

Artificial Intelligence

Whatever that is



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Follow

Best advice I got when I entered academia:
"We're all smart. Distinguish yourself by being
kind."

Hello, world!

- Joseph C. Osborn
- Grew up in St. Louis, MO, USA
- B.S. in Software Engineering, RIT, Rochester, NY, USA
- MFA in games, Univ. Southern California, Los Angeles
- Ph.D. candidate (nearly finished) in CS, UC Santa Cruz
- Research in games, AI, program verification, computer-aided creativity...

Who are you?



Course Outline

- Foundations
 - What is AI?
 - Critical technical practice
 - Python programming
 - State machines & CS theory
 - Search, planning, and game AI

Course Outline

- Statistical techniques
 - Probabilistic programming
 - Machine learning as function approximation
 - (Deep) neural networks
 - Recurrent neural networks

Course Outline

- Knowledge-based techniques
 - Logic and logic programming
 - Rule systems and grammars
 - Planning with logic
 - Non-monotonic logics

Projects

- Currently training an extremely complicated neural network



Projects

- Programming languages for representing games
 - Easier to write, or easier to analyze, or...
- Static/dynamic analysis of game rules
 - Prevent design bugs
 - Ensure design matches program
 - Visualize effects of design changes

Projects

- Analysis and visualization of game playthroughs
 - Games that can observe their own behavior
 - Analysts can understand how players act
 - Designers can visualize AI behaviors
- Crowd-sourced software verification

Research Area

- Social simulation
- Game level/art/etc generation
- Game archiving and citation standards
- Competitive game AI
- Reasoning about emotional impact of games

“AI”



“AI”

“Intelligence is whatever machines
haven't done yet”

—Larry Tesler

Intelligence

- I don't want to talk about it, it's too big and too hairy



(Pre-)History of AI

- 4th century BCE: Syllogistic logic (Aristotle)
- 1206 CE: Programmable robots (Al-Jazari)
- 17th century CE:
 - Cartesianism
 - Calculators of Pascal, Leibniz, and Morland

(Pre-)History of AI

- Mechanical toys and programmable machines through the 19th century
- Boolean logic, Frege's propositional logic, and the work into the 20th century of Tarski, Russell, Godel, Whitehead, etc.
- Turing's Test
- Two main threads: “mechanized reasoning” and “mechanical animals”

History of AI: 1950-60s

- John McCarthy coins term (and many others) & invents LISP
- Automated theorem provers
- Invention of: Neural nets, logical *resolution*, semantic nets, and search techniques
- Good AI checkers players
- ANALOGY, SIR, SAINT, ELIZA

SHRDLU (1971)

Person: PICK UP A BIG RED BLOCK.

Computer: OK. (does it)

Person: GRASP THE PYRAMID.

Computer: I DON'T UNDERSTAND WHICH PYRAMID YOU MEAN.

Person: FIND A BLOCK WHICH IS TALLER THAN THE ONE YOU ARE HOLDING
AND PUT IT INTO THE BOX.

Computer: BY "IT", I ASSUME YOU MEAN THE BLOCK WHICH IS TALLER THAN
THE ONE I AM HOLDING.

