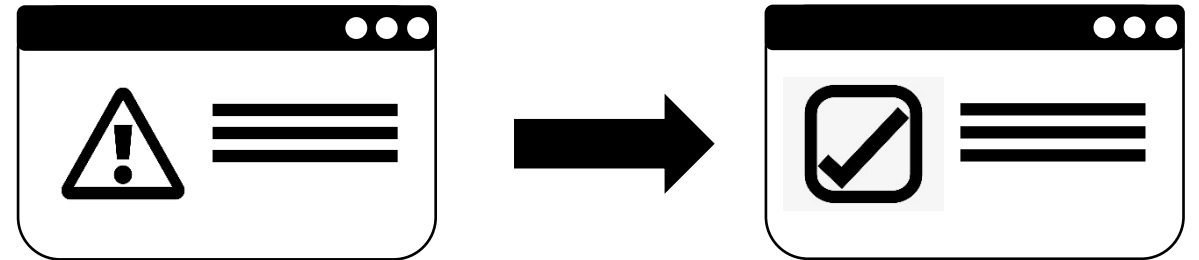
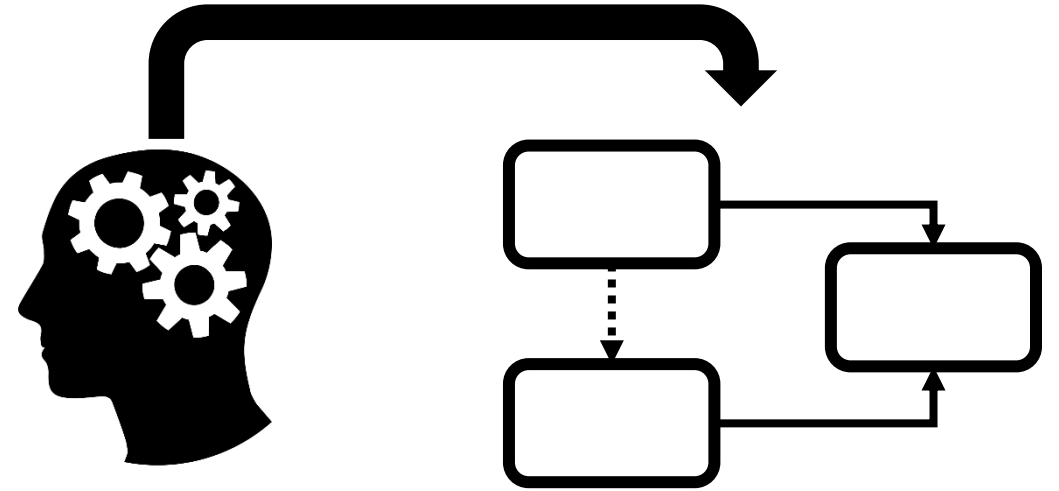
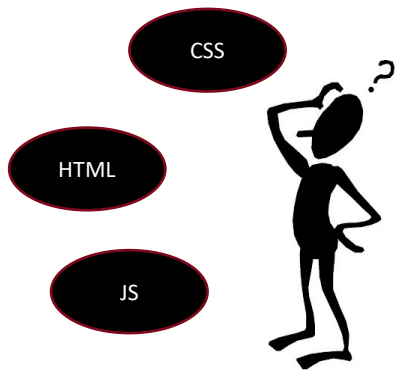
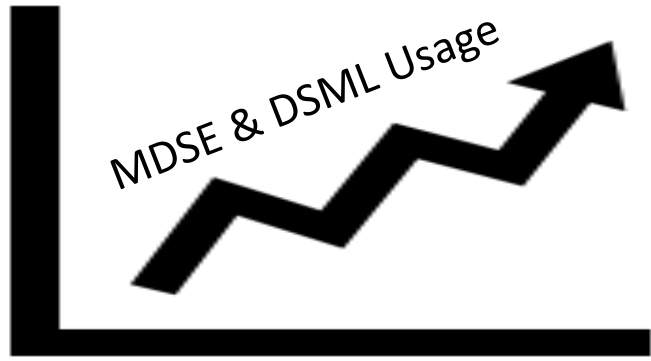


