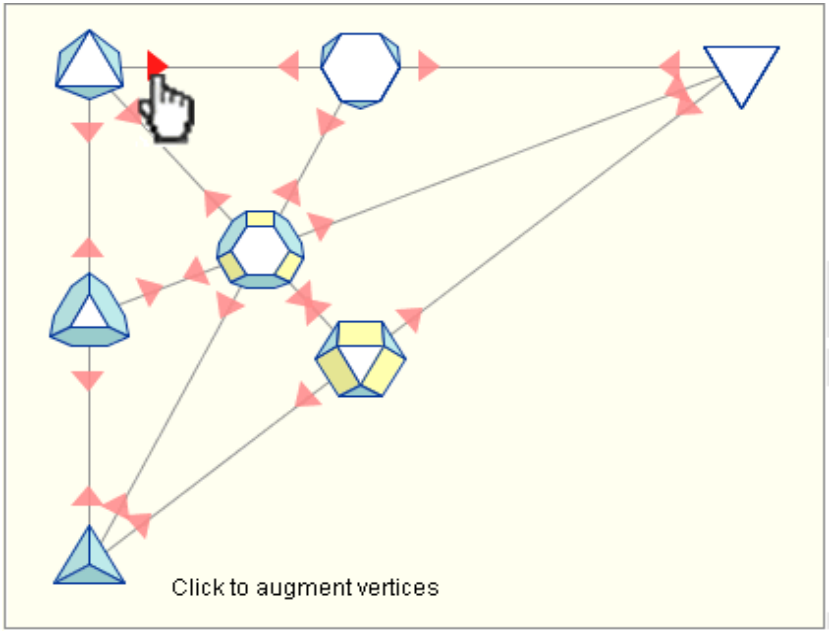
Presence

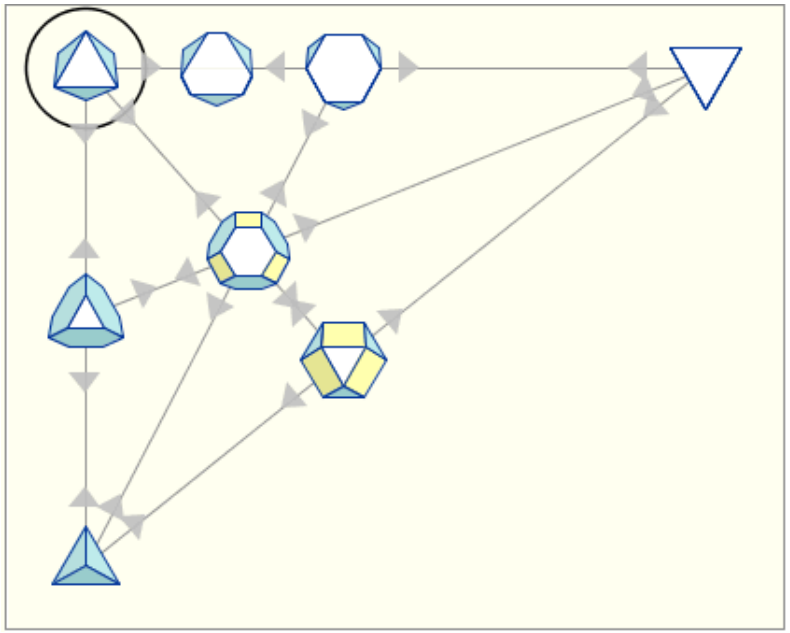
- Concerned with whether the artifact advertises the existence of an action to the user
- Two type:
  - Explicit: availability or existence of an action is explicitly advertised to the user
  - Implicit: even though an action is present, its availability is not advertised to the user, and it is assumed that the user knows that it exists



Example: Presence

- Which types of presence?





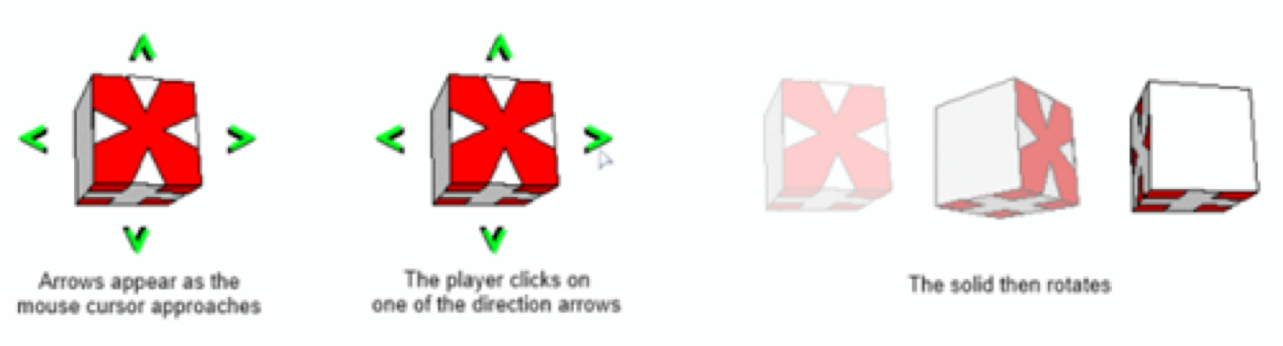
Anatomy of interaction: Action

Agency

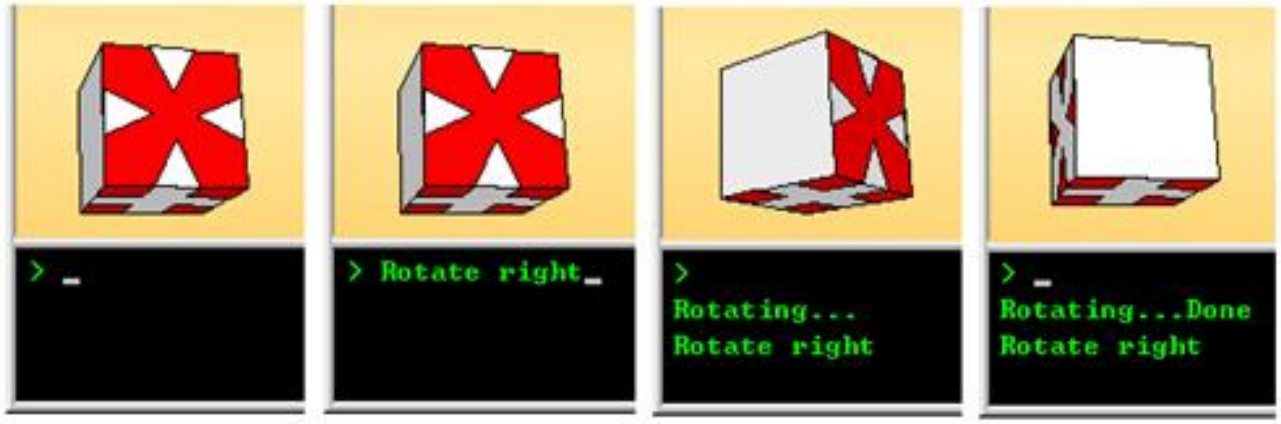
- Concerned with the metaphoric way through which the user expresses an action
- At least two types:
  - Verbal: user expresses an action using her 'mouth', as though she speaks to a UI element, such as by typing a command into a console
  - Manual: user expresses an action using her 'hands', as though she is reaching into the interface and grasping and manipulating a representation, such as using a mouse cursor to drag a representation.