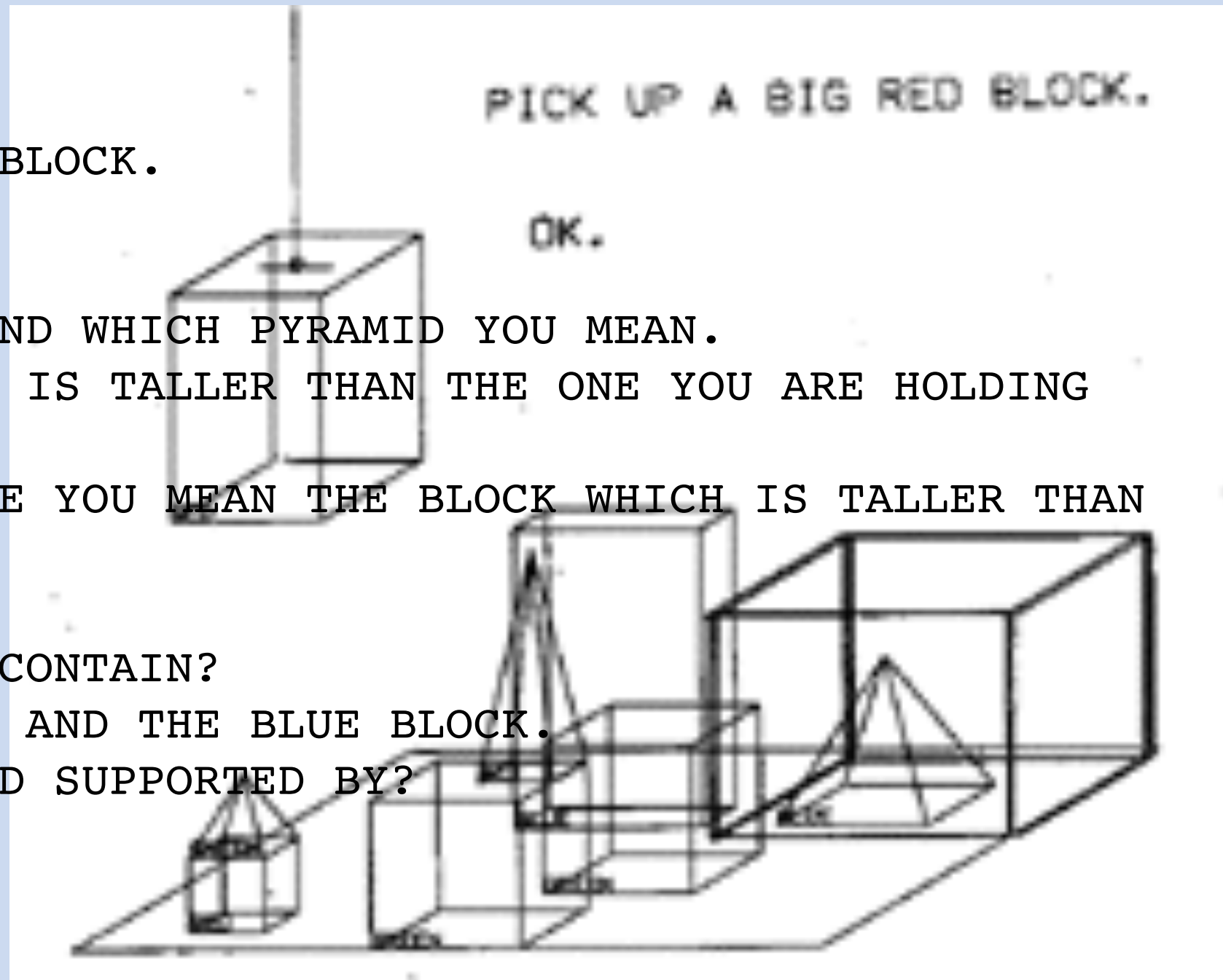
Computer: OK. (does it)

Person: WHAT DOES THE BOX CONTAIN?

Computer: THE BLUE PYRAMID AND THE BLUE BLOCK.

Person: WHAT IS THE PYRAMID SUPPORTED BY?

Computer: THE BOX.



SHRDLU (1971)

Person: DOES A STEEPLE

Computer interrupting: SORRY, I DON'T KNOW THE WORD "STEEPLE".

Person: A "STEEPLE" IS A STACK WHICH CONTAINS TWO GREEN CUBES AND A PYRAMID.

Computer: I UNDERSTAND.

Person: ARE THERE ANY STEEPLES NOW?

Computer: NO.

Person: BUILD ONE.

Computer: OK. (does it)

History of AI: 1970-80s

- “AI Winter” led to a re-branding of AI efforts
- SHRDLU (“blocks world”), ABSTRIPS
- Prolog, expert systems
- MYCIN, INTERNIST
- Meta-Dendral, BACON
- Discourse modeling
- Non-monotonic logics
- Autonomous vehicles

History of AI: 1990s—

- Backgammon and chess (and now Go!) players emerge
- Data mining and information extraction
- Computer vision, natural language processing, planning, game AI, machine translation, non-monotonic logic, ...

