# A General Framework for the Logical Representation of Combinatorial Auctions

*We propose a framework, called CEDL, for representing auction-based markets. CEDL is the first language for describing combinatorial auctions from a logical perspective. The general dimension is illustrated by representing different protocols. The main benefit is to derive properties about protocols.*

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## Introduction

Our goal is to build up a framework for representing and reasoning about auction-based markets

(i) Describing the protocol rules
(ii) Bidders express preferences over goods
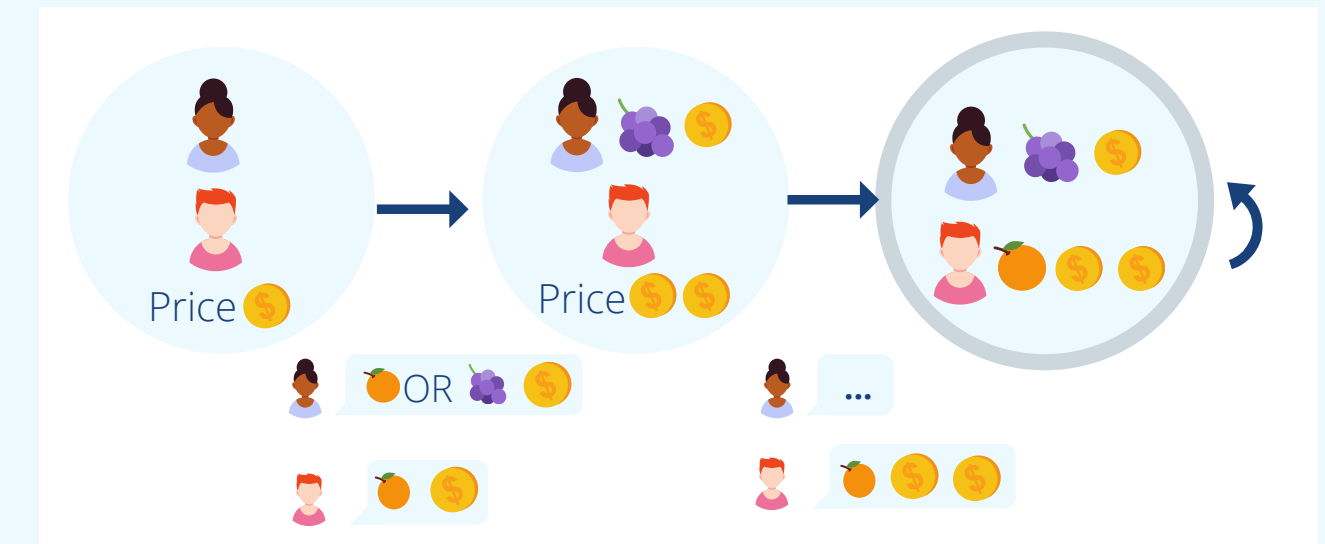


Example: a *path* in the Simultaneous Ascending Auction

## (i) Describing the Protocol: CEDL

The Combinatorial Exchange Description Language (CEDL) is based on the Game Description Language [1]

Syntax:
$\varphi ::= p \mid initial \mid terminal \mid legal(i, \beta) \mid does(i, \beta) \mid \neg\varphi \mid \varphi \wedge \varphi \mid \bigcirc \varphi \mid z{<}z \mid z{>}z \mid z{=}z$

Semantics: based on state-transition models and paths (an execution of an auction)

## (ii) Expressing Preferences: TBBL

Bids in CEDL are expressed with the Tree-Based Bidding Language (TBBL) [2]

Leaves are atomic bids

Negative values represent sellers' bids



## Example: Simultaneous Ascending Auction

Goods are sold simultaneously, the price of unsold goods increases each turn

Action legality rule:
- $legal(i, or[p_1,...,p_n]) \leftrightarrow (p_j = 0 \wedge trade(i,j) = 0) \vee (p_j = price \wedge \neg sold(j)) \vee (p_j = price(j) \wedge trade(i,j) = 1)$

Update rule:
- $\bigcirc (trade(i,j) = 1) \leftrightarrow bid(i,j) \wedge \neg bid(r,j)$, for all $r \neq i$

## Example: Combinatorial Exchange

Agents are traders: they can both buy and sell multiple goods

Initial state:
- $initial \rightarrow bidRound \wedge payment(i) = 0 \wedge trade(i,j) = 0$

