Toward a Causal Model for Automatic Game Balancing

Jeffrey Moffett
Charles Rich
Joseph Beck

1

Overview

- Goals of Research
- Needs of Automatic Game Balancing
- Toward a Causal Model
  - Defining a Causal Model
  - Building the Model
  - Validating the Model: Player Study
- Future Work: Applying the Model

2

Goals of Research

- Make game balancing more scientific
  - Justify changes made to game
  - Model relationships between game factors
  - Create function to optimize
- Build automatic game balancing system
  - Analyze game session
  - Adjust game accordingly
  - Increase fun by balancing game

3

Overview

- Goals of Research
- Needs of Automatic Game Balancing
- Toward a Causal Model
  - Defining a Causal Model
  - Building the Model
  - Validating the Model: Player Study
- Future Work: Applying the Model

4

Needs of Automatic Game Balancing System

- Quantitative
  - Need explicit objective function
  - No way to get data from user post release
- Utilize accessible data from system
  - Available data: health, accuracy, etc.
  - Bio-sensors impractical
- Right level of abstraction
  - High level not useful
  - Need to encompass all games
- Changes made justified by data

5

Needs of Automatic Game Balancing System

- Quantitative
  - Need explicit objective function
  - No way to get data from user post release
- Utilize accessible data from system
  - Available data: health, accuracy, etc.
  - Bio-sensors impractical
- Right level of abstraction
  - High level not useful
  - Need to encompass all games
- Changes made justified by data

6

Needs of Automatic Game Balancing System

- Quantitative
  - Need explicit objective function
  - No way to get data from user post release
- Utilize accessible data from system
  - Available data: health, accuracy, etc.
  - Bio-sensors impractical
- Right level of abstraction
  - High level not useful
  - Need to encompass all games
- Changes made justified by data

7

Needs of Automatic Game Balancing System

- Quantitative
  - Need explicit objective function
  - No way to get data from user post release
- Utilize accessible data from system
  - Available data: health, accuracy, etc.
  - Bio-sensors impractical
- Right level of abstraction
  - High level not useful
  - Need to encompass all games
- Changes made justified by data

8

Prior Work

- Flow (Csikszentmihalyi)
- EVE (Burns)
- MDA (Hunicke, LeBlanc, Zubek)
- GameFlow (Sweetser and Wyeth)
- Predator/Prey Heuristic (Yannakakis and Hallam)

9

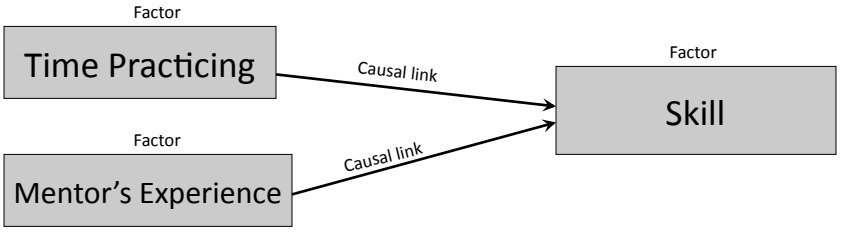
Overview

- Goals of Research
- Needs of Automatic Game Balancing
- Toward a Causal Model
  - Defining a Causal Model
  - Building the Model
  - Validating the Model: Player Study
- Future Work: Applying the Model

10

Causal Model

- Abstract model using cause and effect
- ***Factors***: Represent variables in model
- ***Causal links***: express cause and effect relationship between factors
- Clearly model interaction of game factors