MOLEGA: Modeling Language for Educational Card Games

Kaylynn Borrer & Eric J. Rapos

Miami University Software Technology & Analysis Group (MUSTANG)
Computer Science & Software Engineering
Miami University, Oxford, Ohio, USA

Motivation



Research Questions

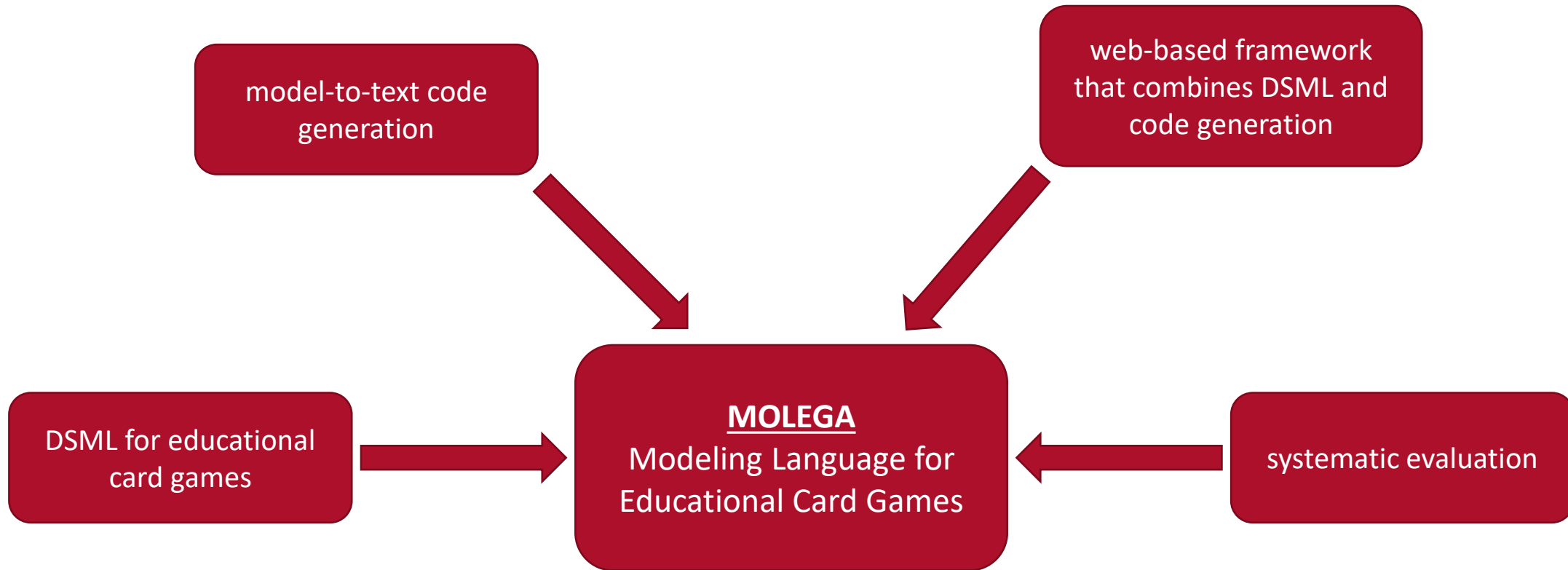
RQ1

Can domain-specific modeling be used to create web-based educational card games?

RQ2

Does a guided framework ensure the generation of consistently correct executable game code?

