Depth in Strategic Games

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The Question

Is there a well-defined property of game systems that corresponds to what designers and players mean when they refer to “strategic depth”?

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Depth in Strategic Games

Preliminary Observations

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Preliminary Observations

- game design and computer science

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- game design and computer science
- tractable, but not currently known

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- game design and computer science
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- existing research

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Preliminary Observations

- game design and computer science
- tractable, but not currently known
- existing research
- laying a foundation

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Depth in Strategic Games

Clarifying the Question

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Clarifying the Question

- “deep” ≠ “good”

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- a spectrum, not a binary

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- psychology-independent

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- “deep” ≠ “good”
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- psychology-independent
- abstract, simplified strategic games

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Clarifying the Question

- “deep” ≠ “good”
- a spectrum, not a binary
- psychology-independent
- abstract, simplified strategic games
- “d”

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Depth in Strategic Games

Why Ask the Question?

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Why Ask the Question?

- conceptual tool to improve design discussions

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- conceptual tool to improve design discussions
- suggest directions for design exploration

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- pure curiosity and knowledge

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Why Ask the Question?

- conceptual tool to improve design discussions
- suggest directions for design exploration
- pure curiosity and knowledge
- general questions about AI and “machine aesthetics”

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Depth in Strategic Games

Our General Approach

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Our General Approach

- strategic games as problem-solving tasks

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Our General Approach

- strategic games as problem-solving tasks
- different “flavors” of hardness

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Our General Approach

- strategic games as problem-solving tasks
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- complexity theory

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- existing properties:

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Our General Approach

- strategic games as problem-solving tasks
- different “flavors” of hardness
- complexity theory
- existing properties:
  - state-space

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Our General Approach

- strategic games as problem-solving tasks
- different “flavors” of hardness
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- existing properties:
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- observing characteristics of real-world games

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- strategic games as problem-solving tasks
- different “flavors” of hardness
- complexity theory
- existing properties:
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  - branching factor
  - “traditional” hardness
- observing characteristics of real-world games
- building a model

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Depth in Strategic Games

Characteristics of Depth

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Characteristics of Depth

- Large community of dedicated players

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- Vast body of knowledge and strategic analysis

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- The Skill Chain (eg, Elo)

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- Large community of dedicated players
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- The Skill Chain (eg, Elo)
- The Strategy Ladder

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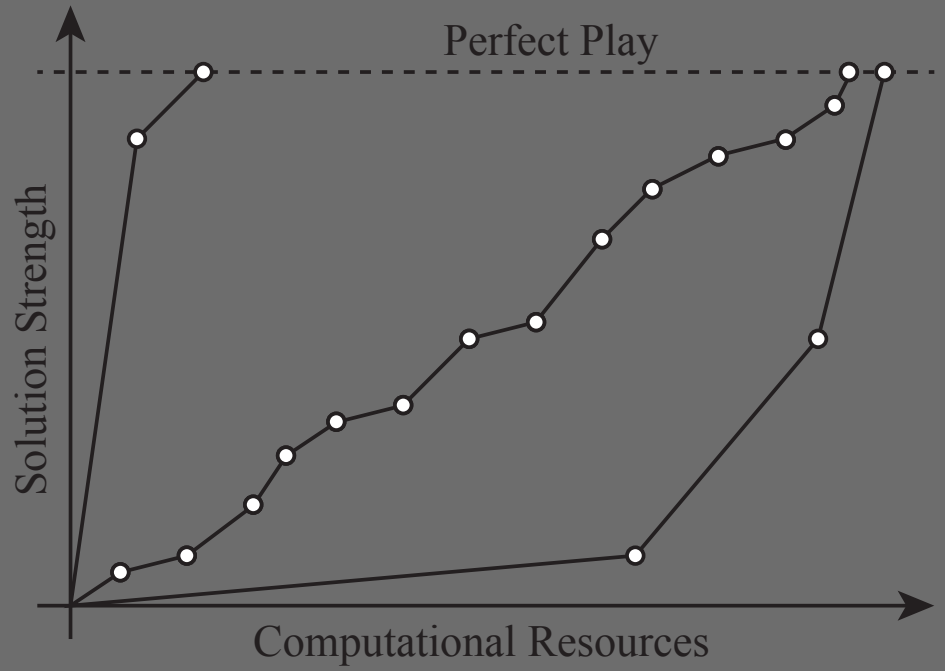
Depth in Strategic Games

