## Corrections and updates for fifth printing of Osborne and Rubinstein's "A Course in Game Theory" (MIT Press, 1994)

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## Corrections

Page, Line	Correction
XV	Martin J. Osborne's email address is now martin.osborne@utoronto.
	ca and his mailing address is Department of Economics, University of
	Toronto, 150 St. George Street, Toronto, Canada, M5S 3G7.
XV	Ariel Rubinstein's email address is now rariel@tauex.tau.ac.il, his
	website is https://arielrubinstein.tau.ac.il, and his second ad-
	dress is Department of Economics, New York University, New York, NY
	10003, USA.
XV	The URL of the authors' web site for the book is now https://www.
	economics.utoronto.ca/osborne/cgt/.
6, 18	Delete "(first proved by Zermelo (1913))".
7, -13	Insert "nonempty" before "disjoint".
23, 14	Replace the sentence "Note that" with "Note that by part (c), the
	players' Nash equilibrium strategies may be found by solving the prob-
	lems $\max_x \min_y u_1(x, y)$ and $\max_y \min_x u_2(x, y)$ ."
30	Add, at the start of line 5, "The result in Exercise 20.4 is due to
	Nash (1951)."
32	Replace the first two sentences of the paragraph above (32.2) with: "Note
	that each function $U_i$ is multilinear. That is, for any mixed strategy
	profile $\alpha$ , any mixed strategies $\beta_i$ and $\gamma_i$ of player $i$ , and any number $\lambda \in$
	$[0,1], \text{ we have } U_i(\alpha_{-i}, \lambda\beta_i + (1-\lambda)\gamma_i) = \lambda U_i(\alpha_{-i}, \beta_i) + (1-\lambda)U_i(\alpha_{-i}, \gamma_i).$
45, 7	Replace "he" with "she".
50, -2	Replace " $0 \le \gamma \le 1$ " with " $0 < \gamma \le 1$ ".
55, -10	Replace " $\mu_3^2(A)$ " with " $\mu_3^2(B)$ ".
56, -9	Replace "the following exercises" with "Exercises 56.4 and 56.5".
60, 22	Replace "player 1" with "player i".

- 60, 23 Replace " $U_i(a_{-i}, a_i^*)$ " with " $u_i(a_{-i}, a_i^*)$ ".
- 68, -2 Add "infinite" before "decimal". (A number has a unique infinite decimal expansion.)
- 99, 3 Replace "the longest" with "a longest".
- 99, 4 Replace  $\Gamma(h^*)$  with  $\Gamma(h', h^*)$  on this line and on lines 6, 8, and 10.
- 99, 5 Replace  $s^*|_{h'}$  with  $s^*_i|_{h'}$ .
- 99, 9 Replace  $s_i^*|_{h^*}$  with  $s_i^*|_{(h',h^*)}$ .
- 100, 7–8 Delete "(a result first proved by Zermelo (1913))".
- 100, 9 The official version of chess is not finite, because a player has the *option* of declaring a draw once a position is repeated three times. Our argument applies to the version of chess in which a draw is automatic in this case.
- $104,\,-9,\,-8$  Replace "she" with "he".
  - 107 Replace the first clause of the sentence starting on line 8 with "Player P(C(t)) prefers S(t+3) to S(t+1) to S(t+2) for  $t \leq T-3$ ".
  - 108 On the fifth line of Exercise 108.1 insert "strategic form of the" before "modification".
  - 108, -2 Delete "only".
  - 114, -2 Replace "Kuhn (1953)" with "Kuhn (1950, 1953)".
  - 115, 2 Replace "Kuhn (1953)" with "Kuhn (1950, 1953)".
  - 122 Add to A3 the requirement that the Pareto frontier of X be connected.
  - 123 In the first display  $(M_i(G_i))$  replace "a SPE" with "an SPE".
  - 123 Replace the second sentence of the proof of Step 1 with "By A3 and the continuity of the preference relations, the domain of  $\phi$  is an interval and  $\phi$  is continuous, one-to-one, and decreasing."
  - 138, 1 (except printings 1–3) Change upper limit of sum from T to  $\infty$ .
  - 138, 9 Replace t with T (twice).
  - 143, -6 In printings 4 and later replace "A payoff profile w" with "A feasible payoff profile w of G". (Note that, according to our definitions, a feasible payoff profile may not be a payoff profile.)
    - 144 In Proposition 144.1, replace "an enforceable payoff profile of G" with "an enforceable convex combination of payoff profiles of G". [The coefficients in the convex combination are not necessarily rational.]
  - 152, 11 Change "it" to "if".
  - 156, 3 Replace the sentence starting "Consider" and the following sentence with "Consider a strategy  $\hat{s}_i$  of player *i* that differs from  $s_i$  only in that after the history  $(a^1, \ldots, a^{t-1})$  it chooses  $a_i$ , and after any longer history *h* it chooses an action that, given the profile  $s_{-i}(h)$  of actions planned by the other players after the history *h*, yields at least *i*'s minmax payoff. The outcome of  $(s_{-i}, \hat{s}_i)$  is a terminal history  $\hat{a}$  that is identical to *a* through period t - 1;  $u_i(\hat{a}^t) > u_i(a^t)$  and  $u_i(\hat{a}^r) \ge u_i(a^r)$  for  $r \ge t + 1$ ."