Our Solution & Contributions



Related Work

DSMLs For Representing Games

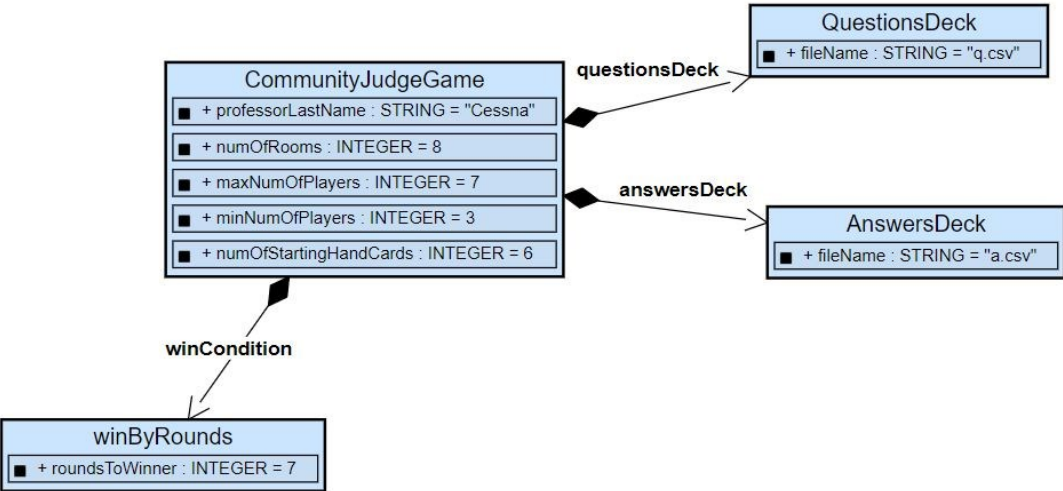
- GLisMO & FA-GLisMO
- SLGML (SharpLudus)

DSMLs for Generating Code

- SharpLudus
- IML

Web-Based Modeling Framework

MOLEGA File ▾ Model Design ▾




```

classDiagram
    class CommunityJudgeGame {
        + professorLastName : STRING = "Cessna"
        + numOfRooms : INTEGER = 8
        + maxNumOfPlayers : INTEGER = 7
        + minNumOfPlayers : INTEGER = 3
        + numOfStartingHandCards : INTEGER = 6
    }
    class QuestionsDeck {
        + fileName : STRING = "q.csv"
    }
    class AnswersDeck {
        + fileName : STRING = "a.csv"
    }
    class winByRounds {
        + roundsToWinner : INTEGER = 7
    }
    CommunityJudgeGame "1" *-- "1" QuestionsDeck : questionsDeck
    CommunityJudgeGame "1" *-- "1" AnswersDeck : answersDeck
    CommunityJudgeGame "1" --> "1" winByRounds : winCondition
      
```

