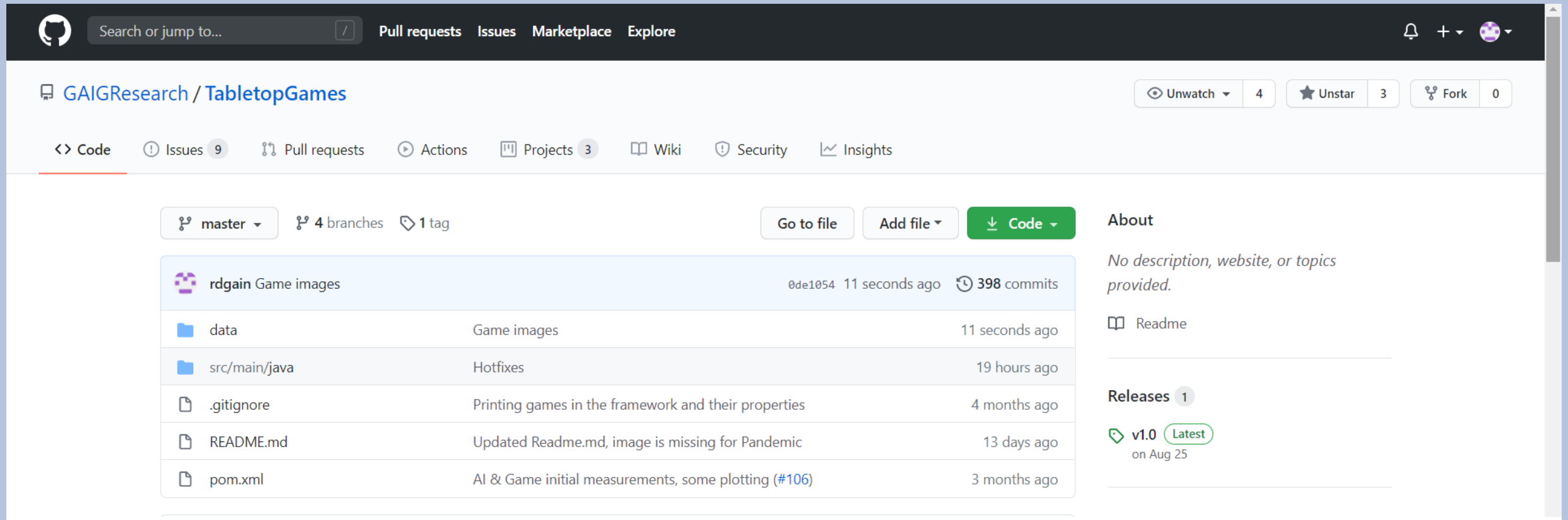

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A Tabletop Games Framework

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EXAG 2020

Game AI Group

Modern Tabletop Games

What?

- Board games
- Card games
- Dice games
- Role-playing games
- Pen and paper games
- …

Why?

- High complexity: many components / rules / players / types of interaction
- Partial observability: facedown decks / player hands of cards / secret objectives
- Diverse/asymmetric player roles
- Control parameters: how many cards per player / how many actions in a turn / value of coins
- Unique game state representations
- Cooperation combined with competition
- Large action spaces

A look to the past (and present?)

Traditional board games

- Chess, Othello, Go etc.

Tabletop games

- Card games: Poker (Moravcik et al. 2017), Bridge(Cazenave and Ventos 2019), Hannabi (Bard et al. 2020)
- Asymmetric player roles: The Resistance (Serrino et al. 2019), Ultimate Werewolf (Eger and Martens 2019)
- Strategic complexity: Pandemic (Chacon and Eger 2019; Sfikas and Liapis 2020)
- Large action spaces: Bloodbowl (Justesen et al. 2019)
- Statistical forward planning applications:
  - MCTS in Settlers of Catan (Szita, Chaslot and Spronck 2009), Risk (Gibson, Desai, and Zhao 2010)
  - RHEA in Splendor (Bravi et al. 2019)
- Play-testing in Ticket to Ride (de Mesentier Silva et al. 2017)
- Procedural Content Generation in TTRPGs (Guzdial et al. 2020)

A look to the past (and present?)

