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**Competition Model between Artificial Intelligence and Human in job market**

**Abstract:**

As artificial intelligence (AI) continues to advance rapidly, its impact on the job market is becoming increasingly significant. This paper presents a modified Lotka-Volterra competition model to explore the dynamics between human employment and AI-driven automation. The model predicts the conditions under which AI will dominate the job market, potentially leading to significant displacement of human workers. Through stability analysis, the study identifies critical bifurcation points where the balance of power shifts between humans and AI, leading to either coexistence or dominance by AI. The results align with recent trends in the global economy, which suggest that automation could drive unemployment rates to unprecedented levels.

**Introduction:**

As artificial intelligence (AI) continues to evolve at an unprecedented pace, it is becoming increasingly clear that we are on the edge of a transformative era. What once seemed the stuff of science fiction is now a tangible reality: AI systems are not just supporting human efforts but are beginning to outpace human capabilities in a wide array of fields.

Consider the groundbreaking achievement of AlphaGo, the AI developed by DeepMind, which defeated the world champion Go player, a feat once thought impossible due to the game's complexity and the human intuition required to excel. This victory was not just a milestone in AI development; it symbolized the beginning of a new era where AI is capable of surpassing human intelligence in even the most challenging intellectual pursuits. Consider the impact of AI-driven automation in manufacturing, where robots now perform tasks that once required human dexterity and decision-making. Similarly, in the realm of finance, AI algorithms are executing trades at speeds and volumes that human traders simply cannot match. Even creative fields are not immune: AI-generated art, music, and writing are becoming more common, raising questions about the future of human creativity in a world where machines can produce comparable, if not superior, content.

This paper presents a model that explores the inevitability of AI replacing human roles in various sectors. By examining current trends and projecting future advancements, the model argues that the rise of AI is not just a possibility but an eventual certainty. The underlying premise is that as AI continues to learn, adapt, and optimize itself, it will reach a point where its efficiency and effectiveness make human involvement redundant in many professional and creative domains.

Overall, this model seeks to challenge conventional assumptions about human superiority in the workforce and provoke a rethinking of our role in an AI-driven world.

**Mathematical Model:**

**My model in this approach is to apply the standard Lotka–Volterra interference competition model. We first assume that there are work positions human(H) and work positions for artificial intelligence (A), and the number of these positions increases logistically without heterogeneous interference. With the continuous advancement of technology, AI will also advance rapidly, which means that the c**ompetitiveness**of AI will continue to grow and the impact of AI on humans in the competition will also increase. To parameterize this effect, we will use and to explain the strength of the effect of AI on humans and of humans on AI.**

**(1)**

**(2)**

**Parameters:**

* H: The number of work positions for humans.
* A: The number of work positions for artificial intelligence (AI).
* : The rate of change of human work positions over time.
* : The rate of change of AI work positions over time.
* rH: The intrinsic growth rate of human work positions.
* r**A​**: The intrinsic growth rate of AI work positions.
* **​**: The carrying capacity for human work positions (the maximum number of human positions that can be supported without competition).
* : The carrying capacity for AI work positions (the maximum number of AI positions that can be supported without competition).
* **​**: The competition coefficient: impact of AI work positions on human work positions.
* **​**: The competition coefficient: impact of human work positions on AI work positions.

**I use the Lotka–Volterra competition model reflecting how humans and artificial intelligence interact with each other without introducing time, "t". In the next section, I will analyze how the equilibria change in response to any changes in .**

**Stability Analysis**

I **will use the Jacobian matrix to analyze the stability of the corresponding equilibrium points of each model and predict the competitive relationship between AI and humans in future job market.**

**To calculate the equilibrium points, set the equations (1) and (2) equal to 0, solve for H\* and A\* respectively, and then combine the corresponding values of H\* and A\* obtained by the two equations. The four equilibriums we get are (H\*, A\*)**

**(0, 0), (0, KA), (KH, 0), (.**

**We only interested in non-trivial solutions. Let’s ignore the equilibrium point at the origin and pay more attention to the boundary and interior equilibrium.**