Palette

GeneralDeck
CustomTheme
BlueTheme
RedTI

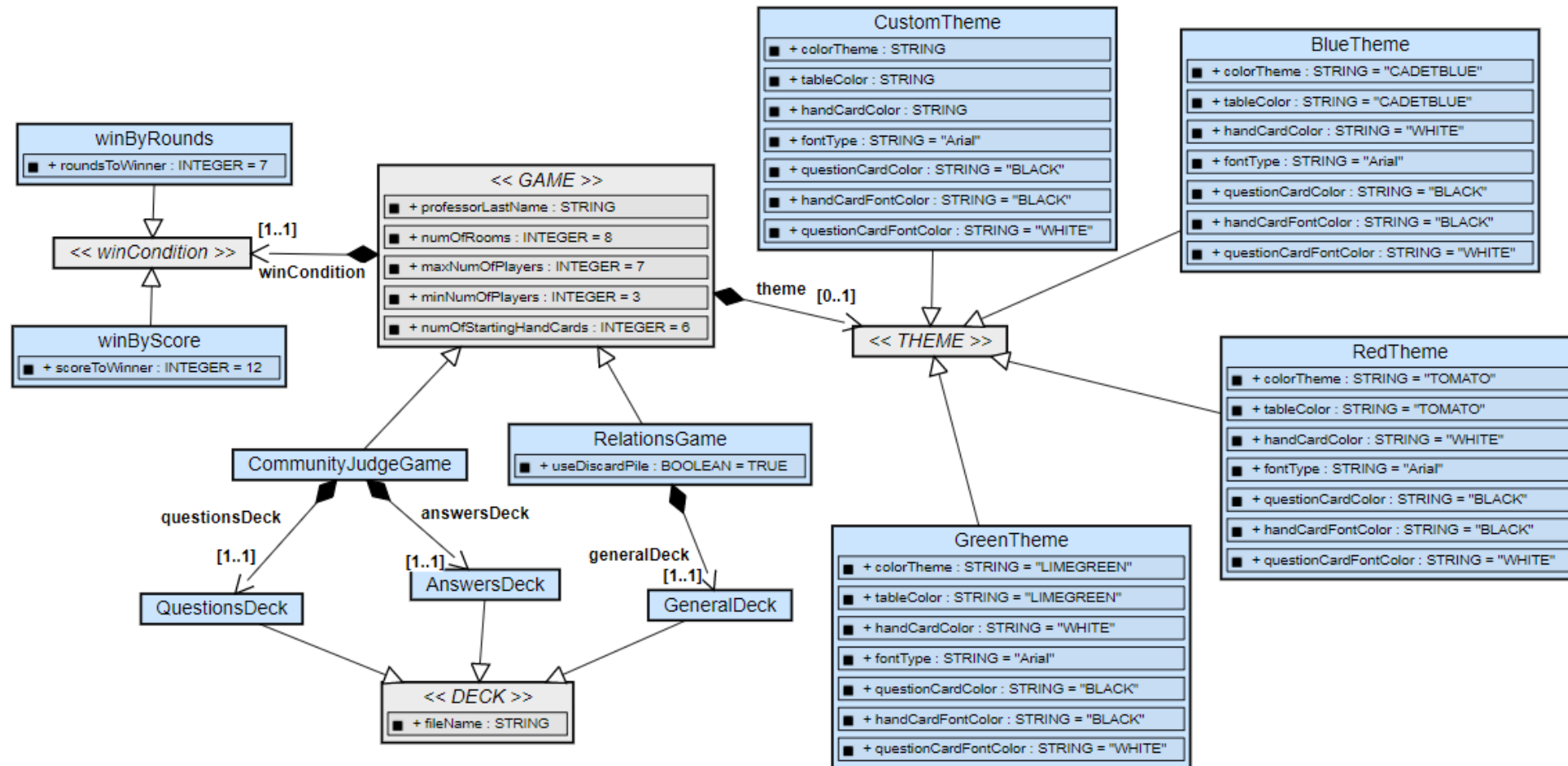
Meta-Model Conformance



Properties Table

Property	Value
Model Name	MOLEGA_Game
File Name	MOLEGA_Game.iml
Conforms To	MOLEGA.iml

MOLEGA Metamodel



Code Generation Target

Dr. Cessna's Community Judge Game

Room 1

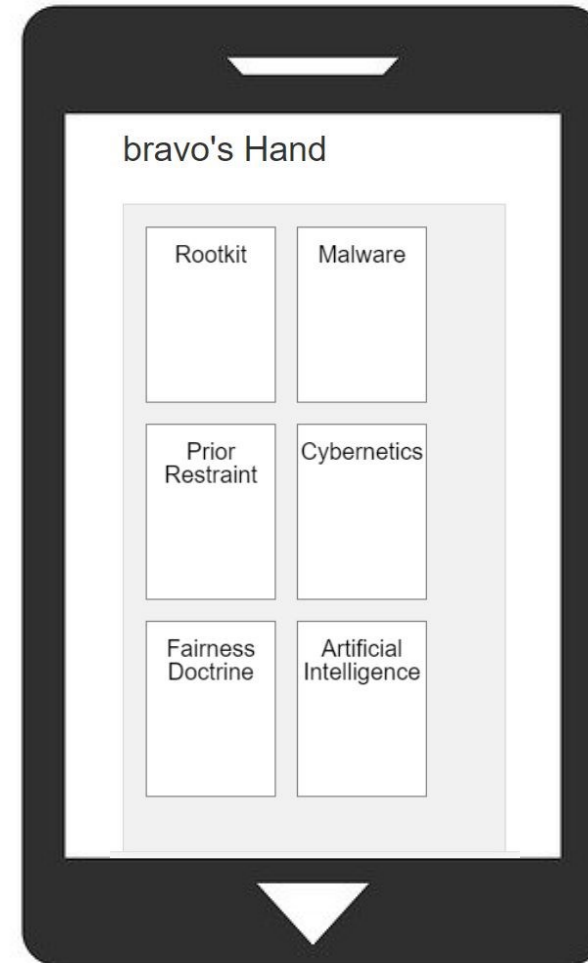
alpha - 0
bravo - 0
charlie - 0

I hate it
when
steals all
my data.