Description-language-based frameworks

- General Game Playing (GGP) (Genesereth, Love, and Pell 2005)
- Ludii (Piette et al. 2019)
- Regular boardgames (RBG) (Kowalski et al. 2019)

Freeform frameworks

- Tabletop Simulator (Henry 2015)
- OpenSpiel (Lanctot et al. 2019)

TAG – 3 motivating pillars

Modern tabletop games as complex AI challenges

- The “Why” before

General game playing of modern tabletop games

- Common API for games and AI players

Facilitating community-driven database for AI research

- Features supporting easy development of new games and AI players under the same common platform

TAG – the technical bit

Java

- No, it's not Python (yet?).
- Yes, it runs fast.
- No game description language, all coded.

Features of interest at a glance

- *Abstract classes* for game/AI skeletons
- Add-on *interfaces* for automatic optimisation of parameters, custom observations
- Ready-made common *rules* / *actions* / *components* (+ extendable)
- *Prototyping GUI* for immediate running and interacting with the game, mid-development
  - … and an easily extendable template for custom displays and interactions
- Game *tagging* / categorisation
- *8 games* implemented, more in development
- *General AI players* compatible with all games (various performance…)
- Fully functioning *game loop*, *game analysis*

TAG – tabletop game concepts

Concepts

- Action: things players do
- Rule: things the game does
- Turn order: defines order of players
- Game phase: time frames with specific rules/actions
- Components: game objects/pieces, what actions are rules modify

Components

- Tokens
- Cards
- Dice
- Counters
- Grid boards
- Graph boards
- *Decks*: ordered lists of components
- *Areas*: mapping from component ID to component

TAG – core classes

Game state (GS)

- Container class, made up of game components + variables
- Describes a moment in time
- Defines component access methods and scoring functions (optional)
- Can be *copied*
- A *reduced copy* is available to AI players as an observation (with hidden information in partial observable modes)

Forward model (FM)

- Logic class, controls the rules which modify a given game state
- Sets up the initial state of the game
- Decides which actions are available in a given game state
- Applies player actions and game rules to advance the game state
- Checks any end of game conditions
- Is available to AI players for game *simulations*