Example: Agency

Manual



Verbal



Example: Agency

- In a study of the *Tower of Hanoi*, two versions of a game were created that differed in terms of agency: in version 1 participants used a mouse to click-and-drag discs from one peg to another; in version 2 participants typed a command to move a disc from one peg to another
- Version 2 was more conducive to reflective thinking while problem solving
  - Participants made fewer mistakes because the cost of error was more
    - That is, typing is a costlier action that clicking

Objective of the game:
Move all of the disks from peg 1 to peg 3
Disks are moved one at a time
No disk can be placed on top of a smaller one

https://www.youtube.com/watch?v=yrNWiFFbcEY

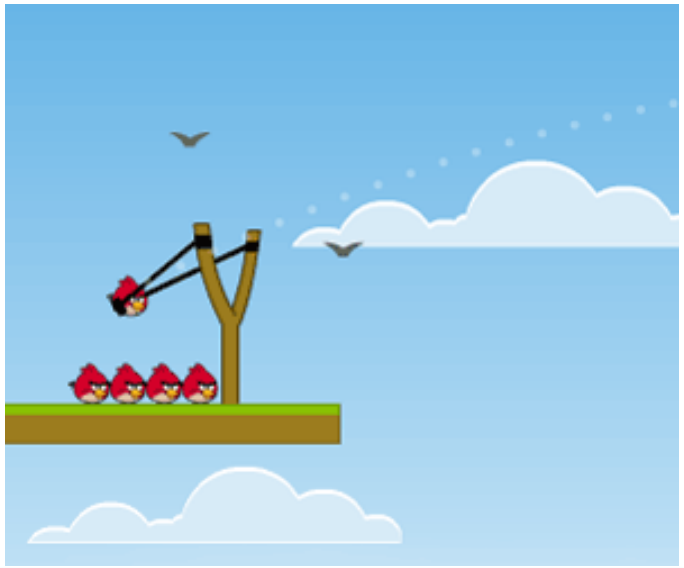
Anatomy of interaction: Action

Granularity

- Concerned with the steps that the user needs to perform in order to compose an action
- Two types:
  - Atomic: cannot be decomposed into steps; an atomic action is itself the only step
  - Composite: can be broken down into more than one step

Example: Granularity

- E.g.: Angry Bird - player taps and drags the bird so as to adjust the launch parameters (e.g., angle of the firing arc, and force applied to the bird), and then she releases her finger from the screen so as to launch the bird. In this case, the main action has atomic granularity
- What about composite granularity?



Example: Granularity

- Which type of granularity?

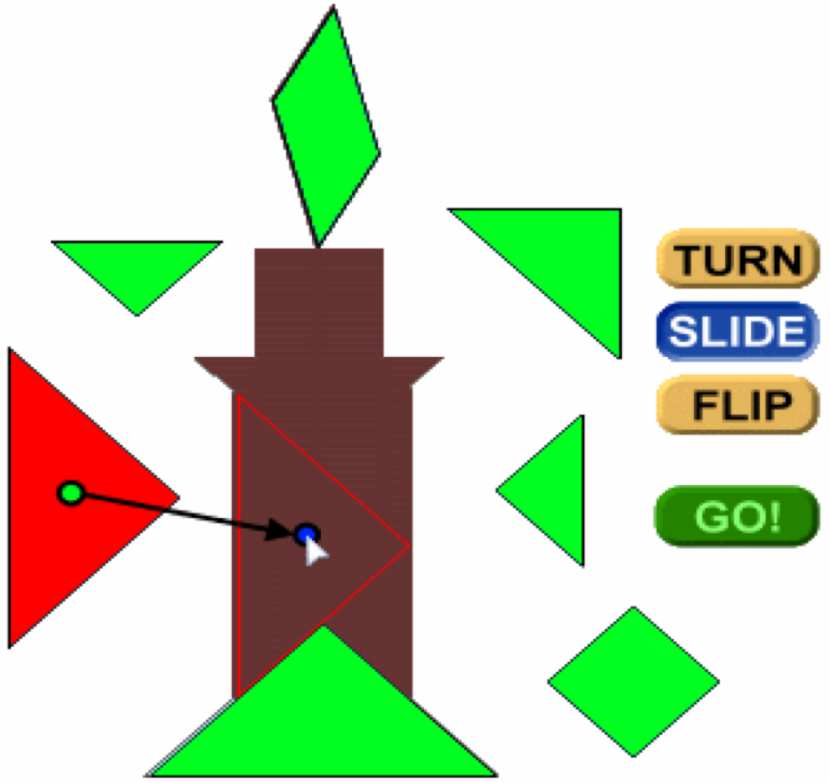
Anatomy of interaction: Action

Focus

- Concerned with the representation to which the user attends in order to act upon a representation of interest; this element deals with the focal point of action
- Two types:
  - Direct: user acts on the representation of interest
  - Indirect: user acts on an intermediary representational element so as to affect change in the representation of interest

Example: Focus

- To move the triangle, the user acts upon the arrow
- Which type of focus is this?

