

ASSIGNMENT SET 2

Multi Agent Systems (TDDE13), Linköping University
By Fredrik Prántare, Autumn Semester 2024

Directions: *Individually* (not in groups or pairs) solve the assignments below and send your solutions (with a clear and precise line of reasoning!) to your TA's mail address (Daniel de Leng, daniel.de.leng@liu.se) before the deadline. It is important that you

1. use the course's *LaTeX*/Word template for the answers (only submit the compiled .pdf; bad formats and file types will be rejected);
2. use "TDDE13: Assignment Set 2" as the header in your mail; and
3. send the answers from your *LiU student account*.

Deadline: See the course's webpage. After the deadline, you receive half the points for correct answers.

Prerequisites: Course lectures + the following chapters in the course's textbook (*Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations*):

- Chapter 9: Aggregating Preferences: Social Choice;
- Chapter 10: Protocols for Strategic Agents: Mechanism Design;
- Chapter 11: Protocols for Multiagent Resource Allocation: Auctions.

Assignments:

- 1** (1.0p) In an informal fashion, thoroughly describe *Arrow's impossibility theorem* and discuss its consequences.
- 2** (1.0p) Show that *plurality voting* between three or more alternatives is **not** necessarily *dominant-strategy truthful* (i.e., that being truthful is not a dominant strategy).
- 3** (1.0p) In the example below, which outcome $o \in \{a, b, c, d\}$ is the *Condorcet winner* and why?

P1: $c \succ b \succ a \succ d$

P2: $b \succ c \succ a \succ d$

P3: $a \succ c \succ b \succ d$

P4: $a \succ d \succ c \succ b$

P5: $b \succ c \succ d \succ a$

$x \succ y$ denotes that the outcome $x \in \{a, b, c, d\}$ is (strictly) preferred to $y \in \{a, b, c, d\}$ by the row's corresponding player.

- 4 (1.0p) Give an example of a situation you know of where it is typically preferable to choose a Condorcet winner over using the *plurality method*.
- 5 (1.0p) Show that, in a sealed-bid single-item *Vickrey auction*, a truthful bidder is guaranteed a utility which is non-negative.
- 6 (1.0p) What are the main differences between *indirect* and *direct* mechanisms? Give an example for both of them.
- 7 (1.0p) Explain, from a computational perspective, why synergistic effects such as *substitutability* and *complementarity* (i.e., goods in a bid bundle can affect each others' values) make the *winner determination problem* for *combinatorial auctions* much more difficult compared to when the bids are only *additive* (i.e., each good has a value, and every bid bundle's value is the sum of its goods' values) in the items that are being auctioned.