AI is a set of *methods*,
techniques, and
approaches

- Heuristic search
- Reinforcement learning
- Case-based reasoning
- Convolutional nets
- Model-finding
- Incomplete reasoning
- Sequence-to-sequence learning
- Hidden markov models
- Support vector machines
- Transition systems
- Proof assistants

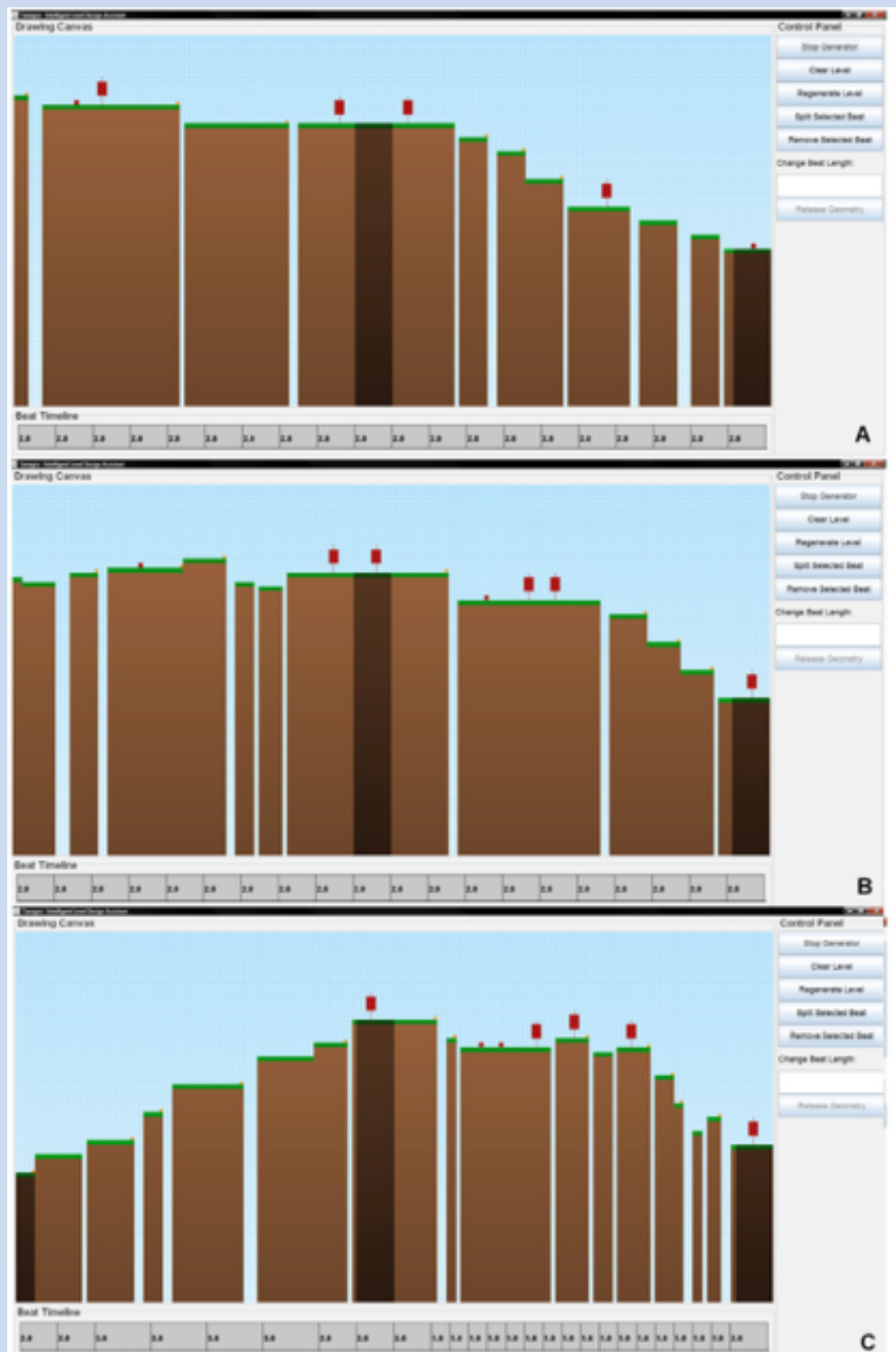


Knowledge-Based

Statistical

“Knowledge-Based Approaches”

- Directly encode *rules* used by humans/experts
 - Or other formal models of e.g. narrative, society, population growth
- Examples
 - Social simulations, video game AI, medical diagnosis, certain chat bots
 - Production systems, proof assistants, logical encodings, hand-built simulations, ...