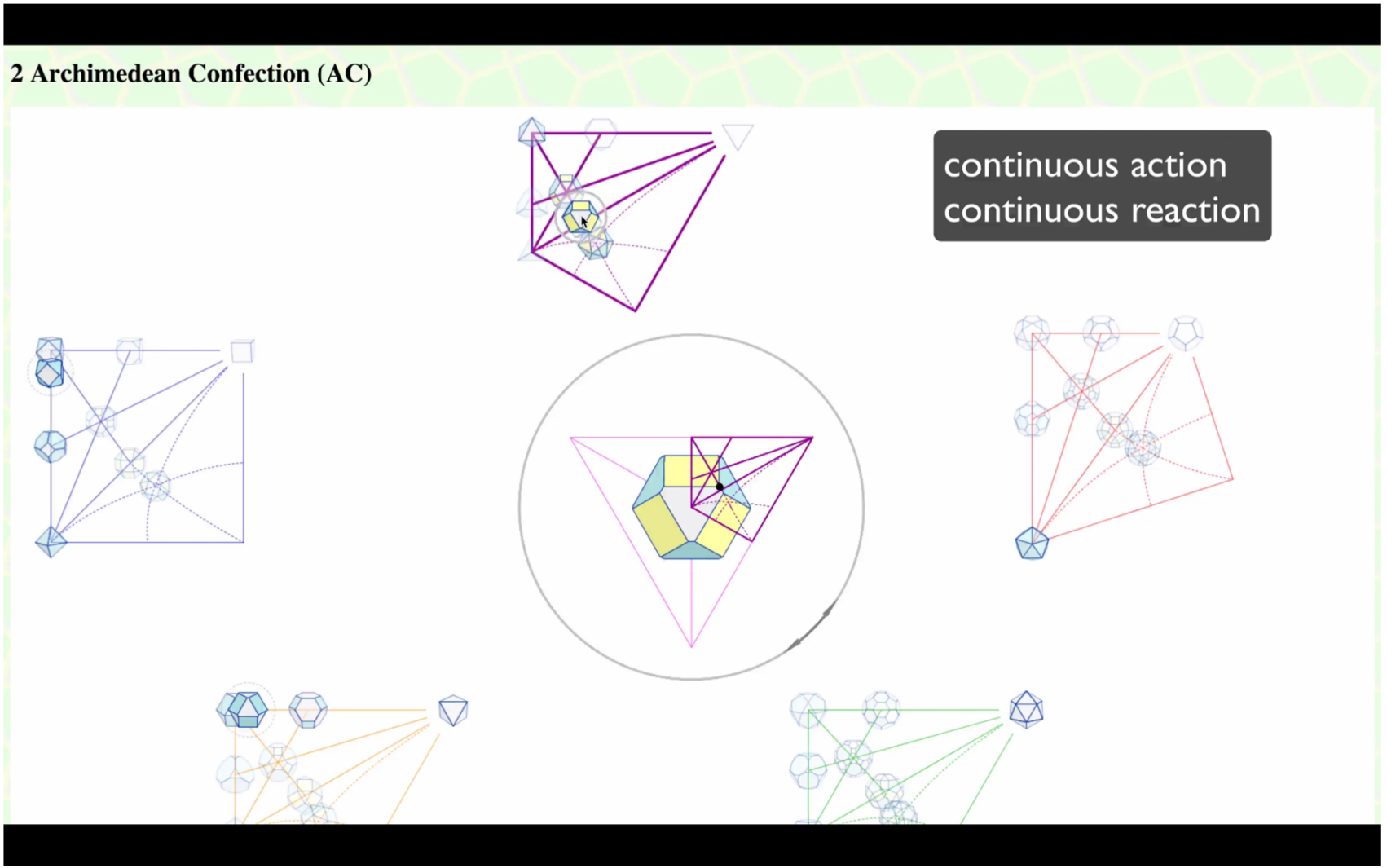


Anatomy of interaction: Action

Flow

- Concerned with how an action is parsed in time
- Two types:
  - Discrete: occurs instantaneously in time and/or is punctuated over time
  - Continuous: occurs over a span of time in a fluid manner

Example: Flow



Anatomy of interaction: Action

Timing

- Concerned with the amount of time available to the user to compose and/or commit an action
- At least two types:
  - User-paced: user is not constrained by any time limitations for composing and committing an action; user has as much time as needed to think about and examine a situation before committing an action
  - System-paced: user has a set amount of time to compose and commit an action

Example: Timing

- In Tower of Hanoi, timing of moving the disks can be either
  - self-paced
    - this form of timing provides the user with the opportunity for reflective cognition and look-ahead planning and decision-making
  - system-paced
    - depending on how fast each action should be performed, then the user's thinking is constrained by the system's pace
    - This form of timing can be used to promote quick decision-making and planning by the user

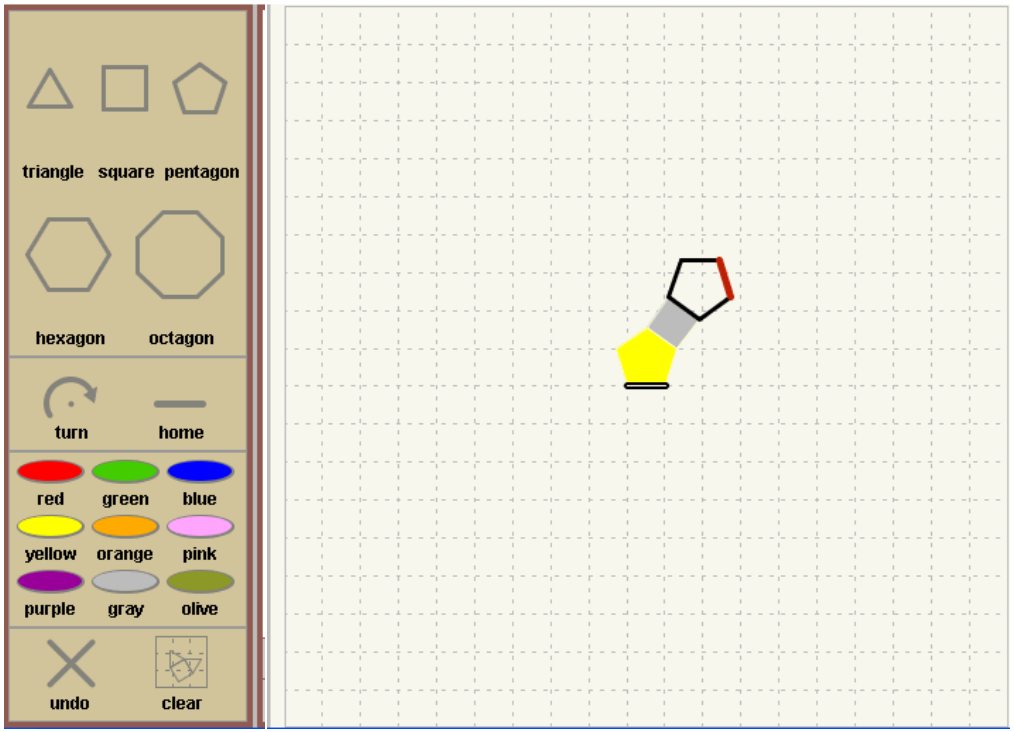
Anatomy of interaction: Reaction

Activation

- Concerned with the commencement of reaction after the user has committed an action
- At least three types:
  - Immediate: occurs instantaneously after the action is committed
  - Delayed: an action is committed and then a span of time passes before its reaction occurs
  - On-demand: reaction only occurs once the user requests it