- 159–160 The sketch of the proof of Proposition 160.1 is flawed. It has been replaced. (The text has been rewritten, moving the result to page 159, where it appears as Proposition 159.1.)
- 185, 5 After the colon modify the text to read: "for example, if  $\gamma = 2$ , |N| = 2, and  $\theta_i = 1$  for both players then the associated game has also, in addition to (1, 1), inefficient equilibria (e.g. (0, 0))".
- 200, -17 Delete "by a player".
- 200, -11 Replace "after the history h" with "after the history h if  $P(h) \in N$  and chance if P(h) = c."
  - 201 Replace the paragraph starting on line -2 with: "Note that Definition 200.1 extends our definition of an extensive game with perfect information and chance moves (see Section 6.3.1) in the sense that the extensive game with perfect information and chance moves  $\langle N, H, P, f_c, (\succeq_i)_{i \in N} \rangle$  may naturally be identified with the extensive game  $\langle N, H, P, f_c, (\mathcal{I}_i)_{i \in N}, (\succeq_i)_{i \in N} \rangle$  in which every member of the information partition of every player is a singleton."
- 215, 5 Replace "the sets of actions" with "the sequences of actions".
- 216, -6 Replace the mathematical expression with  $p^2 \cdot 0 + p \cdot (1-p) \cdot 1 + (1-p) \cdot 0 = p(1-p)$ .
- 217, -2 Replace "Kuhn (1953)" with "Kuhn (1950, 1953)".
- 218, 3 Replace "Kuhn (1953)" with "Kuhn (1950, 1953)".
- 226, 1 Replace from the start of the line to the end of the sentence with "equilibrium since the associated assessment violates sequential rationality at player 2's (singleton) information set."

226, 5 Replace  $\beta_2^{\varepsilon}(C)(c) = 1 - 2\varepsilon$  with  $\beta_2^{\varepsilon}(C)(d) = 2\varepsilon/(1-\varepsilon)$ .

- 229 In the sixth line of Exercise 229.1, replace "S" with "s".
- 252 At the end of Example 252.1 the perturbed strategy of player 3 should be  $\sigma_3^{\varepsilon}(R) = \sigma_3(R)$  if  $\sigma_3(R) < 1$ , and  $\sigma_3^{\varepsilon}(R) = 1 - \varepsilon$  if  $\sigma_3(R) = 1$ .
- 260 After "for all coalitions S and T" on the last line add ", where  $v(\emptyset) = 0$ ".
- 263 On line 12, insert "for all  $S \in C$ " before "by the left-hand inequality", and replace the last sentence of this paragraph with "Thus x(N) = v(N), so that the payoff profile x is in the core."
- 274 Add, between lines 7 and 8, the following paragraph. "Now, for every agent *i* we have  $x_i \omega_i + \varepsilon \in Q$  for every  $\varepsilon > 0$ , so that  $p(x_i \omega_i + \varepsilon) \ge 0$ . Taking  $\varepsilon$  small, we conclude that  $px_i \ge p\omega_i$  for all *i*. But *x* is an allocation, so  $px_i = p\omega_i$  for all *i*."
- 287, 7 Replace  $\geq$  at end of line with  $\leq$ .
- 307, 7–8 Replace  $\succeq_1', \succeq_2$  with  $\succeq_i', \succeq_j$  (twice).
- 307, 15 Replace  $p \cdot x \succeq_j x^*$  with  $p \cdot x \succ_j x^*$ .
- 327 Replace "Recherce" with "Recherche" on line -10.

335, 3	Replace " $[85]$ " with " $[84]$ ".
336, 3	Replace " $[115]$ " with " $[114]$ ".
339	Delete reference to Zermelo (1913).

## **Additional References**

The modifications on pages 114, 115, 217, and 218 require the following additional reference.

Kuhn, H. W. (1950), "Extensive Games", Proceedings of the National Academy of Sciences of the United States of America 36, 570–576. [114, 115, 217, 218]