**(0, KA), (KH, 0), (.**

**Next, we will calculate the Jacobian matrix. Let and . The Jacobian matrix we get is**

**At (0, KA),**

This is a diagonal matrix; we can find two eigenvalues directly:

**.**

**The is always negative. The sign of depends on We start to look at when AI has less of an impact on humans, that is, , so . In this case, > 0, < 0, which means that (0, KA) is a saddle point.** This implies that when AI first introduced to the system, the interference coefficient to humans was small, and it could not replace humans in completing various tasks. Nevertheless, with the innovation of technology, is increasing. , **,** both eigenvalues become negative, meaning the original saddle equilibrium becomes a stable equilibrium point. This implies that AI will eventually dominate in this competition. When the initial number of working AIs exceeds the number of employed humans, the system will evolve toward a stable equilibrium at **(0, KA)**, where the number of employed humans drops to zero.

Another place we need to pay attention to is , this is a bifurcation point because it separates the stable and saddle parts of (0, KA), producing a transcritical bifurcation.

At (KH, 0):

**Since the determinant of a triangular matrix is the product of its diagonal elements, the eigenvalues = , = . < 0.** Human has less impact on AI, meaning ​​, so that KA> ​. In this case, λ2 > 0 and λ1 < 0, indicating that (KH, 0) is a saddle point. This suggests that when human interference with AI is minimal, it cannot fully replace AI. However, As increases and exceeds **.** λ2​ becomes negative, turning the saddle point into a stable equilibrium. This indicates that as human can eventually dominates in long run.

Similarly, a transcritical bifurcation with bifurcation point at . When the human intervention coefficient on AI increases, . At this time, the increased influence of humans will lead to the change of stability from unstable to stable.

In conclusion:

* Before the bifurcation: Humans hold a stable role (**). Influence of AI is limited.**
* **At the bifurcation point:** The parameter ​ reaches a critical value where the influence of AI equals the capacity of humans, leading to a shift in stability.
* **After the bifurcation:** AI becomes the dominant force (), potentially reducing human employment to zero as AI takes over.

**Now, let’s focus on the internal equilibrium. For the convenience of referring to this more complicated equilibrium, we call ( as (x, y), with x and y being both positive numbers. Notice that since x and y are both positive, then the sign of and must be the same, and this internal equilibrium only occurs when , or .**

**Let's look at the Jacobian matrix at (x, y),**

**. (12)**

Trace(J) =

**Det(J) = =**

**From here, we can clearly see that Trace is always negative and the sign of det depends on 1 When it is less than 0, we have , then the interior equilibrium is a saddle point in this case. This reflects both humans and AI have great interference with each other, and the advantage of either side's initial condition can wipe out the other side from the competition. And the change of the interference coefficient on either side will cause (x, y) to approach the boundary equilibrium, and when the interference coefficient of any side begins to less than (x, y) coincides with the boundary equilibrium, resulting only three equilibriums.**

**On the contrary, if 1, we have and det is greater than 0. In order to distinguish whether this is a node or a focus, we need to justify whether it is greater than 0. Using basic arithmetic, we get**

**(13)**

**This means that (x, y) is indeed a stable point. In this case, humans and AI have less interference with each other, and the distribution of jobs between AI and humans are likely to reach a balance point.**

**Therefore, 0 = is the critical bifurcation point. The linear change in stability implies that (x, y) is also transcritical bifurcation. These changes in the stability of the equilibrium tell us that when the influence between humans and AI are weak, the competition for jobs between humans and AI will reach a harmonious balance. And when and/or more than and /or , humans or AI will dominate, replacing the other depending on the initial conditions.**

**Example**

**To keep the example simple, we first assume that the job capacity of both AI and humans is 1, and then we have = = 1.** **Secondly, we will mainly focus on the interior equilibrium because the boundary equilibrium are constant points. In addition, since we mainly focus on the impact of AI on humans, we regard the impact coefficient of humans on AI as a constant and pay attention to the change of this interior equilibrium as incresses.**