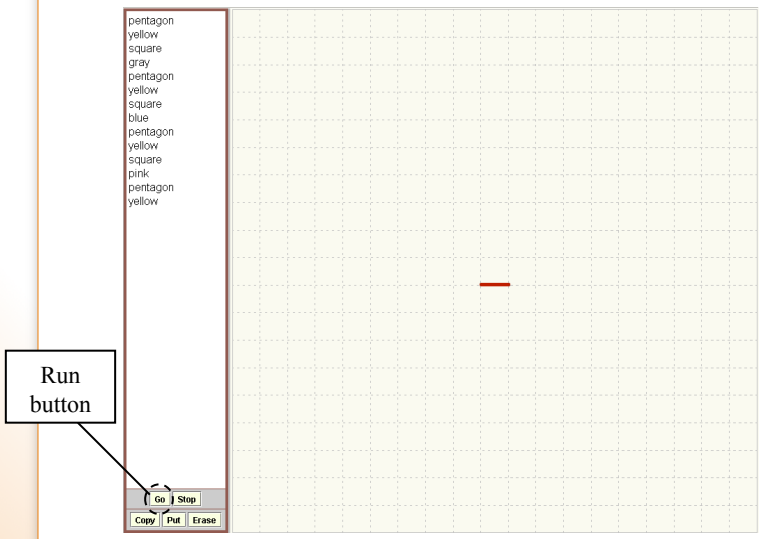
Example: Activation

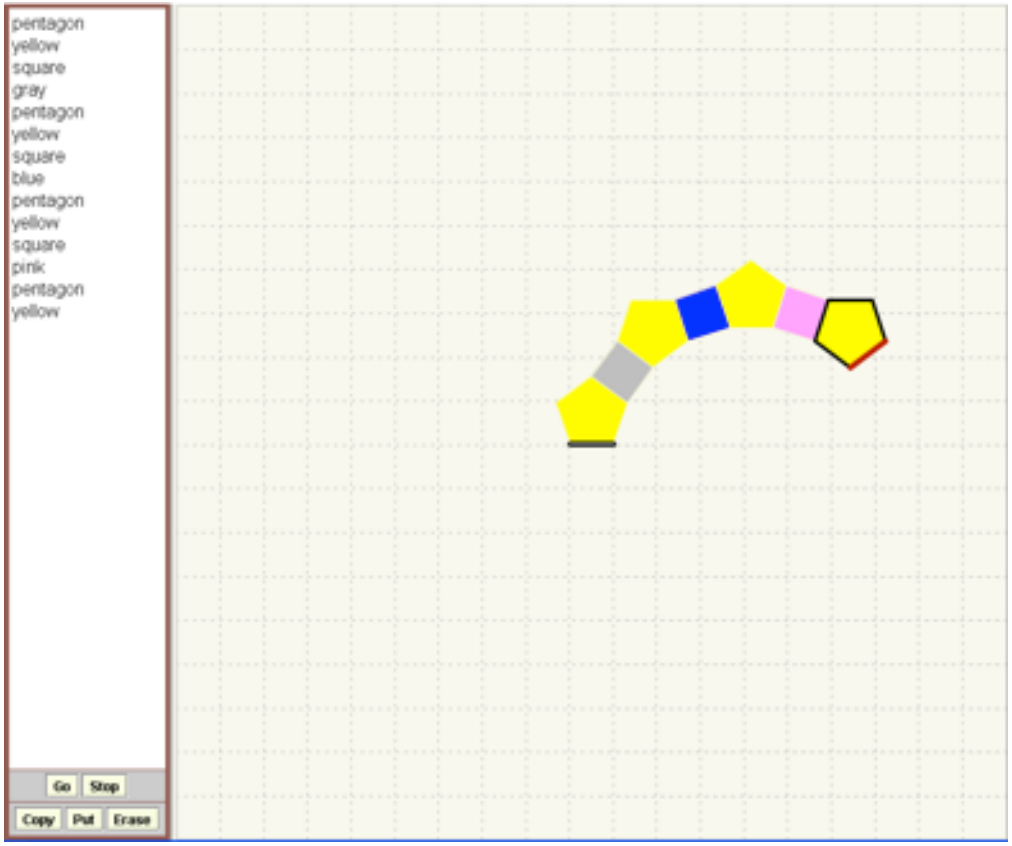
- Immediate activation: As soon as polygons on the left are clicked, they appear on the right-hand panel



Example: Activation

- On-demand activation: After a body of commands is composed, then the user has to click on "run" to see the reaction





Anatomy of interaction: Reaction

Flow

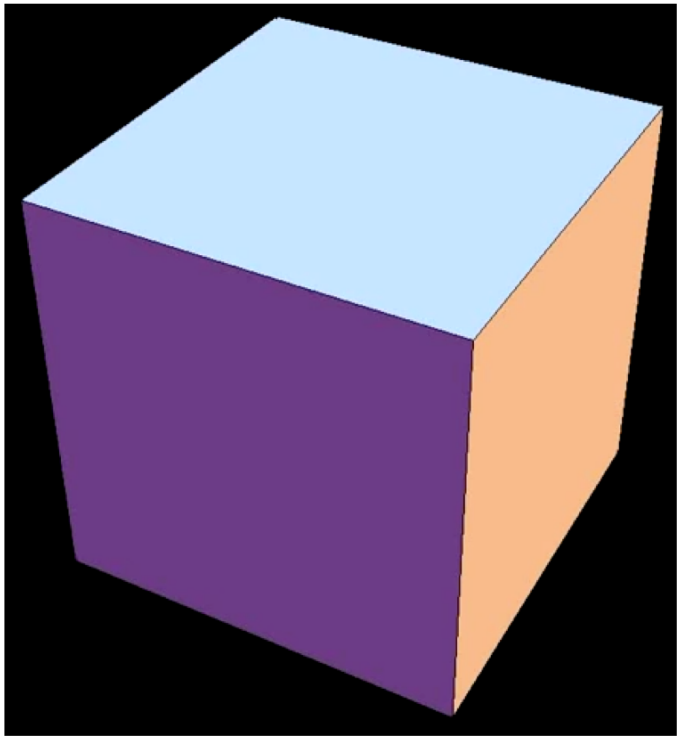
- Concerned with how a reaction is parsed in time
- Two types:
  - Discrete: occurs instantaneously in time and/or is punctuated
  - Continuous: occurs over a span of time in a fluid manner.

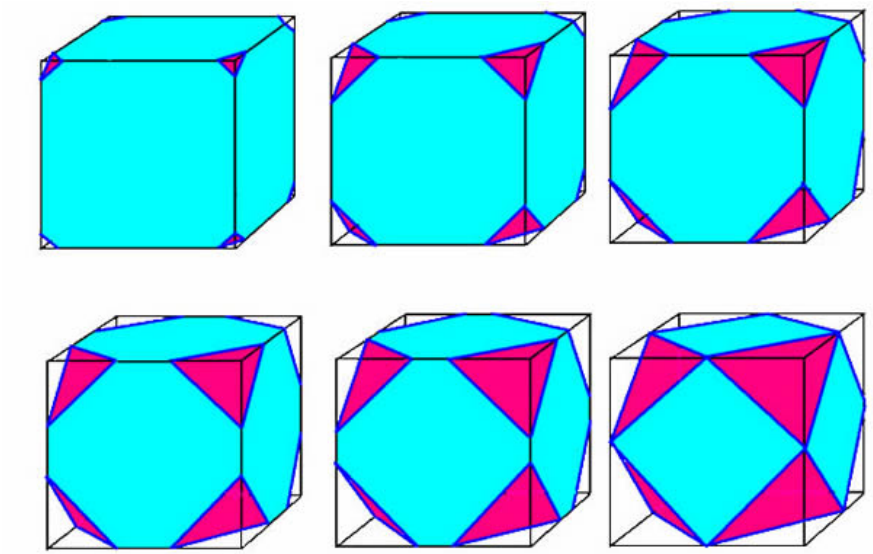
Anatomy of interaction: Reaction

Transition

- Concerned with how change is presented on a 2D display
- Two type:
  - Stacked: changes in a representation are sequentially stacked one on top of another in time; although the rep is visually changing over some duration of time, only the current state at one point in time is perceivable; past stages of change disappear and future stages are not shown
  - Distributed: multiple stages of change in a rep are simultaneously perceivable by being spatially distributed. Of all the changes a rep may pass through, several are chosen as snapshots. Those snapshots are then displayed as new reps, such that the user can view them in parallel on the screen, without previous stages disappearing in time

Example: Stacked vs distributed transition





Anatomy of interaction: Reaction

Spread

- Concerned with the spread of effect that an action causes. An action can cause a change to occur in the rep of interest. However, other reps may be affected as well.
- Two types:
  - self-contained: only causes a change to occur in the representation that is of interest
  - Propagated: causes a change in other reps on the interface; the effect of a reaction propagates such that other reps are affected

Example: Spread

- Which type(s) of spread?