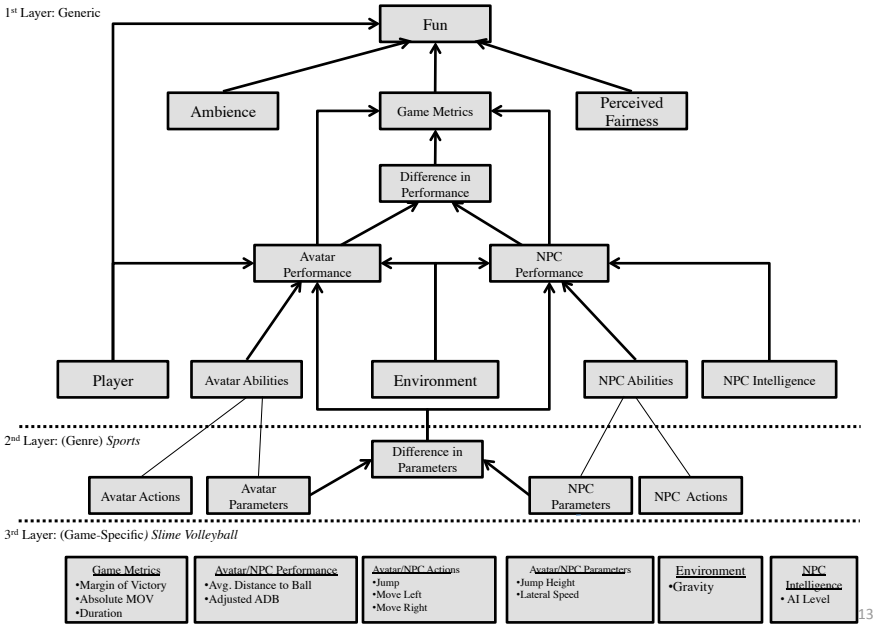
11

Overview

- Goals of Research
- Needs of Automatic Game Balancing
- Toward a Causal Model
  - Defining a Causal Model
  - Building the Model
  - Validating the Model: Player Study
- Future Work: Applying the Model

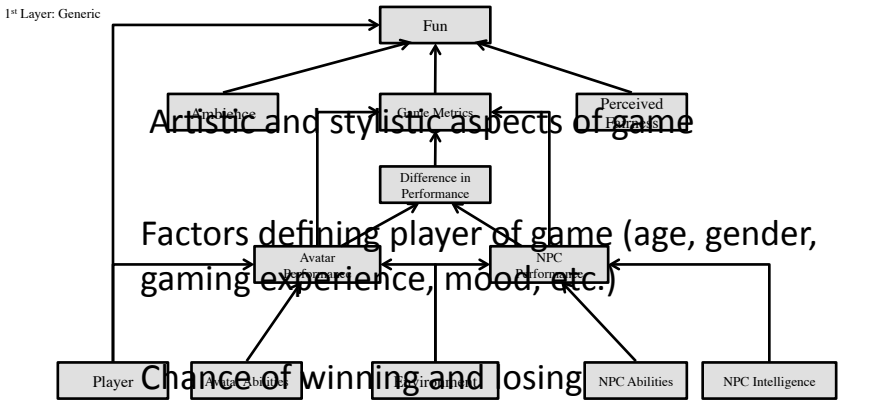
12

Three Layered Causal Model



13

Causal Model: Layer 1



Artistic and stylistic aspects of game

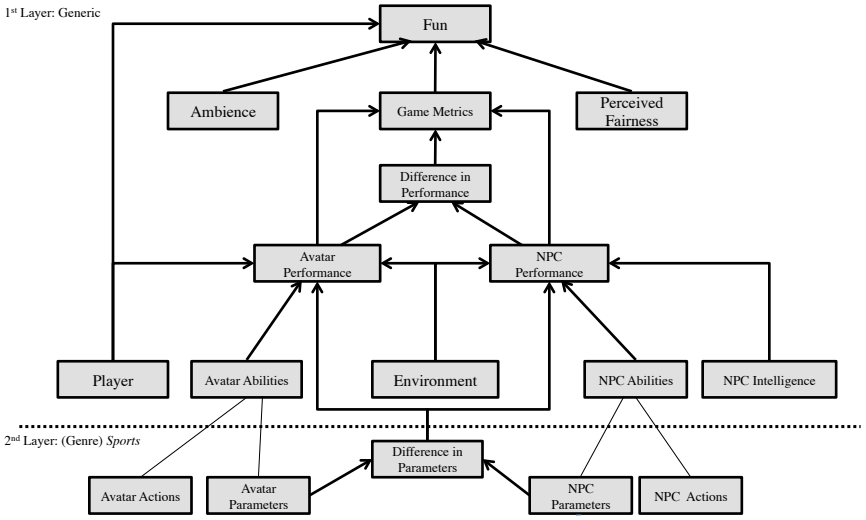
Factors defining player of game (age, gender, gaming experience, mood, etc.)