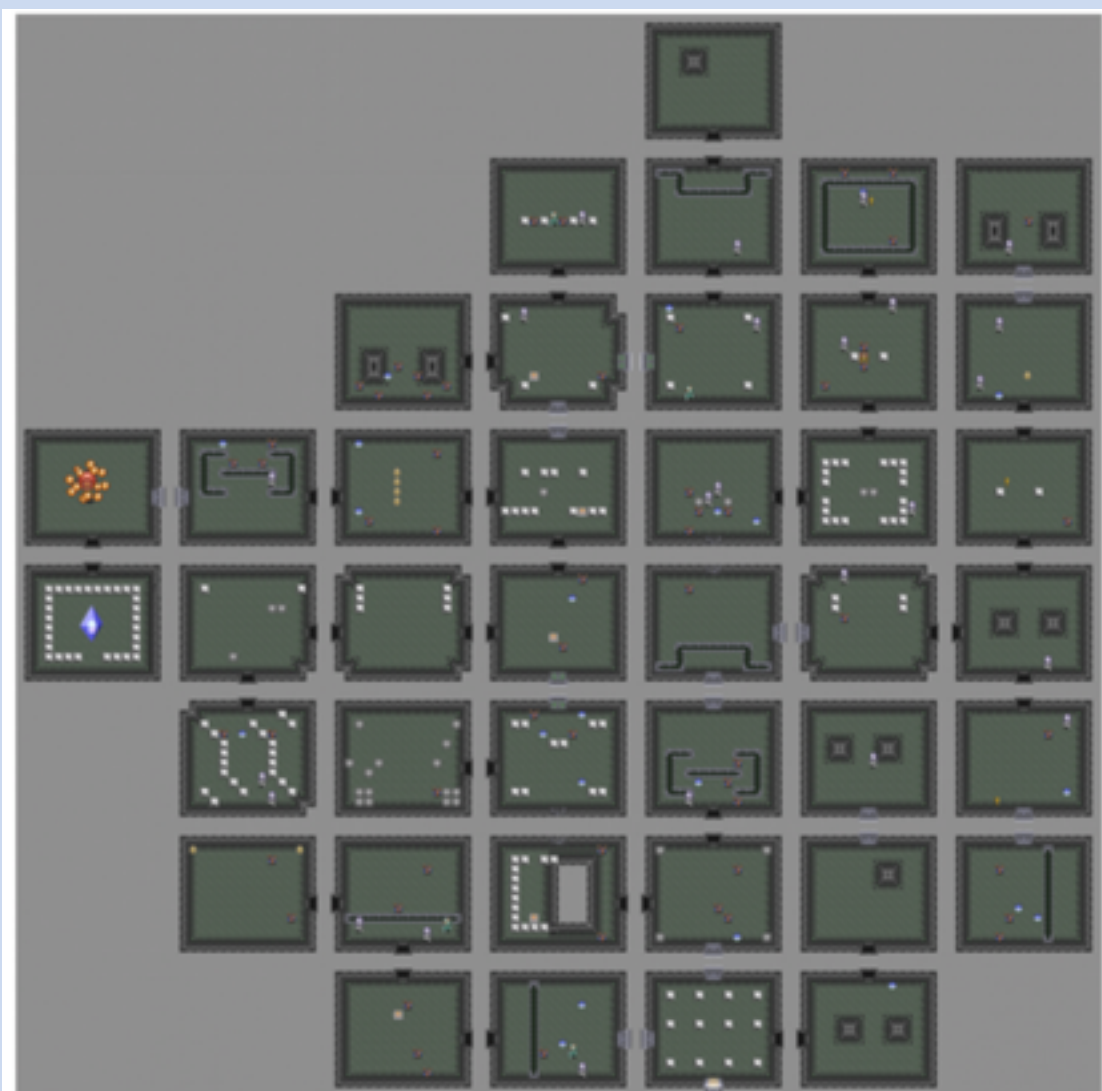
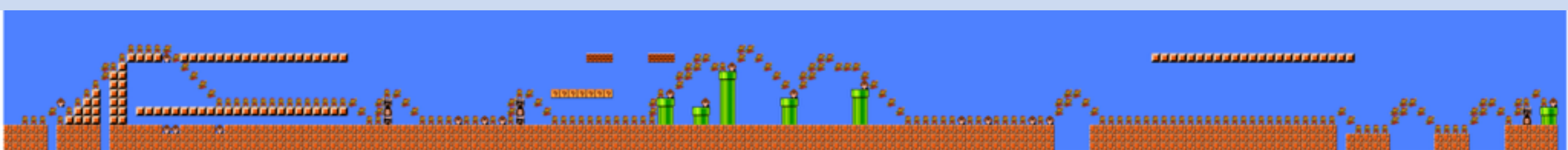