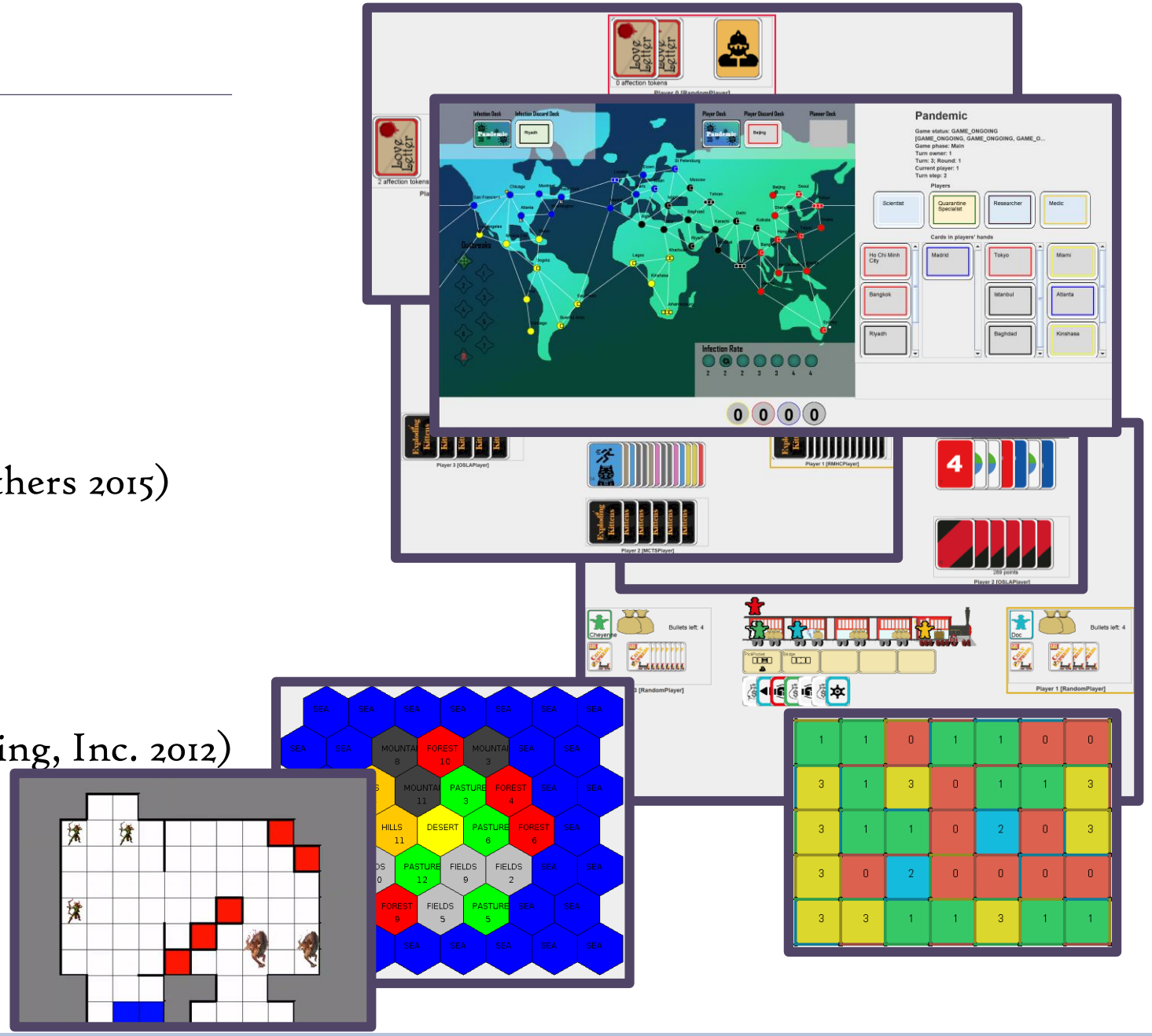
TAG – games

Games implemented

- Tic-Tac-Toe
- Dots & Boxes
- Love Letter (Kanai 2012)
- Uno (Robbins 1971)
- Virus! (Cabrero and others 2015)
- Exploding Kittens (Inman and others 2015)
- Colt Express (Raimbault 2014)
- Pandemic (Leacock 2008)

Games in progress

- Descent (Fantasy Flight Publishing, Inc. 2012)
- Carcassonne (Wrede 2000)
- Settlers of Catan (Teuber 1995)



