Comment on "On the Uniqueness of Stable Marriage Matchings"
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September 3, 2013

Abstract
We prove with the help of a counterexample that Lemma 6 and Corollary 7 from Eeckhout [1] are incorrect.

Theorem 1 in Eeckhout [1] provides the following sufficient condition for the existence of unique stable matchings.

Condition 1 There exists an ordering of the set of females $F = (X_i)$ and an ordering of the set of males $M = (x_i)$ such that the preference profile satisfies
\[
\forall X_i \in F : x_i \succ X_j, \forall j > i, \text{ and } \\
\forall x_i \in M : X_i \succ x_j, \forall j > i
\]

It is claimed in Eeckhout [1] that Condition 1 is also necessary for uniqueness of stable matchings when $N \leq 6$. We observe here that although the claim holds for $N = 4$ (Lemma 5), it is incorrect for the case $N = 6$ (Lemma 6).

Claim 2 There exists a matching problem $(F, M, \succ)$ with $|N| = 6$ where the set of stable marriages $S$ is a singleton and the preference profile does not satisfy Condition 1.

Proof. Consider the matching problem $(F, M, \succ)$ with the following preference lists:

$$(a,b,c)_A, (b,a,c)_B, (a,b,c)_C(A,B,C)_a, (A,C,B)_b, (A,C,B)_c$$

The only stable matching $\mu^*$ for $(F, M, \succ)$ is given by $\mu^*(A,B,C) = (b,a,c)$. This is easily verified using the Gale-Shapley algorithm by observing that the male and female optimal solutions are identical. However, one can confirm that it does not satisfy Condition 1 by considering all possible orderings of $F$ and $M$. An easier way to see that Condition 1 is not satisfied is by observing that none of the females get their top preference in the only stable matching. Therefore, none of the females can be first in the ordering $(X_i)$ from Condition 1. Furthermore, there also exists a ring $(A,a,B,b)$ which, together with Lemma 2 from [1], shows that Condition 1 cannot be satisfied for this example.

The proof of Lemma 6 in Eeckhout [1] argued that if Condition 1 is violated then either $\mu^*$ is not an equilibrium or there exists $\mu' \neq \mu^*$ that is also an equilibrium. The author’s statement that if $b \succ_A a$ and/or $B \succ_a A$ and the remaining conditions of Condition 1 hold then $\mu'(A,B,C) = (b,a,c) \in S$, is not true. Consider, for example, the following preference lists: $(b,a,c)_A, (b,c,a)_B, (a,b,c)_C(A,B,C)_a, (B,C,A)_b, (A,C,B)_c$. Clearly, we have $b \succ_A a$ and all other conditions of Condition 1 are satisfied. However, $\mu'(A,B,C) = (b,a,c) \notin S$. Indeed one can easily check that $\{B,b\}$ blocks $\mu'$.

Remark 3 Since none of females get their most preferred partners in the only stable matching in the example provided above, it is clear that Corollary 7 in Eeckhout [1] is also incorrect.

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