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RESEARCH ARTICLE

Modeling the Complex Interplay: Dynamics of Job Displacement and Evolution of Artificial Intelligence in a Socio-Economic Landscape

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Abstract
This research explores the intricate dynamics of job displacement resulting from artificial intelligence (AI) using a sophisticated non-linear dynamical system modeled through the Lotka-Volterra equations, commonly employed in ecology to elucidate predator–prey dynamics. In this study, we interpret human jobs as the "prey" and AI technology as the "predator," identifying two equilibrium points: $E_1 \equiv (0, 0)$ signifies a state with no jobs and no AI technology, while $E_2 \equiv (s/\beta, r/\alpha)$ denotes a balanced coexistence where job growth and AI development are in equilibrium. Qualitative analysis reveals four regions characterized by different trends in job expansion and AI development, with Region IV indicating a co-evolutionary phase marked by positive feedback. Stability analysis demonstrates that while E_1 remains consistently unstable, E_2 remains stable, providing valuable insights into system dynamics. Scenarios presented suggest a promising future where balanced growth fosters sustainable coexistence between human workers and AI, although challenges arise when AI outpaces human job growth, emphasizing the necessity of effective policy responses to mitigate adverse effects and maximize the benefits of technological advancement. Understanding these dynamics is crucial for policymakers to navigate the complexities of AI-induced job displacement and ensure equitable societal outcomes.

Keywords Artificial intelligence · Dynamical systems · Job displacement · Lotka-Volterra model · Socio-economic dynamics

1 Introduction

AI is the implementations of human intelligence in machines that are specifically designed to think and act like humans. The phrase may also refer to any machine that demonstrates human-like characteristics such as memorization and task-solving.

AI is a branch of computer science that focuses on creating intelligent machines that can think and act like humans and first studied by [1]. AI systems use algorithms and data to solve problems, interpret patterns, and make predictions. AI technology is being used in a variety of fields such as robotics, finance, healthcare, transportation, and more. AI has the potential to revolutionize how humans interact with technology, allowing for more efficient processes and better decision-making capabilities. AI is a rapidly growing technology that has the potential to significantly impact the way we live. AI can automate manual tasks and help us make decisions quickly and accurately, enabling us to do more with less effort. It can also help us discover new insights, uncover hidden patterns, and make predictions about the future. AI is becoming increasingly important in many industries, from healthcare to finance and retail, as it helps organizations become more efficient and competitive.

AI has been the subject of much research and development over the past few decades. AI has found applications in many different fields, from robotics to computer vision, natural language processing and machine learning. It can also be a valuable tool for understanding how AI technology is being used in different industries and how it is evolving over time. Following are a few examples of notable research on job displacements: The DWS data is used to study the

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incidence and costs of job loss during 1982–1991, and the changing face of job loss in the United States during 1981–1995 by [2] and [3], respectively. Using German data, [4] discovered that unemployment considerably reduces total life satisfaction. The findings differ for men and women and are consistent with labor supply elasticity estimates. [5] investigated the 1984–1996 Displaced Worker Surveys to explain how the characteristics of displacement are evolving, with more highly educated, white collar, and nonmanufacturing employees being displaced. [6] addressed the psychological impacts of past unemployment. They observed, using 11 waves of German panel data, that life satisfaction is worse not just for individuals who are now unemployed but also for those who had experienced higher levels of past unemployment. [7] investigated the effect of job loss on total and cause-specific mortality. They identified the workers displaced as a result of all firm closures in Sweden in 1987 and 1988 using linked employer-employee data. They discovered that the overall mortality risk for men increased by 44% in the first 4 years after job loss, whereas there was no effect on female overall mortality or in the long term. However, there was a roughly threefold rise in suicides and alcohol-related mortality for both sexes in the short term. Discrete duration models are used to examine the influence of involuntary work displacements on the likelihood of divorce by [8]. [9] examined the theories of expensive job relocation and assessed their compatibility with the actual data available for the United States. [10] explored the potential economic impact of lost earnings and tax revenues from AI and machine learning in the United States. [11] analyzed the relationship between job displacement and various measures of subjective well-being by sex using matched cross-sectional data from the 2010 and 2012 Displaced Workers Supplements of the Current Population Surveys and the 2010, 2012, and 2013 American Time Use Survey Well-Being Modules. [12] studied the implications of AI and deep learning in a future of compelling business strategies. [13] investigated the importance of explainability in medical AI and conducted an ethical review of what explainability entails for the acceptance of AI-driven technologies into clinical practice.. One notable study by [14] examines the role of AI-driven automation in reshaping job tasks and skill requirements, highlighting the need for workers to adapt to evolving job demands. Similarly, [15] investigate the effects of AI adoption on employment dynamics, emphasizing the importance of policy interventions to mitigate job displacement and promote inclusive growth.The globalization of artificial intelligence and its implications for environmental politics are addressed by [16] and [17].