Anatomy of interaction: Reaction

State

- Concerned with the conditions of the interface once the reaction process is complete and the interface reaches equilibrium
- Three types:
  - Created: new reps are created which did not exist before the action was committed
  - Deleted: some reps are deleted from the interface
  - Altered: one or more properties of some reps (e.g., their value, position, size, orientation, etc.) are modified

Example: State

- What types of state do you observe here?

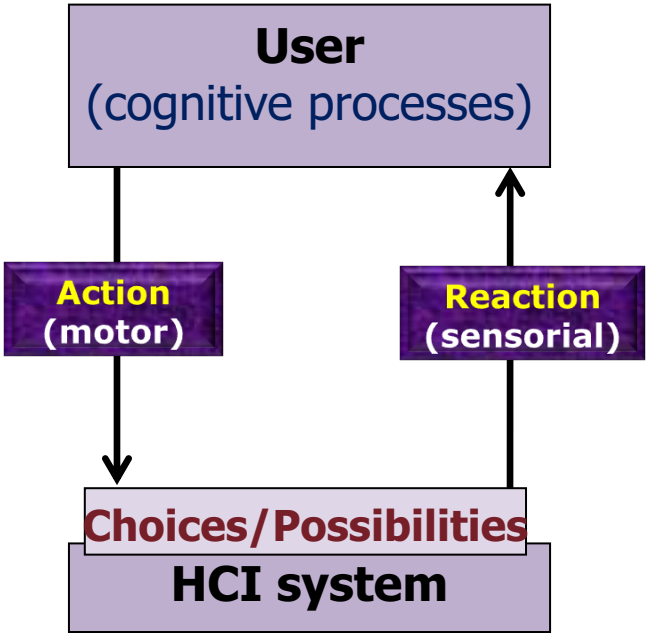
Anatomy of interaction: Reaction

Context

- Concerned with the general context in which reps exist as the interface reaches equilibrium. Before an action is committed, a rep exists within some context. During the reaction process, that context can change or it can remain the same.
- Two types:
  - Changed: representations will be in a different context once the reaction process finishes
  - Unchanged: representations remain in the same context after the completion of the reaction
- E.g., think about Bejeweled and Sokoban; what types of context do they have?

Micro-elements of interactivity

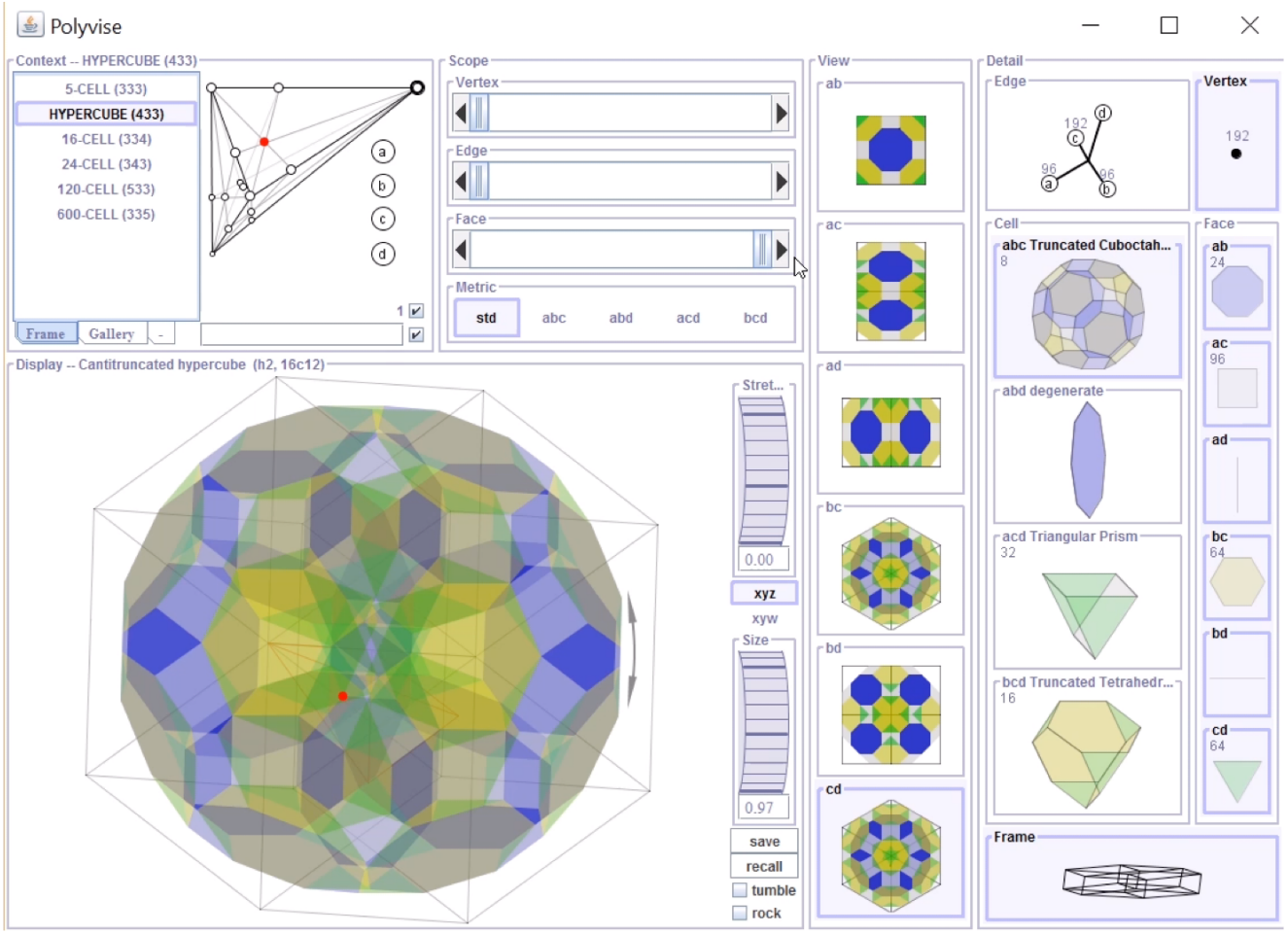
1. Presence
   - Explicit or implicit
2. Agency
   - typing, clicking, flying or walking
3. Granularity
   - Atomic, composite
4. Focus
   - Directly, indirectly
5. Flow
   - Discrete, continuous
6. Timing
   - User-paced, system-paced



1. Activation
   - Immediate, delayed, on-demand
2. Flow
   - Discrete, continuous
3. Transition
   - Stacked, distributed
4. Spread
   - Self-contained, propagated
5. State
   - Created, altered, deleted
6. Context
   - Changed, unchanged

Overall example of micro-level elements

- Analyze this with regard to all its elements and their types



Micro-level interactivity

- Using such a framework, designers can methodically analyze the combinatorial possibilities that the operational types of interaction elements create in terms of design variations. For example, if each interaction has 12 elements, each of which has at least 2 types, the number of possible ways to operationalize an interaction is at least 2 to the power of 12 , or 4,096. It should be noted that not all elements are applicable or important in all situations. But they provide for systematic thinking about design and have definite effects on the mind of the user.