**We assume that humans have a minor influence coefficient on AI, then we let 0.6. We plot ( in terms of. From figure 1, we can see that if the number of jobs for AI and humans is to remain positive, then and must be less than one. We can also find that before it is less than 1, the stable internal equilibrium approaches the equilibrium on the A-axis of the figure 1 as is moving toward 0. It shows the influence of AI on human continues to increase, the available jobs of human will gradually decrease, and AI will replace human at the end.**

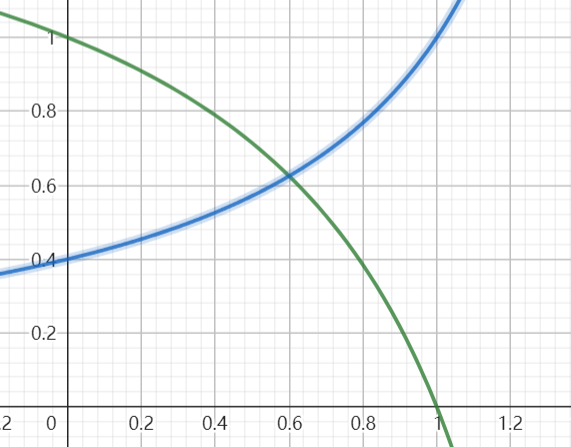
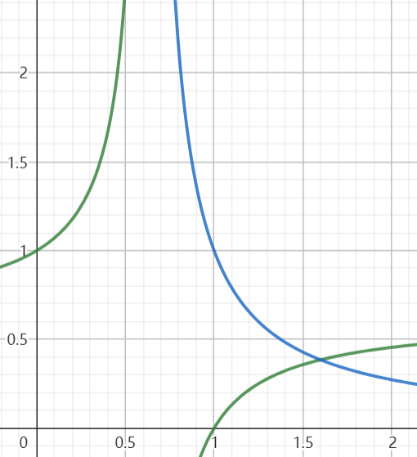
 

Figure 1 Figure 2

figure 1: Evolution of the Internal Equilibrium with Minor Human Influence on AI

figure 2: Dynamics of the Internal Equilibrium with Significant Mutual Influence

blue:**blue:**

green:**green:**

x-axis:

**However, what is more interesting is if we assume that both AI and humans have a greater influence on each other, namely, . We assume this time = 1.6, then after we plot ( in figure 2, with the increase of AI’s influence on humans, especially when AI’s influence on humans is greater than the impact of humans on AI, the original unstable equilibrium approaches the H-axis of figure 2 as is moving toward 0, but it does not overlap with the stable equilibrium on the original boundary. In this case, humans may even become the winners of this competition.**

**Conclusion:**

My model is a modified Lotka-Volterra competition model to analyze the competitive dynamics between humans and AI in the job market. The model captures the interplay between human and AI job positions, driven by competition coefficients that reflect the influence each has on the other.

The results of this model align with trends observed in the real-world economy. For example, studies have suggested that automation could lead to a 15% unemployment rate in 2023, with this figure potentially climbing to 30% in the following years (Manyika & Sneader, 2018). However, the model also provides a more nuanced perspective by indicating that AI will not necessarily replace humans if the mutual influence between humans and AI is significant from the outset. In such scenarios, the competitive balance could prevent AI from completely overtaking human roles.

While the model offers valuable insights, it does have limitations. One key limitation is that it does not account for external factors like the COVID-19 pandemic, which accelerated AI adoption and could hasten the displacement of human workers. Additionally, the model does not incorporate the possibility that humans could actively contribute to AI's growth, further altering the competitive dynamics. These factors could significantly impact the future balance between human and AI job positions, suggesting areas for future research and model refinement.

This model provides a theoretical framework for understanding the competitive dynamics between humans and AI in the job market. It underscores the importance of considering both technological advancements and human-AI interactions when predicting future employment trends. While the model aligns with current economic predictions, it also highlights the potential for a balanced coexistence, depending on initial conditions and mutual influences. However, future iterations of the model should incorporate additional real-world factors to enhance its predictive power and applicability.

**Citation:**

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