The Strategy Ladder



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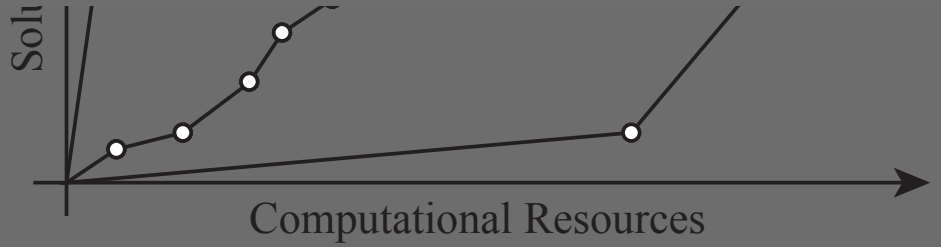
Depth in Strategic Games

The Strategy Ladder

The capacity for a game system to allow for a ranked sequence of approximate solutions



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Depth in Strategic Games

The Strategy Ladder

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The Strategy Ladder

- Strategies - complete algorithmic descriptions

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- Strategies - complete algorithmic descriptions
  - when & how to search

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  - when & how to evaluate

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The Strategy Ladder

- Strategies - complete algorithmic descriptions
  - when & how to search
  - when & how to evaluate
  - when & how to use heuristics

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Depth in Strategic Games

The Strategy Ladder

- Strategies - complete algorithmic descriptions
  - when & how to search
  - when & how to evaluate
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- Computational Resources

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Depth in Strategic Games

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  - when & how to evaluate
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  - Number of operations

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  - Number of operations
  - Working memory

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  - Working memory
  - K-complexity “footprint”
- Strength
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  - Quality of move selection
- Steps
  - What is the model’s output?

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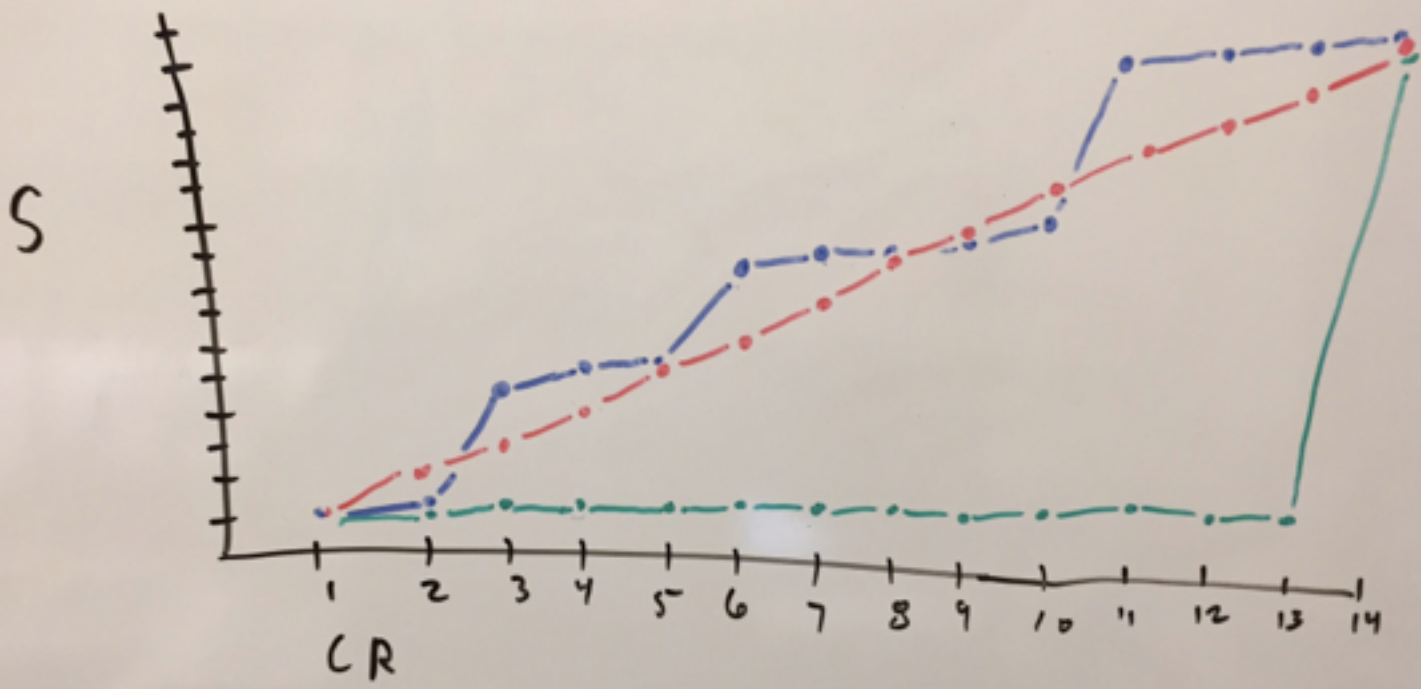
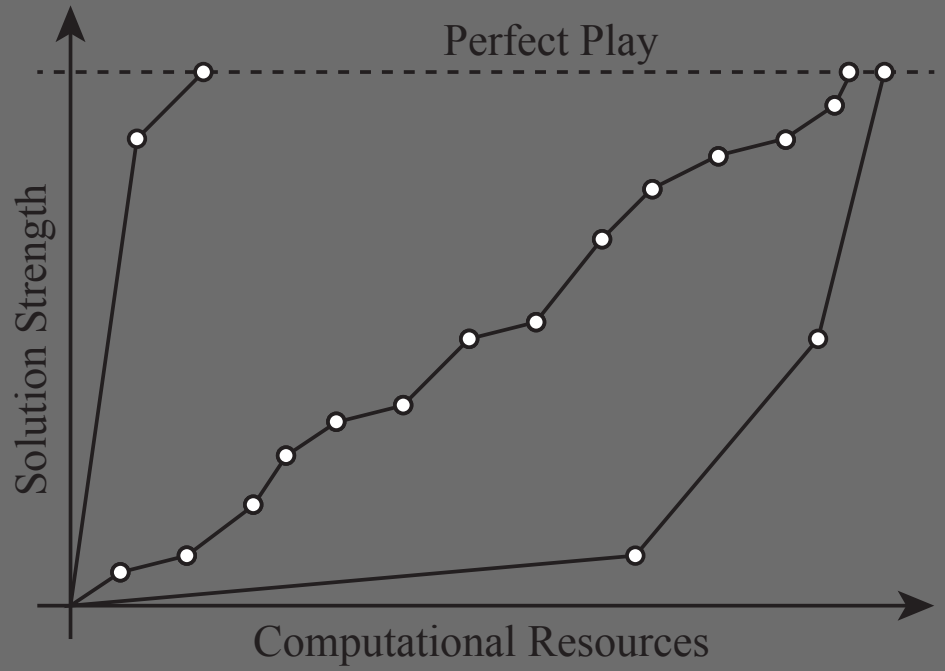