Core interaction pattern

- Every HCI system has a core interaction pattern
  - Compound suite of interactions that are used often and repeated in an HCI system = core set of interactions
  - Each interaction has an anatomical structure which is made of
    - Presence, agency, granularity, focus, flow, timing, activation, flow, transition, spread, state, and context

Core interactions and experience

The set of core interactions (each having an anatomical structure) which users use to act upon system representations gives emergence to its interactivity (micro & macro) and hence affects both experience and usability of the system.

The more coupling between structural elements of interaction and user needs, the more human-centered the interactivity of the artifact.

Need to give a lot of thought to the design of the core interactions and their structural anatomy.

Interaction units / molecules

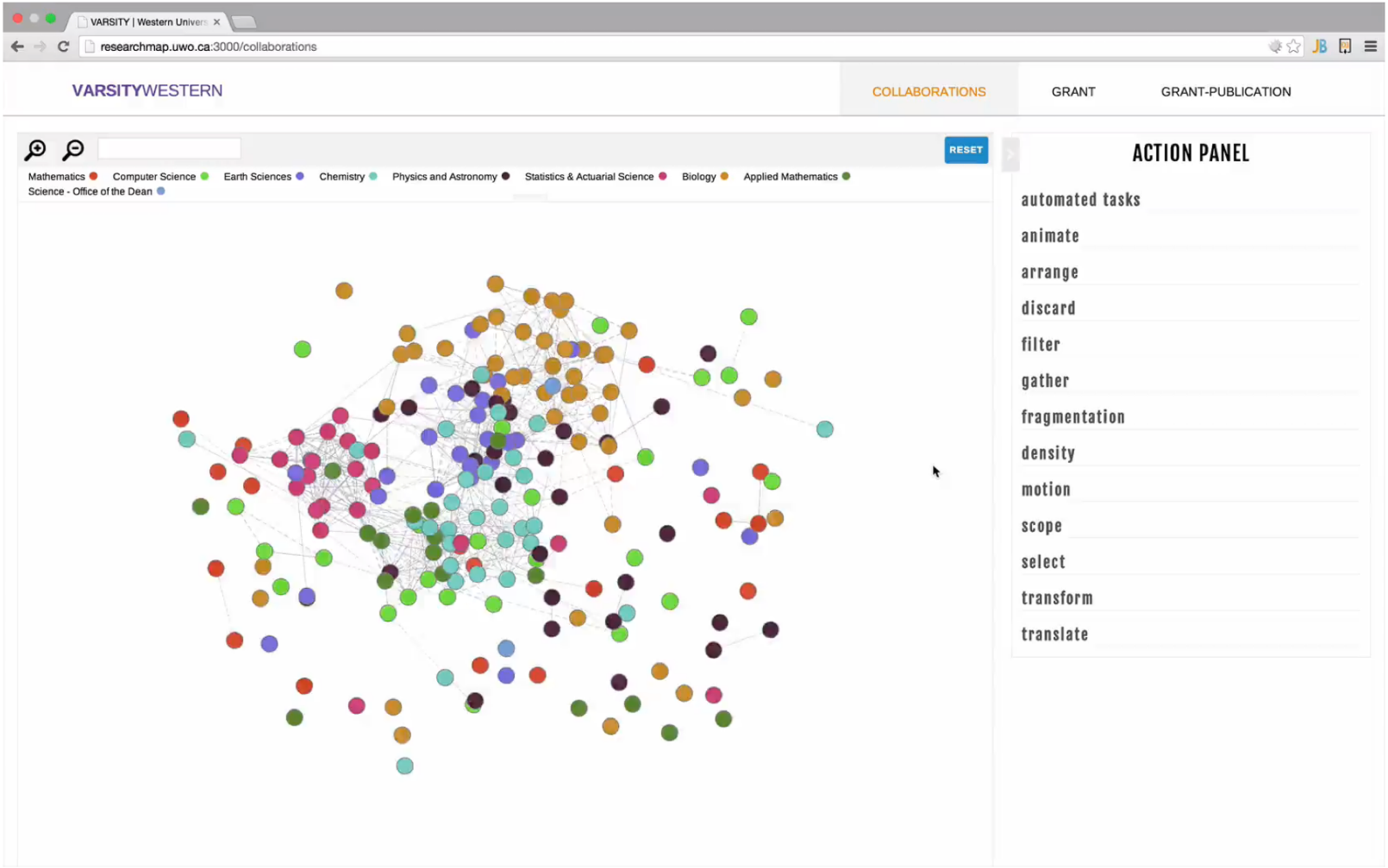
- Each interaction is made of two parts
  - Action and reaction (or outcome)
- Action-reaction form an interaction unit or molecule
- Users have a set of choices or options to interact with different representation at the interface
- The chain of interactions at the micro-level creates a trajectory and gives rise to macro-level interaction
  - We can refer to this as activity and distributed thinking (performing activities such as problem solving, learning, ...)
  - We only directly design at the event-level and, to some extent, the action-level

Macro-Level Interactivity: Analysis of Trajectory of Interaction

Interactivity: Macro-level factors

- Diversity
  - This factor is concerned with the number and diversity of interactions that are available to the user
    - A multiplicity of interactions allows the user to perform different types of cognitive tasks

