Artificial Intelligence

- Since most games involve having two participants (be they “players” or “enemies” within the game’s context), what can be done when there are less users of a program than participants?
  - Clearly, part of the program itself must fulfill the role of participant.

Artificial Intelligence

- How, then, can a program even attempt to make intelligent decisions within the context of a game?
  - A quick side note: this discussion’s impact reaches past games, but for simplicity, we’ll stick to this context for today’s lecture.

Artificial Intelligence

- The definition of AI –the capability of a machine/software to imitate intelligent human behaviors.
  - General Intelligence (e.g., deduction, reasoning, problem solving, natural language processing)
  - Expert Systems (e.g., diagnosis systems)
  - Perception (e.g., computer vision)
  - Social Intelligence (e.g., affective computing)

Artificial Intelligence

- But AI can also be defined more specifically (e.g., IBM’s Chess software “Deep Blue”)
- The aspect we’ll be focusing on – “future prediction”.
  - What moves will the other participants likely make? What effects will result?
  - How can these potential situations be manipulated to a participant’s favor?

Artificial Intelligence

- Humans and Computers are functioning differently
  - Humans start learning at the child-birth and function independently at the age of ??
  - Computers need software, and never function with the total independence
  - computers are incredibly *good* at – performing millions, even billions of small calculations per second

Artificial Intelligence

- Humans and Computers are built and functioning differently
  - Humans store the long-term memory and forget the short-term memory
  - Computers can store everything and never forget (e.g., Google “Lewinsky Scandal”)
  - Humans are incredibly *good* at creativity, and always generate new ideals and products

AI vs Machine Learning

- An important note – due to Hollywood’s love of using “artificial intelligence” in the movies, there’s a bit of a misconception as to what it actually is.
- There are actually two different, somewhat related areas that are focused on modeling intelligence through computers.

AI vs Machine Learning

- Artificial intelligence –Creating an algorithm based directly on our own thought processes regarding a problem.
- Machine learning – uses mathematical modeling + statistics to (hopefully) enable the computer to learn from data and draw its own conclusions.
  - spam filtering and search engine

Artificial Intelligence

- Taking these observations into account, one commonly used strategy is that of "*search*."
  - The core idea: see what happens if a participant were to make any particular move from a given set of "candidate" moves.
  - From there, take the move that gives the "best" result.

Search

- For this class’s purposes, we’ll just use the entire set of possible moves as the “candidate set” of moves.
  - There’s an AI class in the department that will look at alternative situations and get into more detail.

Search

- In the context of a game, say… tic-tac-toe…

O	**O**	**O**
O	**X**	**O**
O	**O**	**O**

Search

- this means checking how desirable each of “O”s potential moves is.

O	O	O
O	X	O
O	O	O

Search

- Problem: what is a "good" state for the game to be in?
  - Related question: does searching through our potential moves – and *only the one participant's* potential moves – give us enough data to reach a proper decision about what is a "good" state?

Search

- A frequent approach: search not only through “O”s moves, but *also* through “X”s moves!

O	**X**	**X**
X	**X**	**X**
X	**X**	**X**

Search

- Repeat this for a while to search through a greater magnitude of such potential states.