Chance of winning and losing

Variables code tracks (score, kills, deaths, etc.)

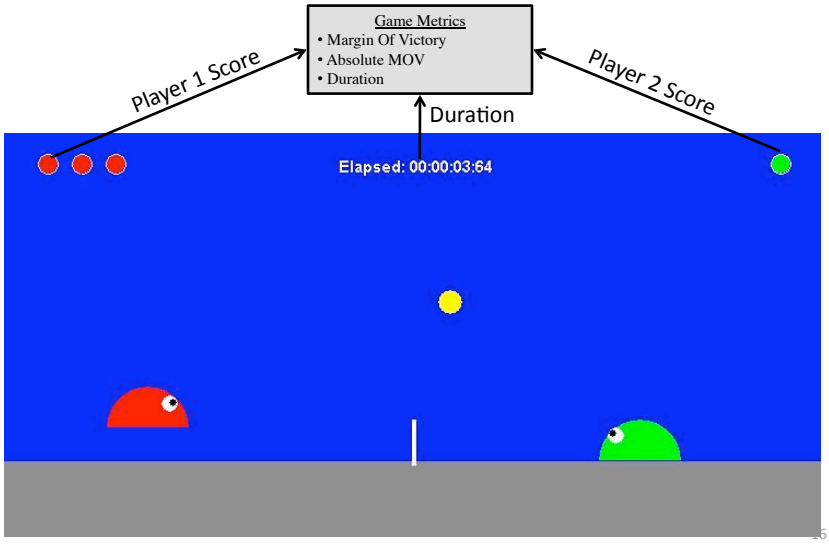
14

Causal Model: Layer 1+2



15

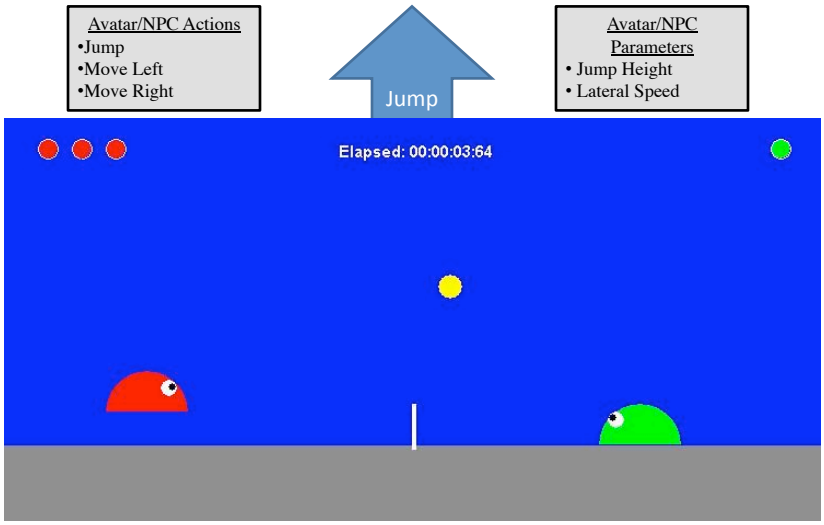
Causal Model: Layer 3
Instantiating Game Metrics



16

Causal Model: Layer 3

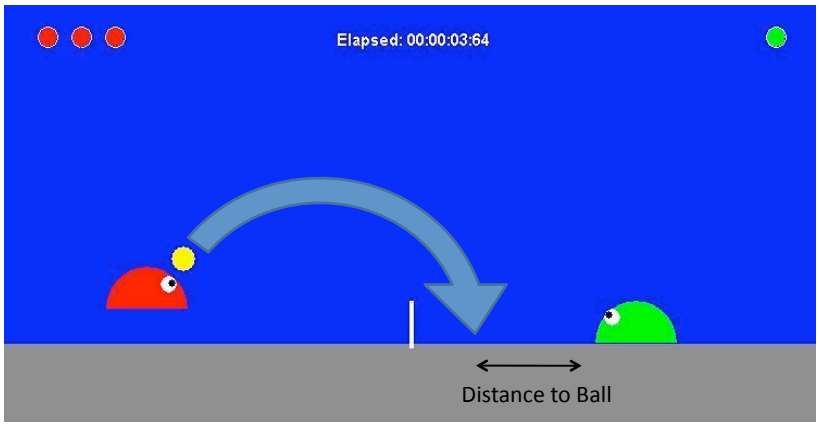
Instantiating Avatar/NPC Actions and Parameters



