# Nash Equilibrium: "A Beautiful Mind" Bonus Question

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## 1 Question

**In the movie there is a clip of Nash with his friends in a bar. From a hypothetical dating scenario, Nash got the inspiration for Nash Equilibrium (NE). Write the corresponding game (with the help of graphs), and find out NE. Is the depiction of NE in the movie correct? If not correct, what is wrong?**

## 2 Scene breakdown by Nash in the movie

In the bar scene when the blonde and her friends entered the bar, Nash and his friends conjectured the best ways to approach the blonde and/or her friends such that they could all pair up and gain utility. While Nash's friends subscribed to Adam Smith's idea of the "invisible hand" and the best outcome for the group is achieved when individuals are left to pursue what is best for themselves, Nash argued that this alone is incomplete, as the best outcome for the group can only be achieved when individuals pursue what is best both for themselves and for the group. To illustrate this, Nash provided the following scenarios:

- Scenario 1: everyone approaches the blonde
  Result: no one gets the blonde as they block each other out
- Scenario 2: everyone approaches the blonde's friends
  Result: no one gets the blonde or her friends as they don't like being second choice
- Optimal scenario: no one goes for the blonde
  Not getting in each other's way, and not insulting the other girls, while Nash goes for the blonde (implied by one of Nash's friends), and this is the only way they can all pair up
  Best results come when: everyone in the group does what is best for himself AND the group.

However, is this really a Nash Equilibrium when each player has incentive to deviate i.e. go for the blonde themselves, instead of one of her friends?

## 3 Analysis

Here we have provided arbitrary payoffs – all that matters is that 'blonde' is preferred to 'friend', and both of them are preferred to being alone.

The concept of Nash equilibrium stipulates that each player's strategy choice is a best response to the strategies actually played by his/her rivals. The movie presents the situation where all individuals go for different brunettes as the Nash Equilibrium. However, this is not correct.

Player 2

| Player 1 | *Blonde* | *Friend* |
|---|---|---|
| *Blonde* | 0,0 | 2,1 |
| *Friend* | 1,2 | 1,1 |

For Player 1, it is optimal to go for the 'Friend' if Player 2 chooses the 'blonde'. If Player 2 chooses the 'friend' instead, it is optimal for Player 1 to go for the 'blonde'. Due to the symmetry in the game, this leads to two pure-Nash strategy equilibria: (blonde, friend) and (friend, blonde). In reality they would have to coordinate their actions and decide, for instance with a coin flip, who can go for the blonde and who goes for the friend, otherwise they might end up off-equilibrium if they both simultaneously choose without coordinating.

## 4 In context

Overall, as shown in our analysis the movie fails to explain the concept of Nash Equilibrium. The optimal decision in the movie seems to ignore the blonde and everyone going for one of her friends, however, the two pure-strategy Nash equilibria are actually that one goes for the blonde and the other one(s) go for the friend(s). Nonetheless, the movie highlights an important idea in microeconomics and game theory which is that players must take into account other player's actions in order to obtain a best response and maximise their payoffs. This supports the view that players do not always act in isolation following their self-interest to maximise their utility. This goes against the writings of Adam Smith.

Adam Smith believed that in any economic or social interaction, an individual following his or her own interest works seeks the best outcome for themselves. In the interactions between buyers and sellers, for example, by following the interests of both agents, the best outcomes of individual exchanges will also encourage the best overall outcome for society. Indeed, he is quoted in the scene by Nash's friends: "in competition, individual ambition serves the common good." Here Nash goes on to show how this may not always be true.