Update rule:
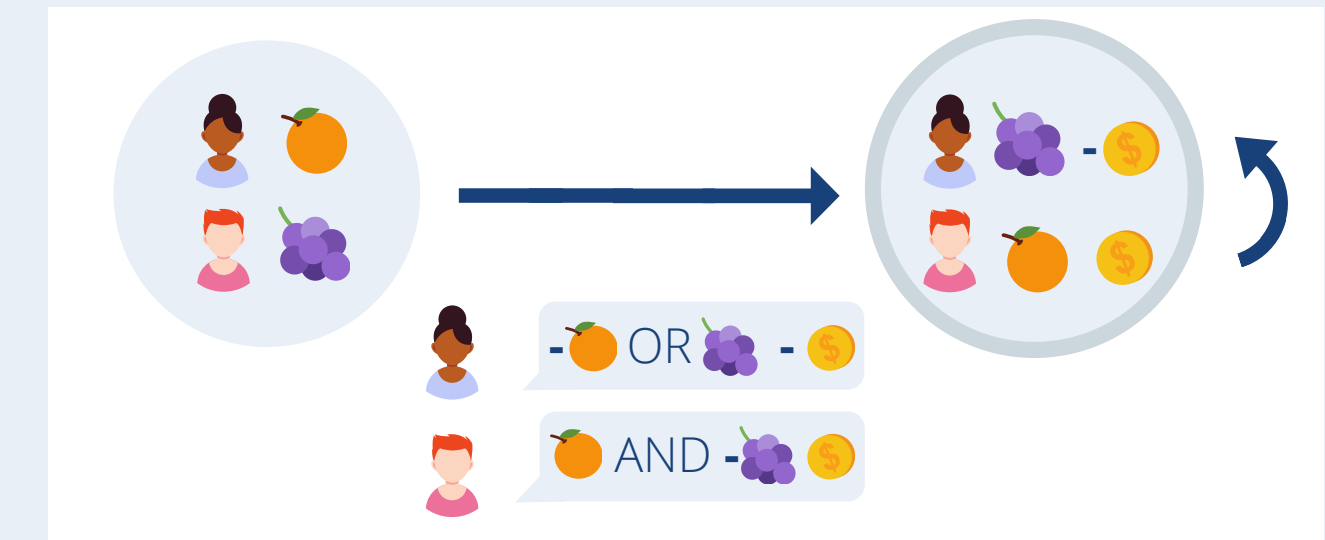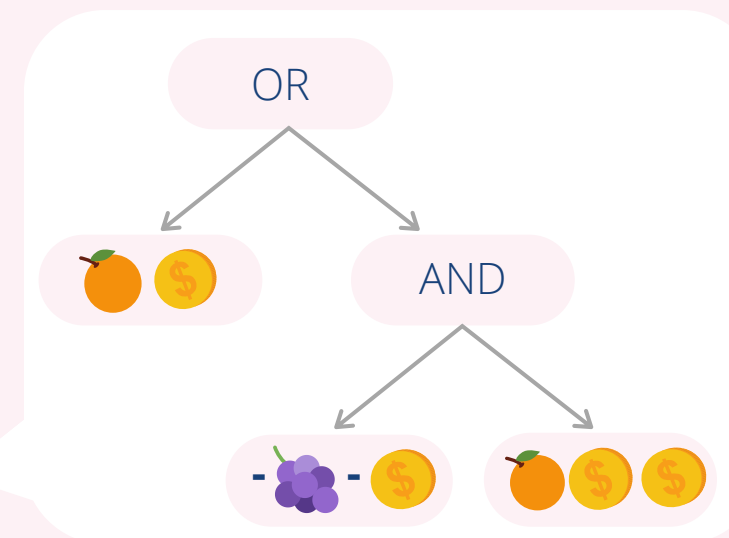- $does(\beta_1, ..., \beta_m) \rightarrow \bigcirc (trade(i) = win(i,\beta_1, ..., \beta_m, x_{1,1}, ..., x_{nm}))$



Example: a *path* in the Combinatorial Exchange

## Benefit of CEDL

We derive properties:
- Termination, playability
- Individual rationality and budget balance

## Future Work

We intend to explore the bidders' perspective: strategic reasoning about knowledge, preferences and rationality

Check our paper on ArXiv!

**References**
[1] Genesereth, M., Love, N., and Pell, B. (2005). General game playing. AI Magazine, 26(2):62–72.
[2] Parkes, D.C., et. al (2005). ICE: An Iterative Combinatorial Exchange. In: Proc. of the EC'05.