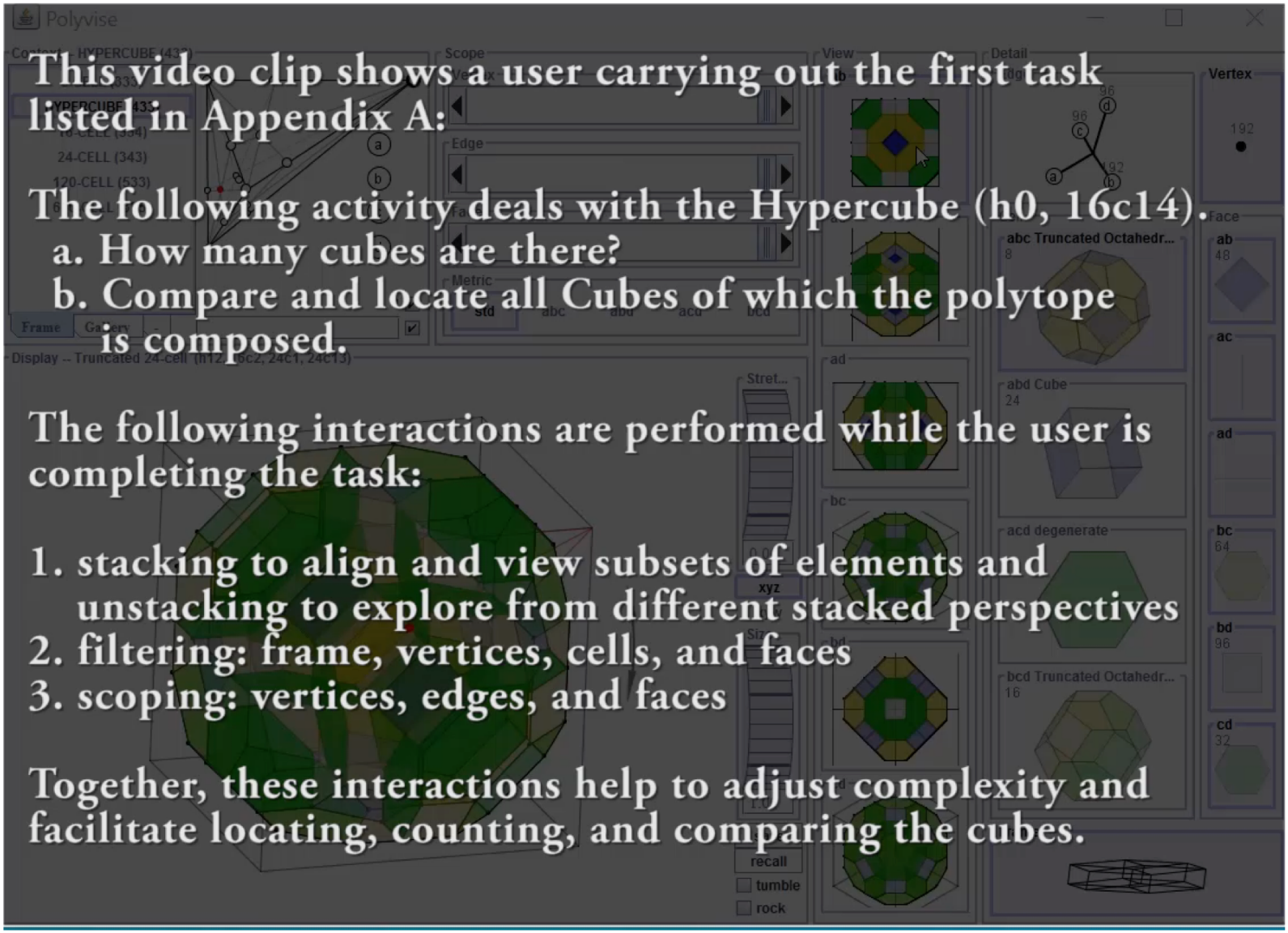
Example: Diversity



Interactivity: Macro-level factors

- Complementarity
  - This factor is concerned with harmonious and reciprocal relationships among interactions, and how well they work with and supplement each other.
    - This factor affects the quality of interaction of a tool by allowing the user to conduct more coordinated and integrated cognitive activities—although each individual interaction independently supports one particular action, collectively the interactions can work together and assist the user to perform more complicated tasks and activities

Example: Complementarity



Interactivity: Macro-level factors

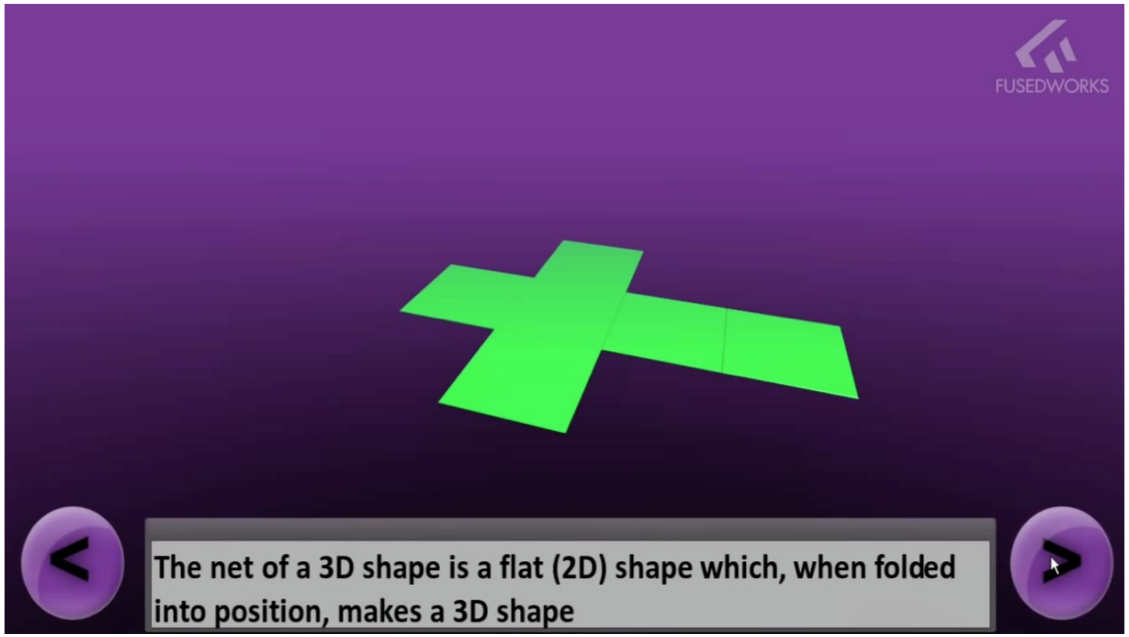
- Flexibility
  - This factor is concerned with the range and availability of adjustability options
    - A highly flexible tool provides options for the user to be able to adjust the properties of the interface to suit his/her needs, characteristics, and goals
      - E.g.,
        - customizing the perceptual characteristics of the representations (e.g., color, brightness, viewing perspective, level of detail, and size)
        - Changing the pace of animation

Interactivity: Macro-level factors

- Genre
  - This factor is concerned with the types of transactions that are available to the user
    - This refers to the overall transactional nature of a system
      - access-based
        - No new information is put into the system
      - annotation-based
        - User can add info to existing representations
      - construction-based
        - User can create new representations
      - combination-based
        - User can do 2 or more of the above