Recently, [18] used topic modelling and term extraction to investigate the effects of AI on occupations. [19] emphasized the critical importance of AI-based methodologies in several biological research domains, such as proteomics and drug design procedures, and ultimately investigated the relevance of AI in daily clinical practice and healthcare systems. Finally, they discussed the limitations and future prospects of artificial intelligence in modern biomedical research. The technique of data mining is used by [20] to analyze and anticipate crimes that jeopardize public health. [21] propose a framework for assessing the social and economic impacts of AI technologies, offering insights into the potential benefits and challenges of AI adoption for different sectors of the economy. According to studies, the collaboration of the government and the people can successfully avoid the emergence of incidents that risk public health. The barriers to AI adoption in smart cities are studied by [22]. [23] investigated how artificial intelligence (AI) may be utilized to improve illness detection, prognosis, and subgrouping. Given the past issues with prediction, diagnosis, and treatment in psychiatry, the concept that AI may increase medicine's understanding of biological categories of mental diseases as well as deliver better therapies is enticing. Moreover, recent developments in AI ethics and governance, as discussed by [24], underscore the importance of addressing ethical considerations and ensuring responsible AI deployment to mitigate adverse effects on employment and society. Additionally, advancements in AI technologies, such as deep learning and natural language processing, as explored by [25], have implications for job automation and workforce skill requirements, necessitating continuous adaptation and upskilling among workers.

The rapid integration of artificial intelligence (AI) into our socio-economic fabric has triggered profound changes in the employment landscape, giving rise to intricate dynamics between job displacement and technological evolution. This study employs a non-linear dynamical systems approach, drawing inspiration from Lotka-Volterra-type ecological models, to capture and explore the complex interplay between the number of jobs (J) and the level of AI technology (A). As AI continues to reshape industries, understanding the feedback loop between job market dynamics and technological progress becomes crucial for anticipating and managing societal transitions. This research endeavors to contribute to the theoretical framework by introducing a model that reflects the nuanced relationships between job growth, displacement, and the development of AI. While recognizing the limitations of such a simplified model, this study aims to shed light on the multifaceted interactions that characterize our evolving socio-economic landscape.

2 Job Displacement

AI is capable of automating many jobs that were previously done by humans, leading to potential job displacement in certain industries. It is important to prepare the workforce for this shift and create new job opportunities in emerging industries. The rise of artificial intelligence (AI) has undoubtedly brought about significant changes in the job market. With its ability to automate tasks that were traditionally performed by humans, there is a growing concern about potential job displacement in certain industries. However, it is crucial to understand that AI is not here to replace human workers entirely, but rather to augment and enhance their capabilities. While some jobs may indeed be automated, this shift also brings forth new opportunities and creates a demand for skills in emerging industries. It is imperative for the workforce to adapt and prepare for this change by acquiring new skills and knowledge that align with the evolving job market. Governments, educational institutions, and organizations should collaborate to provide training programs and resources that equip individuals with the necessary skills required in the era of automation. This includes nurturing creativity, critical thinking, problem-solving abilities, as well as technical skills related to AI and emerging technologies.

Moreover, it is essential to identify potential areas where human expertise can complement AI technology. Jobs that require emotional intelligence, complex decision-making, empathy, or creative problem-solving are less likely to be fully automated. By focusing on these aspects and fostering a culture of lifelong learning and adaptability within the workforce, individuals can navigate through this technological shift more effectively. Furthermore, it is crucial for governments and organizations to invest in research and development initiatives aimed at creating new job opportunities in emerging industries such as AI development itself or other sectors where human involvement remains indispensable. By capitalizing on these emerging fields and encouraging entrepreneurship within the workforce, we can create a sustainable future where both humans and AI coexist harmoniously.

In conclusion, while there may be concerns regarding potential job displacement due to AI automation, it is vital to view this shift as an opportunity rather than a threat. By preparing the workforce through up-skilling initiatives and creating new job opportunities in emerging industries, we can ensure a smooth transition into an era where humans work alongside AI technology for mutual benefit.

