Heuristic report

1. To find good evaluation function, I begin with evaluation of current opponent heuristics. Improved score provides best results with average winning rate between 60 and 70%. This heuristic try to maximize the difference *[own possible moves – opponents possible moves]*
2. Though here are different rules (knight move instead of queen moves), I try to use heuristic proposed during lecture and give more weight to minimization of opponent mobility. My first heuristic try to maximize the difference *[own possible moves – 2*opponents possible moves]*. The results improved: average winning rate became between 67 and 72%
3. To build second heuristic I made the following steps:
    a. Add additional factor: state of the game (understand whether the game just begin or here is the end game). To do it, I introduce "Game deep ratio". The formulas is: $game\_deep\_ratio = \frac{Current\ number\ of\ blank\ cells}{total\ number\ of\ cells\ on\ the\ board}$.
    b. Then I constructed formula for coefficient which I will apply to adjust weights of components of my new heuristic: $coeff = \frac{1}{game\_deep\_ratio^2}$. Game deep ratio has a range [0:1] (it is begin with the number close to 1 and the decrease to the 0), so coeff will grow exponentially when the game begins
    c. Finally I take my first heuristic and apply the coeff to *opponents possible moves factor:* I suppose that when on the board the number of blank cells decrease, I want pay much more attention to decreasing of opponent mobility (try to finish the game)
    d. Formula for this heuristic is: IS2=*[own possible moves – 2*opponents possible moves*coeff]*
    e. The results of this heuristic is slightly the same as the previous, there is no improvement if we apply variable weight only for one factor
4. Finally I constructed more complex heuristic with the following logic:
    a. When the game begins, it is important to take good position. In our case it is some place around center of the board, as here is in average more possible moves and as results less risk to be "blocked" (not as in classical queen moves game, but just because we don't have the options to jump)
    b. Then we should slightly change our priorities: it is less important to be in the center and more important to block opponent (decrease number opponents possible moves as much as possible)
    c. To do this, I calculate factor "proximity to center". It has a formula: *proximity_to_center= abs(current_location_row_coordinate – center_row_coordinate) + abs(current_location_column_coordinate – center_column_coordinate).* Due to special L move of agent I don't use special formulas for Euclidian or Manhattan distance. Also I would like to make this in the range comparable with [*own possible moves – opponents possible moves*] factor to avoid scaling problems.
    d. As a final step I adjusted some fixed weights and include proximity to center in the IS2. The resulting formula is: : IS3=*[own possible moves – 3*opponents possible moves*coeff – 3* proximity_to_center*coeff]*
    e. The results of this heuristic is much better: winning rate is 75+% and usually about 80%
5. Some sample of the results of heuristic can be found below:

	ID_improved	Student		
Opponent	Improved score[1]	IS weighted (IS1)	IS1 with variable weight (IS2)	IS2 with location priority (IS3)
Random	**20**	**20**	**19**	**18**
MM_Null	**15**	**16**	**18**	**18**
MM_Open	**16**	**13**	**12**	**16**
MM_Improved	**8**	**11**	**9**	**11**
AB_Null	**14**	**13**	**13**	**17**
AB_Open	**10**	**11**	**14**	**13**
AB_Improved	**11**	**17**	**13**	**17**
Total (% of wins)	**67.14**	**72.14**	**70.00**	**78.57**

Table 1. Some examples of game results (number of win games)

[1] Here is an example how ID improved plays. During each game the distribution of wins-losses could be slightly different, but in average the performance of this heuristic is about 60-70% wins.