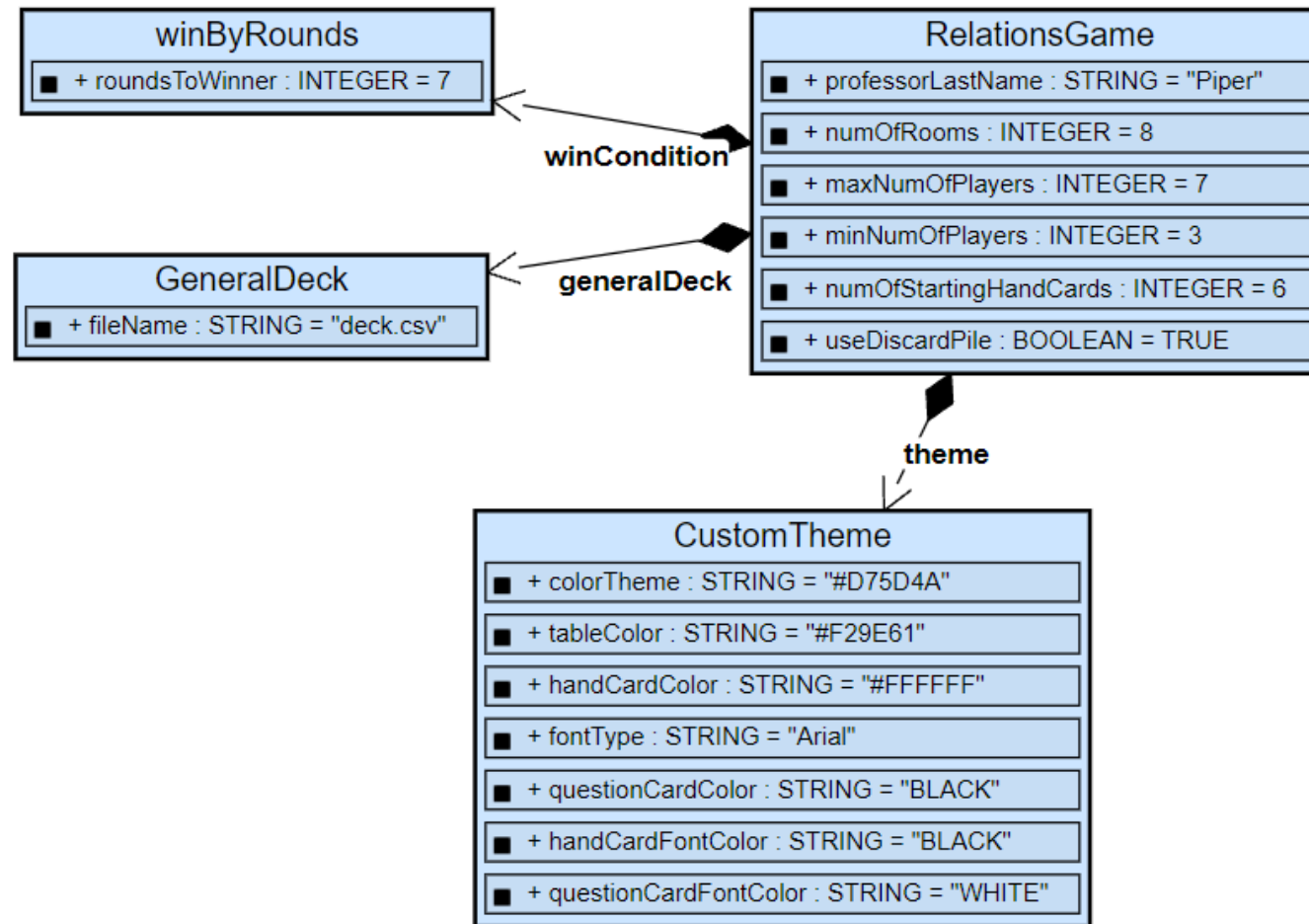
charlie's Hand

PageRank Net Neutrality Veil of Ignorance Ad Hoc Committee for Responsible Computing Autonomy Hackers

Code Generation Target (cont.)