TAG – players

Human play

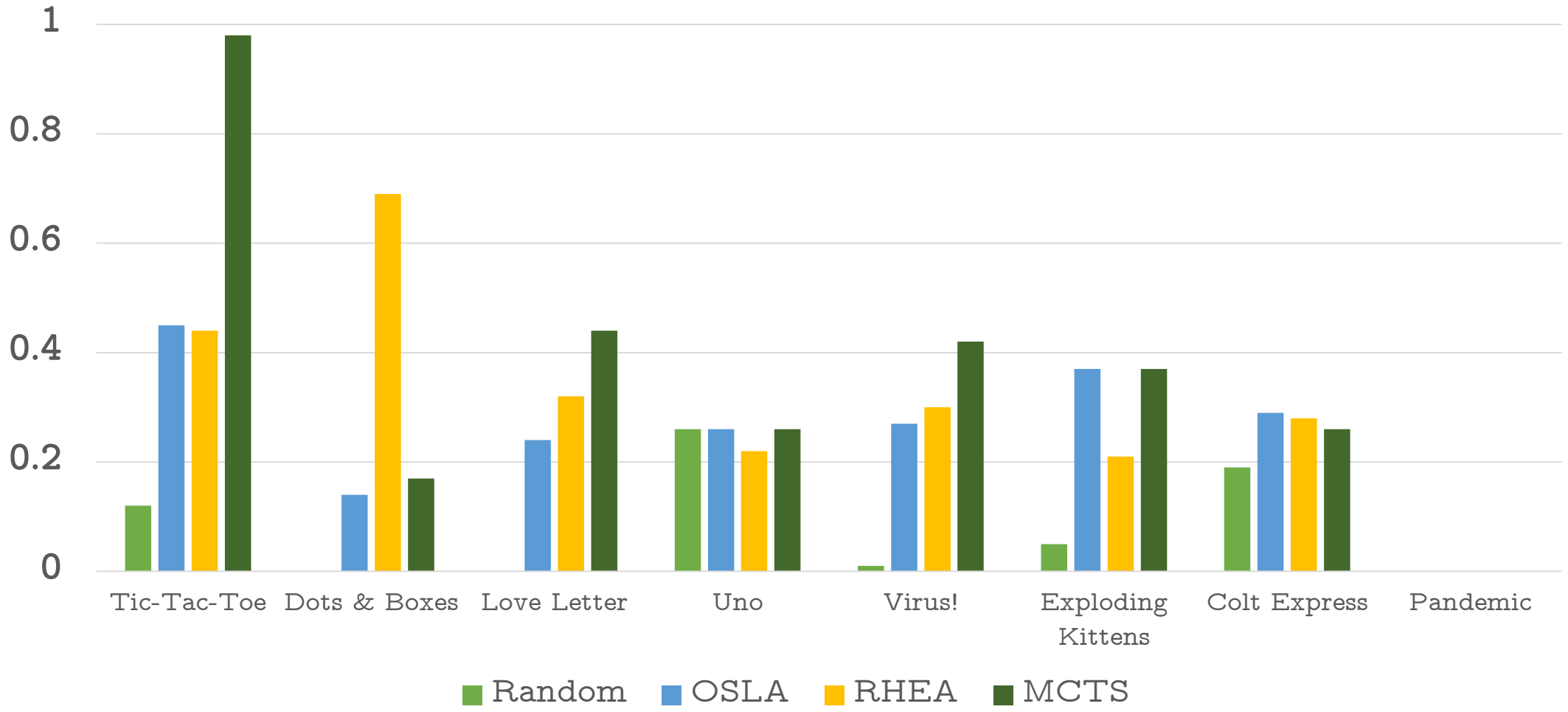
- Console: use keyboard to enter console input and read printed game states
- GUI: use action buttons (or more complex custom interactions designed per game) to directly interact with the game and observe a visual representation of the game state

Automatic players

- Random: randomly chooses one of the available actions
- One Step Look Ahead (OSLA): exhaustively tries all possible actions, simulating their effect with the FM, and chooses the one which leads to the game state with the highest *score*
- Rolling Horizon Evolutionary Algorithm (RHEA): evolves a sequence of actions, using the FM to simulate their effect and chooses the first action of the sequence which led to the highest *score*
- Monte Carlo Tree Search (MCTS): builds an asymmetric game tree, using the FM to simulate the effect of actions and build statistics of observed *scores*; chooses the most visited child from the root

* *Game state evaluation*: uses scoring functions defined in the games, but can be swapped for other heuristic functions.

AI Player Performance



A look to the future

- Competitive, cooperative, mixed games
- Hidden information, belief systems
- Dynamic/changing rules
- Asymmetric player roles
- Role-playing, strategy, campaign games
- Parameter optimisation
- Observation diversity: object-based, vector, feature-based

Takeaways

Tabletop games

- Exciting opportunities for research

TAG: Java framework for tabletop games

- Providing common API for implementing both games and AI players

Open-source framework

- https://github.com/GAIGResearch/TabletopGames

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Thank you for watching!

More about TAG

https://tinyurl.com/TAG-EXAG

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