3 Mathematical Model

Let us consider a more complex non-linear dynamical system to represent job displacement due to artificial intelligence. We can use a Lotka-Volterra type of model, which is commonly used in ecology to describe predator–prey interactions. In this case, we'll interpret it as the interaction between jobs (prey) and AI technology (predator). The equations can be as follows:

$$\left.\begin{aligned} \frac{dJ}{dt} &= rJ - \alpha JA \\ \frac{dA}{dt} &= -sA + \beta JA. \end{aligned}\right\} \tag{1}$$

Here, $J(t)$ represents the number of jobs, and $A(t)$ represents the level of AI technology at any instant t. The parameters r, α, s and β all are positive real constants and have the following interpretations:

r: Job growth rate without AI influence.

α: Rate of job displacement due to AI.

s: Rate of AI technology decay without job influence.

β: Rate of AI development influenced by the number of jobs.

In the context of dynamical system (1), the first equation proposes that job expansion (rJ) faces hindrance due to the concurrent impact of AI-induced displacement (αJA). Simultaneously, the second equation within the dynamical system (1) highlights that the decline in AI technology ($-sA$) is offset by its developmental trajectory, influenced by the prevailing job market conditions (βJA). This articulates a dynamic equilibrium, portraying the intricate interplay between job growth, the effects of AI-induced job displacement, and the reciprocal influence on the evolution of AI technology within the framework of the proposed system.

4 Equilibrium Points

Equilibrium points in a dynamical system are critical states where the rates of change for the system's variables become zero. These points signify a balance in the system, where the influences driving changes in the variables are precisely counteracted, resulting in a stable state. In the context of the given dynamical system modeling job displacement due to artificial intelligence, the equilibrium points are found by setting the derivatives of the job and AI technology variables to zero. Understanding these equilibrium points is essential for comprehending the long-term behavior and stability of the system under the influences of job displacement and AI evolution.

In our exploration of equilibrium points in the dynamical system modeling job displacement due to artificial intelligence, we employ a dual approach for their determination: the analytical approach and the qualitative approach. This two-pronged approach enhances our comprehension of the intricate relationships between job displacement and AI evolution in the modeled system.

4.1 Analytical Approach

The analytical approach involves rigorous mathematical techniques, where we set the derivatives of the system's variables to zero and solve the resulting equations algebraically.

The equilibrium points of the dynamical system (1) are determined by setting all derivatives to zero, i.e.,

$$(r - \alpha A)J = 0 \text{ and } (-s + \beta J)A = 0.$$

Solving these two equations simultaneously, we have $J = 0$, s/β and $A = 0$, r/α resulting in two equilibrium points (0, 0) and $(s/\beta, r/\alpha)$.

These points, denoted as $E_1 \equiv (0, 0)$ and $E_2 \equiv (s/\beta, r/\alpha)$, represent states of stability in the system where the rates of change for both jobs and AI technology are zero. The equilibrium point $E_1(0, 0)$ signifies a state of no jobs and no AI technology, while the point $E_2(s/\beta, r/\alpha)$ reflects a balanced coexistence where job growth and AI development are in equilibrium, i.e., the point $E_2(s/\beta, r/\alpha)$ indicating the maximum sustainable levels for jobs and AI technology within the dynamics of the system. Understanding these equilibrium points is crucial for comprehending the long-term behavior and stability of the system under the influence of job displacement and AI evolution.

4.2 Qualitative Approach

A qualitative approach emphasizes the conceptual understanding of the system's behavior. By considering the underlying dynamics and trends in the equations, we gain insights into the system's stability and equilibrium without necessitating explicit numerical solutions.

The identification of equilibrium points in our dynamical system, representing the complex interplay between job displacement and artificial intelligence evolution, is facilitated by the intersection of nullclines. Nullclines are curves in the phase space where the derivatives of one or both variables are zero. In our system, the nullclines represent the points at which the rates of change for jobs and AI technology become zero. Consequently, the equilibrium points E_1 and E_2, characterized by these zero rates of change, emerge at the intersections of these nullclines.

The nullclines for the availability of the jobs are given by

$$J = 0 \text{ or } r - \alpha A = 0.$$

Similarly, the nullclines for the AI technology adaptation are given by

$$A = 0 \text{ or } -s + \beta J = 0.$$

Since, the equilibrium points are the intersections of the nullclines, therefore we have two equilibrium points E_1 and E_2 given by

$$E_1 \equiv (0, 0) \text{ and } E_2 \equiv (s/\beta, r/\alpha).$$

Figure 1 visually depicts these equilibrium points, providing a graphical representation of the system's stable states where the influences of job displacement and AI evolution are in balance. The region I corresponds to $dJ/dt > 0$ and $dA/dt < 0$, i.e., in this region, the number of jobs is increasing while AI technology is on the decline. This scenario suggests a phase characterized by job expansion in the face of diminishing AI development. Such a configuration may arise when job opportunities thrive despite a slowdown or decreasing investment in AI technology. This region underscores the intricate dynamics within the system, where job growth appears resilient even in the absence of a strong concurrent surge in AI advancements, revealing the nuanced interplay between these variables.