17

Causal Model: Layer 3

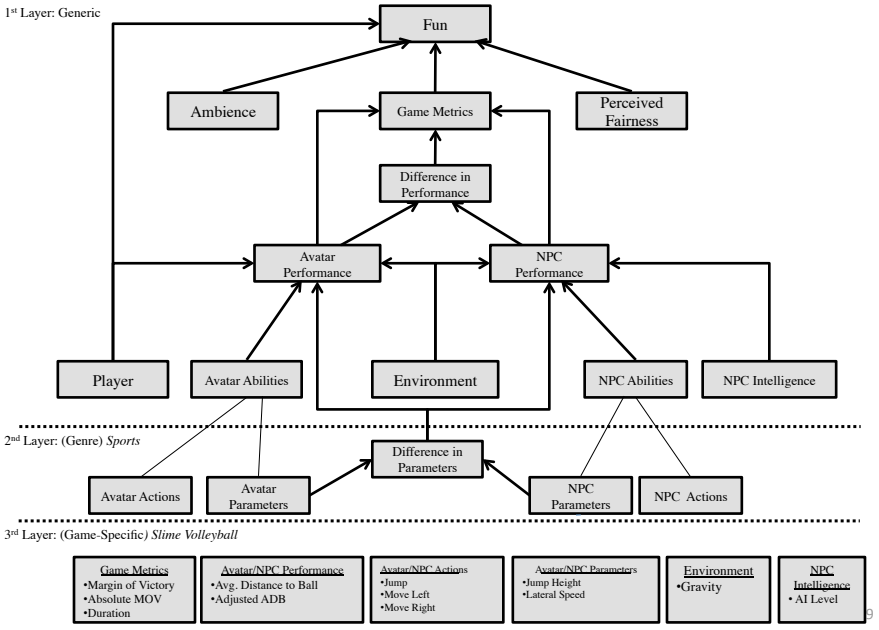
Instantiating Performance



Performance
•Average Distance to ball (ADB)
•Time to Ball

18

Causal Model: Layer 1+2+3



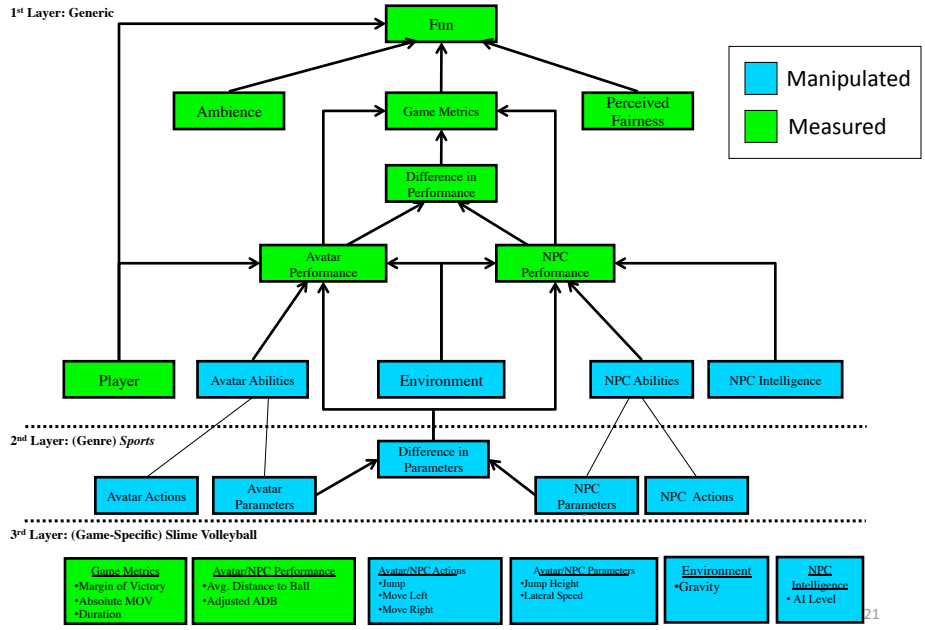
19

Overview

- Goals of Research
- Needs of Automatic Game Balancing
- Toward a Causal Model
  - Defining a Causal Model
  - Building the Model
  - Validating the Model: Player Study
- Future Work: Applying the Model

