## Introduction



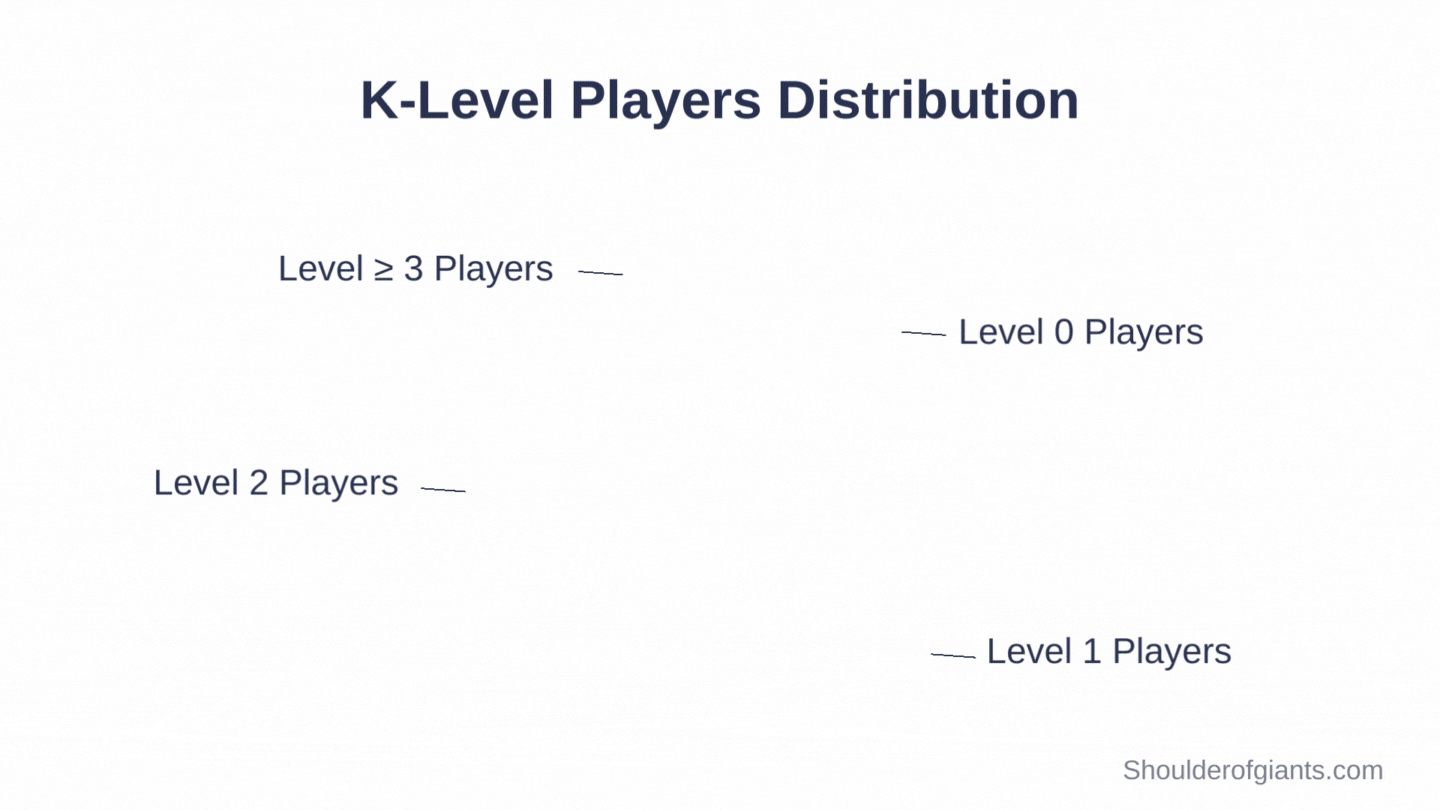
1. K-Level Thinking (or K-Level Argumentation, K-Level Reasoning) is a game theory and behavior finance model that tries to explain the individual player's decision in a game-like environment.
2. The model identifies different levels of strategic players in the market with different rationalities.

## When to use?

1. **In a multi-player game:** The result depends on each player's decisions.
2. **Strategy-based game:** In a rock-paper-scissor-like situation, where specific strategies can beat others. e.g., Poker, Penalty kick, Auction, Stock market, etc.

1. **Example:** Half of the average
2. The game is called half of the average.
3. Imagine playing there are x players.
4. Each player can select a number from 0 to 100.
5. We calculate the average of all chosen numbers and call it m.
6. We calculate the half of the m and call it n.
7. The player who has chosen n is the winner. In other words, the winner is the person who strategically selects half of the average of all numbers.
8. Assuming every player has no particular strategy and chooses a random number. These players, we call them level 0 players. Then m would be 50 because they choose randomly from 0 to 100, and the average would be 50. Then n would be 25.
9. By definition, any player choosing above 50 are level 0 player because n would never be bigger than 50 even if all players are level 0.
10. The level 1 player assumes everybody is a level 0 player. Hence he would choose 25.
11. The level 2 player assumes everybody is a level 1 player. Hence he would choose 12.5.
12. The level 3 player assumes everybody is a level 2 player. Hence he would choose 6.25.
13. The level k player assumes everybody is a level k-1 player. Hence he would choose half of what the k-1 player would choose.
14. K represents how many steps one player thinks ahead or assumes the other players are thinking forward.
15. Following this logic, if all players are rational, the optimum choice is always to choose 0 because everybody assumes everybody is rational, and they also know that everybody is reasonable. Hence everybody would go through the exact reasoning and select 0.
16. In reality, if one conducted this experiment in a group, the outcome number n would never be 0. It often lies between 15-20. At the University of Columbia, the average outcome was 22.6. The player-level distribution would be something like this:
    1. ≈20% of the players are level 0.
    2. ≈30% of the players are level 1.
    3. ≈40% of the players are level 2.
    4. ≈5% of the players are level 3.
    5. <5% of the players are level 4.

## Real applications:



1. **Stock market:**In the stock market, one must first understand that the institutions are high-level players who have researched the market comprehensively. They have more knowledge and more tools than any individual investor. Hence an individual investor is likely to be at a disadvantage. It is often not that clear to everyone since most humans tend to have a superiority bias where they think they are better than the average. The k-level thinking framework could help them understand the other players and help them identify themselves.
2. **Poker:**The main difference to our previous example "half of the average" is that the card statistic plays a much more significant role here. A good player not only understands the mindset of his opponent but also has the statistical skills to maximize the likelihood of winning. Poker is even more complex, and the outcome is even less predictable.
3. **Popularity Contest:** Choosing the object that most people want instead of the thing that one personally wants. In situations such as reporting about a specific topic to a boss, presenting a speech to an audience, or choosing a party that others would choose.

## Takeaway:

1. Not every player in the market is entirely reasonable. Some players still play randomly even after fully knowing the rule.
2. The model also shows that thinking too many steps ahead of the crowd is not always the optimal decision. If the average player in a group is level 1, then the level 2 player would win, even if the level 9 player has thought nine steps ahead.
3. Level 4 or above players are scarce in the population. Most humans are level 1 players who think 1 step ahead.
4. It is essential to know your opponents first before making a decision. Sometimes a level 2 strategy would be enough, and sometimes one needs to think four steps ahead.
5. One needs to identify first if one is playing mainly playing against human psychology or mainly playing against a math problem. In this case, the player who makes the most accurate assumption about the other players wins. The example above is a socio-psychology game, not a math game.