Example Model



Code Generation Result

Prof. Piper's Relations Game

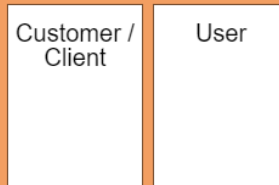
Room 1

Eric - 2

Adam - 0

Taylor - 0

Your Point Cards:



Eric's Hand



Pass Turn

Code Generation Evaluation

coverage-based approach

for each model element, a test was created

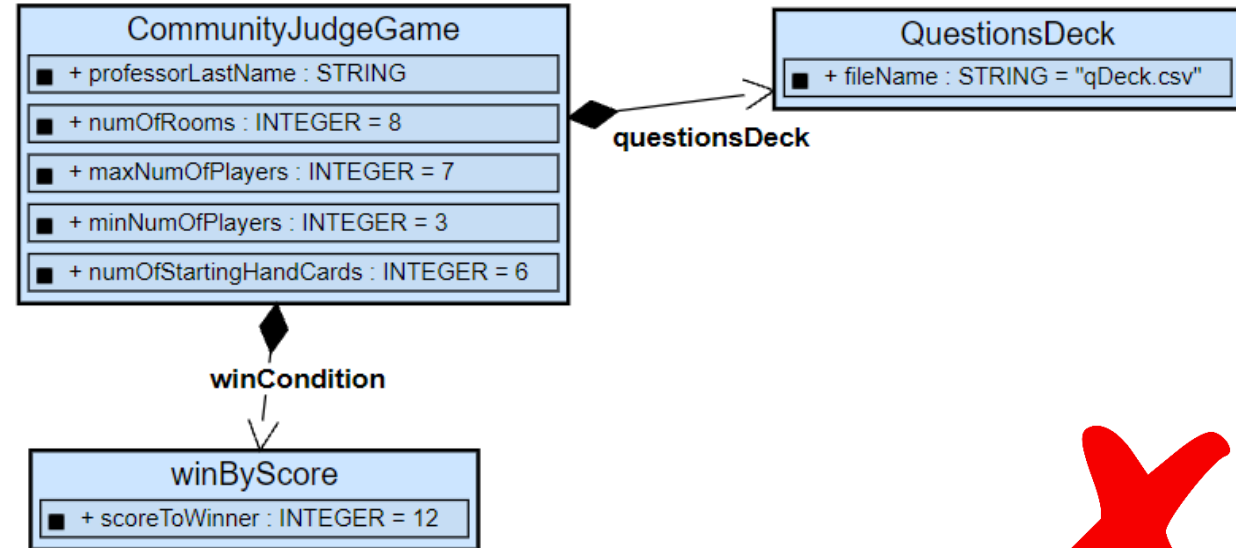
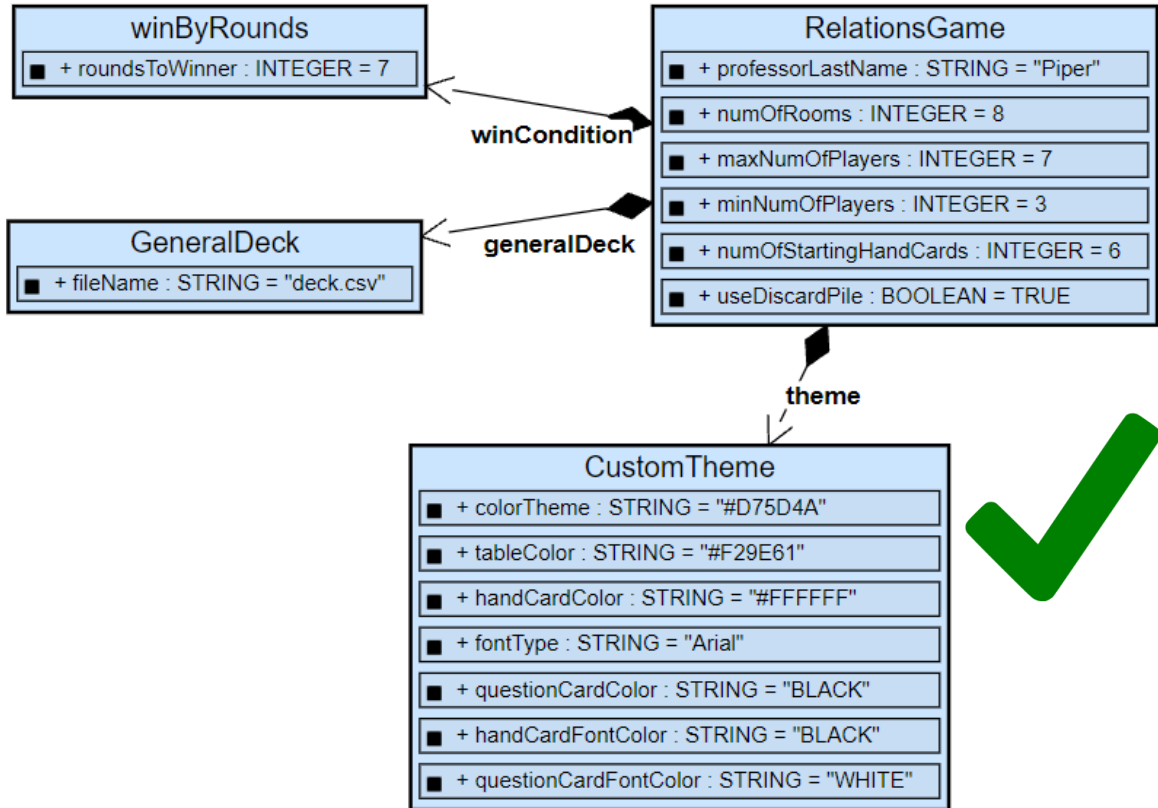
53 cases to show correctness of valid code generation