20

Grouping Slime Volleyball Factors



21

Slime Volleyball Study
Setup

- 136 participants
- Collected information on player
  - Age
  - Gender
  - Gamer Type
- Varied factors in model for each player
- Asked to rate game after playing
  - Fun
  - Perceived fairness
- Ambience as unmeasured variance

22

Slime Volleyball Study

Pre-game Survey

Age	Gender	Gamer Type
• Under 20	• Male	• Casual
• 20 to 25	• Female	• Normal
• 26 to 30		• Hardcore
• 31 plus		• Unknown

23

Slime Volleyball Study

Post-game Survey

- How much fun was this match? (0-9)
  - 0: No Fun
  - 9: Very Fun
- How fair was this match? (0-9 where 0 means computer had advantage, 5 was an even match, and 9 means you had the advantage)
  - Perceived Fairness
  - Binned Fairness
  - Absolute Fairness

24

Slime Volleyball Study
Analysis

- Justify causal links with correlations
  - Highly correlated (r >.32)
  - Remove if not justified
- Test causal links not in model
  - Correlation
  - Add if justified
- Determine how much variance we account for

25

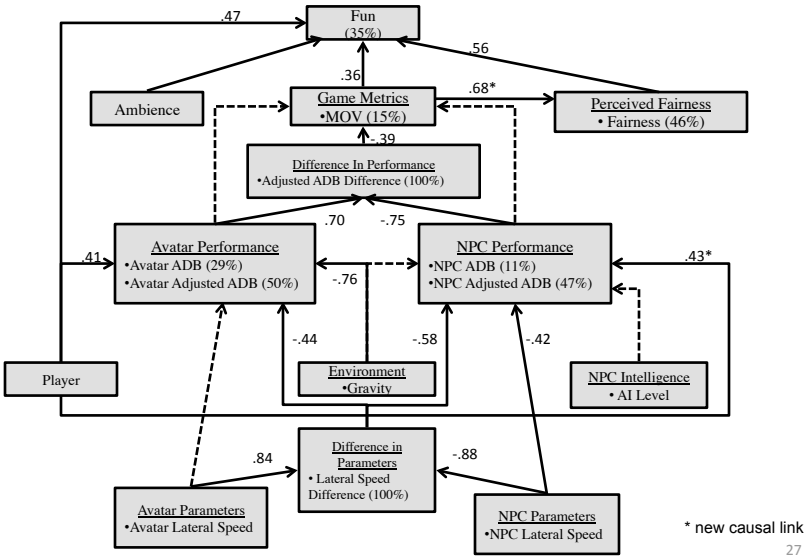
Slime Volleyball Study
Using Correlations

- Correlation does not imply causality!!!
  - Correct
  - We are not using correlation to create causal links
- Building causal model from prior knowledge
  - Academic experience
  - Research
  - Game playing experience
- Using correlations to support proposed causality

26

Slime Volleyball Study

Results



27

Overview

- Goals of Research
- Needs of Automatic Game Balancing
- Toward a Causal Model
  - Defining a Causal Model
  - Building the Model
  - Validating the Model: Player Study
- Future Work: Applying the Model

28

Future Work: Applying the Model

- What in the model will be altered?
  - Only alter values in nodes
  - Alter values and structure of model
- How should the model be altered?
  - Linear Regression
  - Reinforcement Learning
  - Other
- What game should be used to test automatic game balancing system?
  - Utilizes all nodes
  - Expand to other genre
  - Able to change node values easily
- Finished in May 2010 for Master Thesis

29

Ongoing Study

- Instantiating new causal model
- Participants needed
  - http://moffett-research.genbook.com/
    - A25 Fuller Laboratory
    - Play on local machine
  - http://users.wpi.edu/~jeffmoffett
    - Download game
    - Play from home
    - Email results

30

Questions?

31