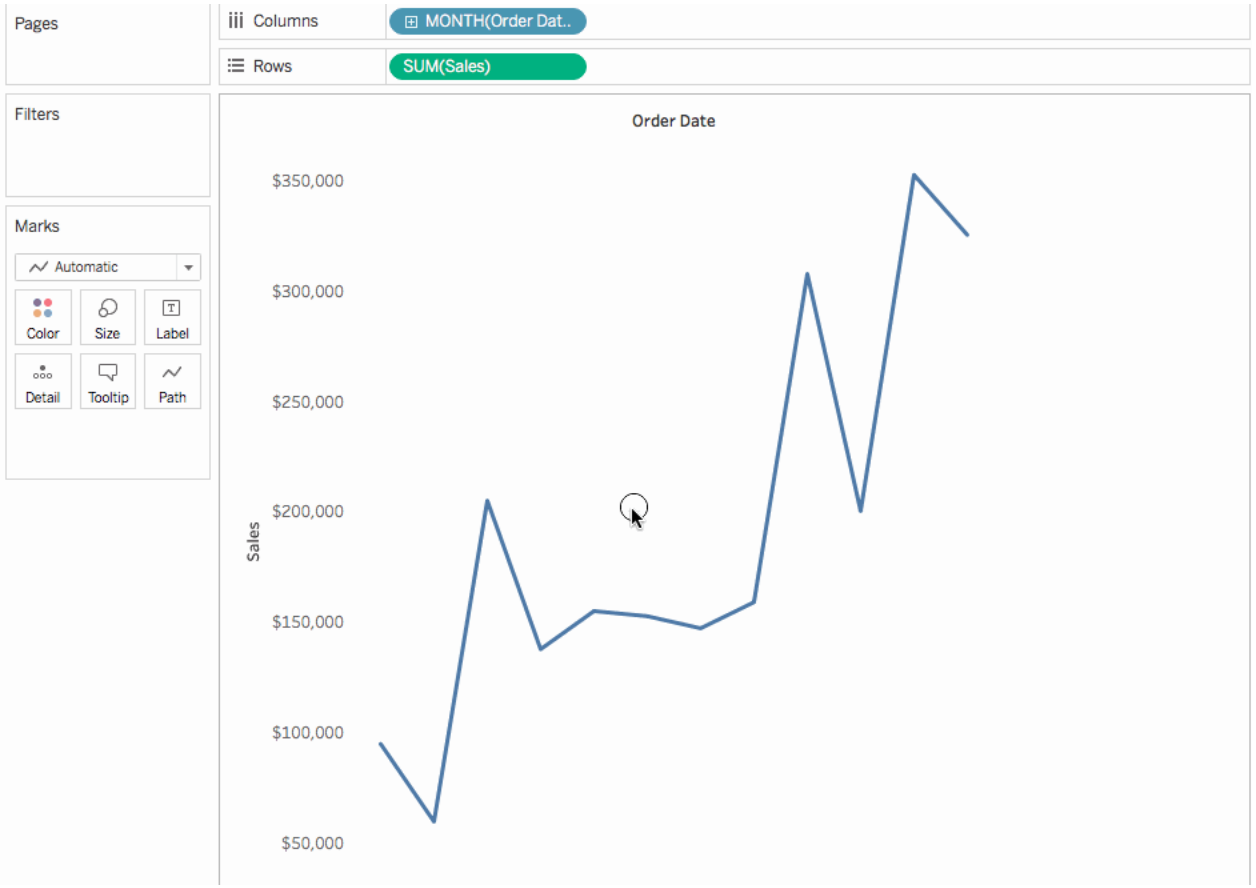
Interactivity: Macro-level factors

- Genre
  - Access-based
    - The overall operation by which users interact with artifact is access to contained information
    - No new information is put into the system



Interactivity: Macro-level factors

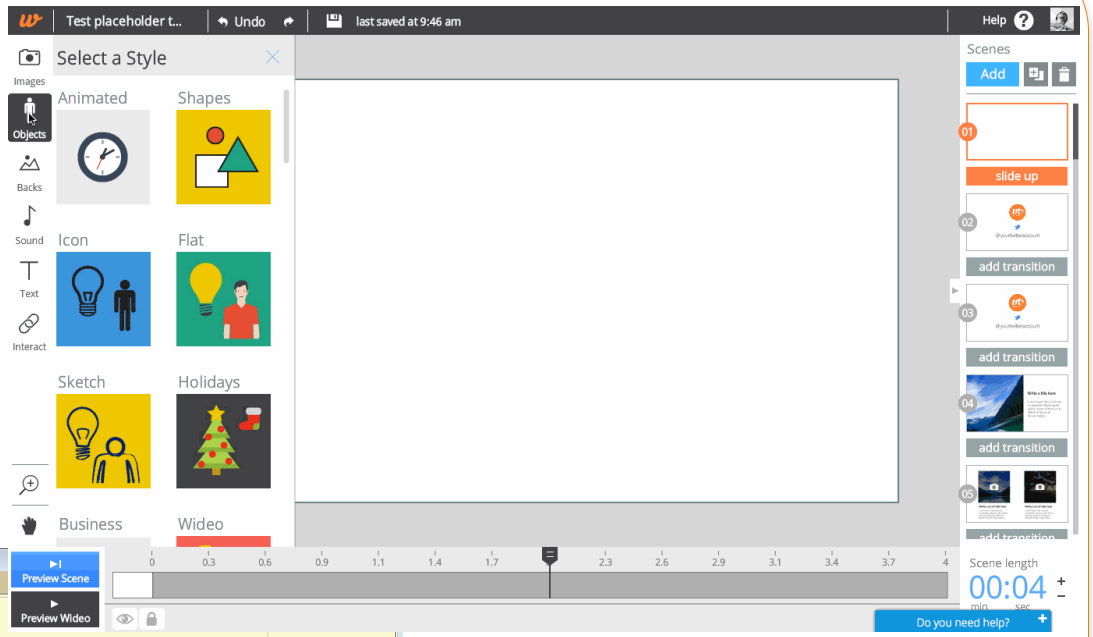
- Genre
  - Annotation-based

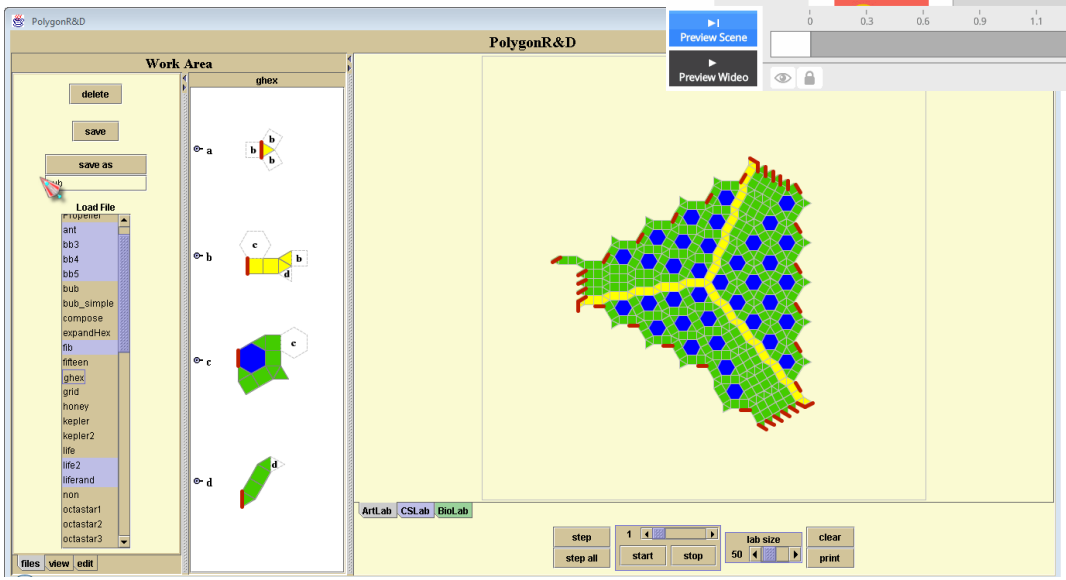


https://onlinehelp.tableau.com/current/pro/desktop/en-us/annotations_annotations_add.html

Interactivity: Macro-level factors

- Genre
  - Combination-based





Sources

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- Parsons P, Sedig K, Didandeh A, Khosravi A. (2015). Interactivity in Visual Analytics: Use of Conceptual Frameworks to Support Human-centered Design of a Decision-support Tool. *48th Annual Hawaii International Conference on System Sciences (HICSS), IEEE*, 1138-1147.

Summary

- Interactivity
  - Operational aspect of interaction
  - Anatomy of interaction
  - Micro- and macro-level elements