40 cases to show lack-of generation of invalid model definitions

3 metrics of success

- Is code generated? (RQ1)
- Is code correct? (RQ2)
- Does the generated code run on a server environment? (RQ2)

Valid vs. Invalid Models



Meta-Model Conformance

X

Issues:

- Class "CommunityJudgeGame" Required Attribute "professorLastName" is missing a value and must be instantiated.
- A "CommunityJudgeGame" Class exists with too few outbound "answersDeck" relations; this instance contains 0 but requires at least 1

Code Generation Results

Valid Community Judge			
Test Case	Generate?	Correct?	Does it Run?
<u>Base Model</u>			
Base Valid Model	✓	✓	✓
<u>Class Changes</u>			
Use Blue Theme	✓	✓	✓
Use Red Theme	✓	✓	✓
Use Green Theme	✓	✓	✓
Use Custom Theme (CSS, all valid)	✓	✓	✓
Use Custom Theme (hex, all valid)	✓	✓	✓
Use Win By Score	✓	✓	✓
Extra Theme (Not Connected)	✓	✓	✓
Extra Win Condition (Not Connected)	✓	✓	✓
Extra Questions Deck (Not Connected)	✓	✓	✓
Extra Answers Deck (Not Connected)	✓	✓	✓
<u>Attribute Changes</u>			
Change Prof Name	✓	✓	✓
Change Num of Rooms	✓	✓	✓
Change Max Players	✓	✓	✓
Change Min Players	✓	✓	✓
Change Num Starting Cards	✓	✓	✓
Change Deck Name (Questions)	✓	✓	✓
Change Deck Name (Answers)	✓	✓	✓
Change Color Theme	✓	✓	✓
Change Table Color	✓	✓	✓
Change Hand Card Color	✓	✓	✓
Change Font	✓	✓	✓
Change Question Card Color	✓	✓	✓
Change Hand Card Color	✓	✓	✓
Change Question Card Font Color	✓	✓	✓
Change Rounds to Winner	✓	✓	✓
Change Score to Winner	✓	✓	✓

Valid Relations			
Test Case	Generate?	Correct?	Does it Run?
<u>Base Model</u>			
Base Valid Model	✓	✓	✓
<u>Class Changes</u>			
Use Blue Theme	✓	✓	✓
Use Red Theme	✓	✓	✓
Use Green Theme	✓	✓	✓
Use Custom Theme (CSS, all valid)	✓	✓	✓
Use Custom Theme (hex, all valid)	✓	✓	✓
Use Win By Score	✓	✓	✓
Extra Theme (Not Connected)	✓	✓	✓
Extra Win Condition (Not Connected)	✓	✓	✓
Extra General Deck (Not Connected)	✓	✓	✓
<u>Attribute Changes</u>			
Change Prof Name	✓	✓	✓
Change Num of Rooms	✓	✓	✓
Change Max Players	✓	✓	✓
Change Min Players	✓	✓	✓
Change Num Starting Cards	✓	✓	✓
Change Use Discard Pile to False	✓	✓	✓
Change Deck Name (General)	✓	✓	✓
Change Color Theme	✓	✓	✓
Change Table Color	✓	✓	✓
Change Hand Card Color	✓	✓	✓
Change Font	✓	✓	✓
Change Question Card Color	✓	✓	✓
Change Hand Card Color	✓	✓	✓
Change Question Card Font Color	✓	✓	✓
Change Rounds to Winner	✓	✓	✓
Change Score to Winner	✓	✓	✓