O	**O**	**X**
X	**X**	**O**
O	**X**	**X**

Search

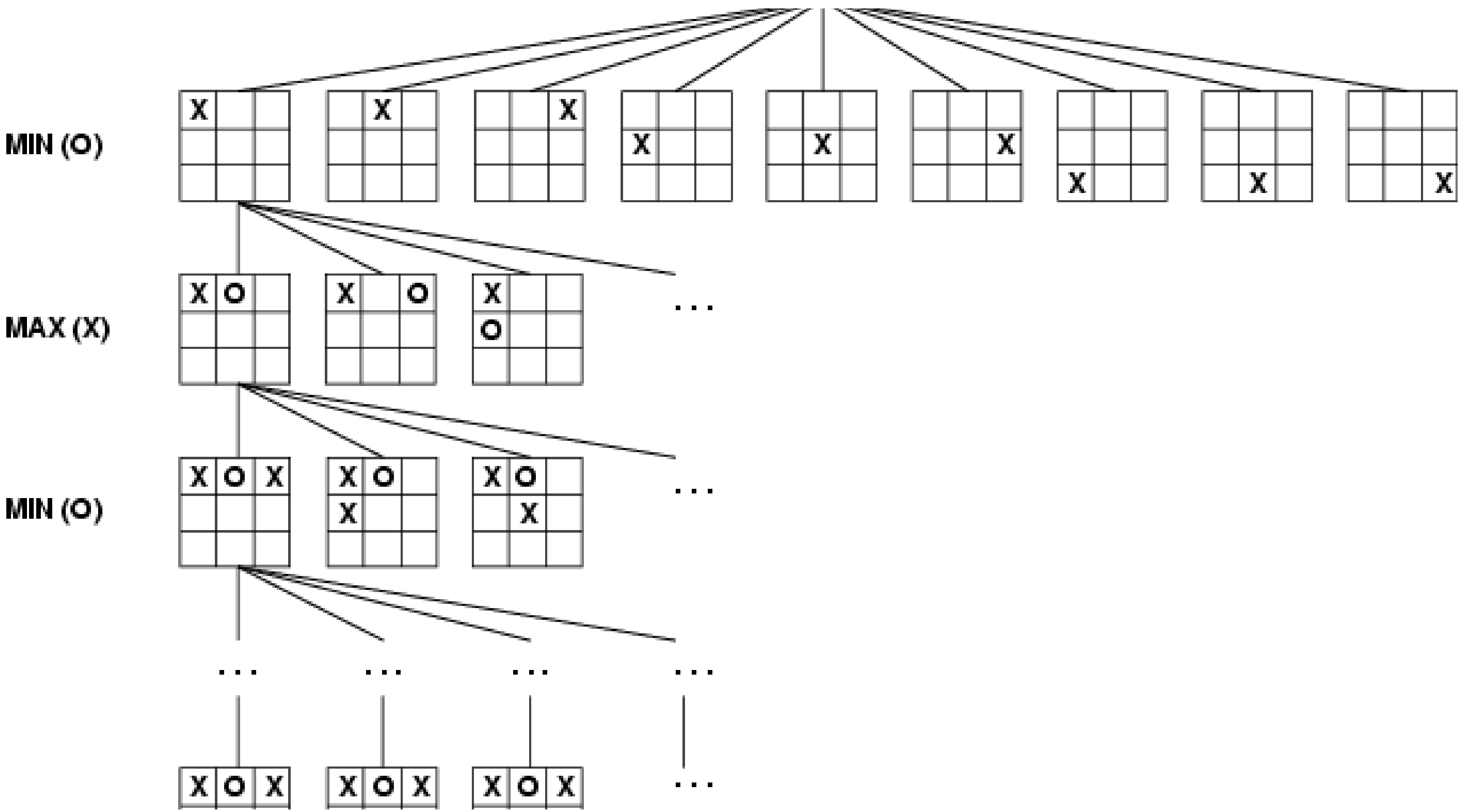
- For a game like tic-tac-toe, it is easy enough for a computer to search through absolutely every state.

O	**O**	**X**
X	**X**	**O**
O	**X**	**X**

Search

- Now, how can we search through all of these states effectively?
  - Generate them recursively!
  - A participant may predict the actions of another participant by using its own move evaluation techniques for that other participant.

Search Space



Search

- For other games (like chess), the *search space* is too large to fully check every possible state.
- For such cases, each potential original move can be evaluated based on the potential consequences of that move.

State Evaluation

- A few remaining questions:
  - How can we evaluate a move based on its potential future outcomes?
  - What makes a “good” state “good”?

State Evaluation

- For tic-tac-toe and many other games, one such example is known as the minimax search.
  - The idea: minimize the other player’s maximum gain.
  - Or vice-versa: maximize the participant’s potential minimum gain.
  - The number of game states it has to examine is exponential in the number of moves.
  - Alpha-beta pruning technique helps

State Evaluation

- Keep in mind: in tic-tac-toe, blindly making the move that gives yourself the chance to win is not necessarily the best.
  - It's important to make sure that the same move doesn't cause you to lose!

Search

- While O “could” win if it took the move on the top… that move is actually a guaranteed loss.

O	O	
X	**X**	O

Search

- The best move is to take the blocking move on the right.
  - Maybe X will slip up later…

O	**O**	
X	**X**	**O**