“Knowledge-Based Approaches”

- Benefits
 - “Build it to understand it”
 - Easy to explain conclusions and behaviors
 - Potentially *expressive* for system creators
- Drawbacks
 - Requires very introspective experts who are also experts in AI systems
 - Can be fragile in the face of new situations
 - Implicit bias in experts creeps in

“Statistical Approaches”

- Improve at a *task* by *learning* from *examples*
 - Fit a curve given example points
 - Classify images as “dog” or “cat”
 - More examples -> better results
- Examples
 - Photo face tagging, advertising placement, some game level generation work, ...
 - Neural networks, regression, support vector machines, hidden markov models, “machine learning” in general...



I am GameSage.
Click me when you are ready to begin.

GameSage allows users to describe a hypothetical videogame and get a list of the existing games that are closest to the description.

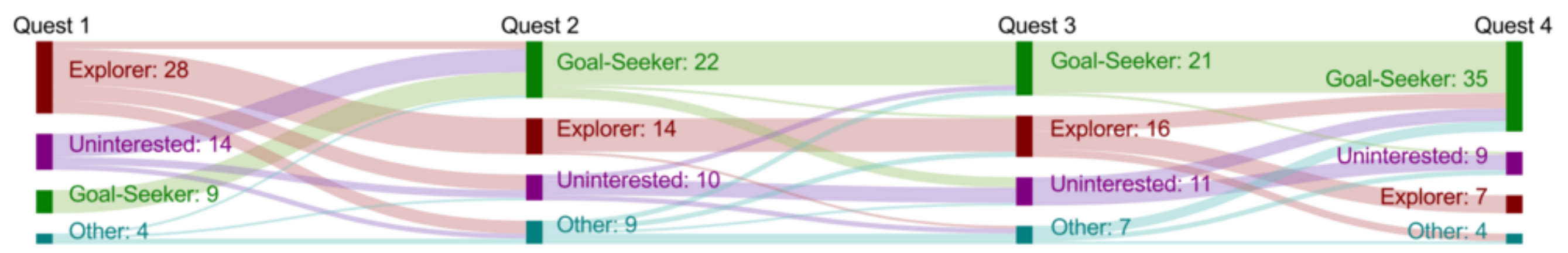


Figure 1: Illustration of the play style shifts observed among players in the user study (n=55). Each vertical block represents a segment (quest or episode) of the game and is divided into 4 play styles with their size proportional to the number of participants. The flow between blocks represent shifts on the observed play style over time.

“Statistical Approaches”

- Benefits
 - Generalize to unseen situations
 - Doesn't require understanding *how* people do things, just *what* solutions look like
 - After training, queries can be very efficient
- Drawbacks
 - Hard to control and explain
 - Implicit bias in dataset creeps in
 - Training can be expensive (or training sets hard to come by)

Exercise

- Pair up
- Identify three “AI” systems that you know something about.
- For each, discuss:
 - Is it mainly knowledge-based or mainly statistical/machine-learning-based?
 - How can you tell?
 - What are some of its weaknesses/blind spots?