Code Generation Results (cont.)

<u>Invalid Community Judge</u>			
<u>Test Case</u>	<u>Generate?</u>	<u>Correct?</u>	<u>Does it Run?</u>
<u>Missing Classes</u>			
Missing Game	✗	N/A	N/A
Missing Questions Deck	✗	N/A	N/A
Missing Answers Deck	✗	N/A	N/A
Missing Win Condition	✗	N/A	N/A
<u>Missing Attribute Values</u>			
Missing Prof Name	✗	N/A	N/A
Missing Questions Deck Name	✗	N/A	N/A
Missing Answers Deck Name	✗	N/A	N/A
Missing Values from Custom Theme	✗	N/A	N/A
Missing/Deleted Other Attributes	✗	N/A	N/A
<u>Surplus Relations</u>			
Surplus Themes	✗	N/A	N/A
Surplus Win Conditions	✗	N/A	N/A
Surplus Questions Decks	✗	N/A	N/A
Surplus Answers Decks	✗	N/A	N/A
Surplus Games	✗	N/A	N/A
<u>Invalid Inputs</u>			
Max Players Less Than Min Players	✗	N/A	N/A
Both Decks the Same File Name	✗	N/A	N/A
Attributes Zero or Negative	✗	N/A	N/A
Win Rounds Zero or Negative	✗	N/A	N/A
Win Score Zero or Negative	✗	N/A	N/A
Invalid CSS/Hex Color	✗	N/A	N/A
Invalid Font Type	✗	N/A	N/A
Invalid Composite Connection	✗	N/A	N/A

<u>Invalid Relations</u>			
<u>Test Case</u>	<u>Generate?</u>	<u>Correct?</u>	<u>Does it Run?</u>
<u>Missing Classes</u>			
Missing Game	✗	N/A	N/A
Missing General Deck	✗	N/A	N/A
Missing Win Condition	✗	N/A	N/A
<u>Missing Attribute Values</u>			
Missing Prof Name	✗	N/A	N/A
Missing General Deck Name	✗	N/A	N/A
Missing Values from Custom Theme	✗	N/A	N/A
Missing/Deleted Other Attributes	✗	N/A	N/A
<u>Surplus Relations</u>			
Surplus Themes	✗	N/A	N/A
Surplus Win Conditions	✗	N/A	N/A
Surplus General Decks	✗	N/A	N/A
Surplus Games	✗	N/A	N/A
<u>Invalid Inputs</u>			
Max Players Less Than Min Players	✗	N/A	N/A
Relations Attributes Zero or Negative	✗	N/A	N/A
Win Rounds Zero or Negative	✗	N/A	N/A
Win Score Zero or Negative	✗	N/A	N/A
Invalid CSS/Hex Color	✗	N/A	N/A
Invalid Font Type	✗	N/A	N/A
Invalid Composite Connection	✗	N/A	N/A

Threats to Validity

focus on correctness over validity

- proof of concept
- only capable of representing two variants

manual steps in evaluation

- expected output creation
- bash script compared actual to expected

Future Work

User Studies

- usability of framework by users
- assessment of usefulness from students and educators in relation to code generation output

Additional Game Variants

- Addition of more game rules
- Possibly refactoring the metamodel to allow mixtures of rules

Developed MOLEGA: Modeling Language for Educational Card Games

- DSML for representing web-based educational card games
- Model-to-text web code generation
- Web-based framework that combines DSML and code generation process

Technical Evaluation

- 100% of tests passed in code generation
- 100% of tests passed in accuracy of generation

Guided modeling framework leads to consistently correct code generation outputs

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