ALEX: $d=4$ $d=0$ $d=1$

PAPER: $d=4$ $d=4$ $d=1$

Depth in Strategic Games

The Strategy Ladder



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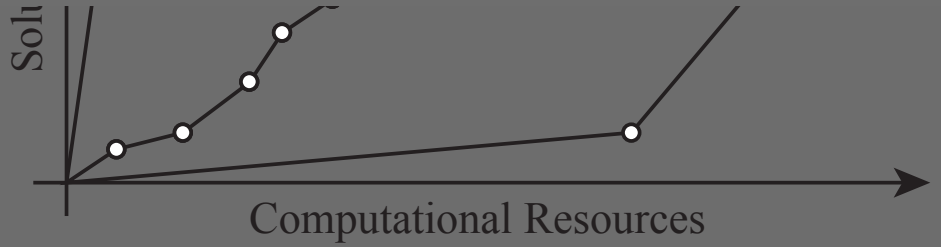
The Strategy Ladder

The shape of this curve reveals something important about the game's underlying structure



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Applications of the Model

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Applications of the Model

- Conceptual tool for speculation

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Applications of the Model

- Conceptual tool for speculation
- Direct observation of real games at low CR levels

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- Conceptual tool for speculation
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- Complete analysis of small games, toy games

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Applications of the Model

- Conceptual tool for speculation
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- Complete analysis of small games, toy games
- Research tool for observing how d changes as you change aspects of the rule set

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Depth in Strategic Games

Observations: Search vs. Heuristics

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- Games of low *d* fail by having *simple* best avail strats

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- Games of low *d* fail by having *simple* best avail strats
- Simple strategies

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Observations: Search vs. Heuristics

- Games of low *d* fail by having *simple* best avail strats
- Simple strategies
  - pure search

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- Games of pure search

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  - don’t “feel” deep

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- Complex strategies
  - knowledge

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  - knowledge
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- Semi-ordered game structure allows for heuristics as a form of search-compression

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Next Steps

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Next Steps

- Further refinement of the model

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- Further refinement of the model
- Application to simple games

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- Development and analysis of toy games

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- Development and analysis of toy games
- Full Analysis of toy versions of real games

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Next Steps

- Further refinement of the model
- Application to simple games
- Development and analysis of toy games
- Full Analysis of toy versions of real games
- Partial analysis of real games

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Next Steps

- Further refinement of the model
- Application to simple games
- Development and analysis of toy games
- Full Analysis of toy versions of real games
- Partial analysis of real games
- Further exploration of search vs. heuristics

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