The region II corresponds to $dJ/dt < 0$ and $dA/dt < 0$, i.e., in this region, both the number of jobs and AI technology are experiencing a decrease. This sector of the phase space signifies a state of contraction, where job opportunities are diminishing alongside a decline in AI development. The co-occurrence of negative rates of change for both variables in this region indicates a period of economic downturn or stagnation, highlighting the interconnected nature of job displacement and the suppression of AI advancement within the dynamics of the modeled system.

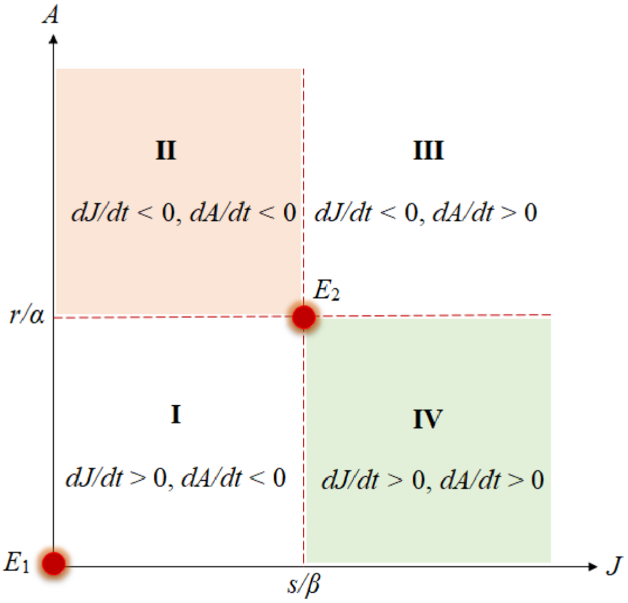


Fig. 1 Nullclines and equilibrium points

The phase categorized as a recession phase is typically represented by a region where both the number of jobs ($dJ/dt < 0$) and AI technology ($dA/dt < 0$) are decreasing. This corresponds to a situation where economic activity is contracting, job opportunities are diminishing, and there's a simultaneous decline in advancements in artificial intelligence. Therefore, the region labeled as region II, where $dJ/dt < 0$ and $dA/dt < 0$, can be considered as indicative of a ***recession phase*** within the context of the modeled dynamical system.

The region III corresponds to $dJ/dt < 0$ and $dA/dt > 0$, i.e., in this region, the number of jobs is decreasing while AI technology is on the rise. This configuration suggests a scenario where job opportunities are contracting even as AI continues to advance. Region III indicates a phase in the system where job displacement occurs amid ongoing technological progress, illustrating the complex dynamics and potential challenges associated with the coexistence of declining employment and escalating advancements in artificial intelligence.

Finally, the region IV corresponds to $dJ/dt > 0$ and $dA/dt > 0$, i.e., in this region, the number of jobs is increasing concurrently with the increase in AI technology. This signifies a co-evolutionary phase where job growth and AI development mutually reinforce each other, fostering a positive feedback loop. The shaded region illustrates a dynamic scenario in which the advancement of AI contributes to job creation, and in turn, the expanding job market fuels further advancements in AI technology. This interdependence reflects the complex and symbiotic relationship between job opportunities and technological progress within the conceptual framework of the modeled dynamical system.

5 Stability of Equilibrium Points

To discuss the linear stability of equilibrium points, we perturb the equilibrium point (J^*, A^*) to $(J^* + \varepsilon_1(t), A^* + \varepsilon_2(t))$, where $\varepsilon_{1,2}(t) << 1$. Now, linearizing the system (1), we have

$$\left.\begin{array}{l} \dot{\varepsilon}_1(t) = f(J^* + \varepsilon_1, A^* + \varepsilon_2) = f_J^0\varepsilon_1 + f_A^0\varepsilon_2 \\ \dot{\varepsilon}_2(t) = g(J^* + \varepsilon_1, A^* + \varepsilon_2) = g_J^0\varepsilon_1 + g_A^0\varepsilon_2 \end{array}\right\} \tag{2}$$

where $f_J^0 = \frac{\partial f}{\partial J}\Big|_{(J^*,A^*)}, f_A^0 = \frac{\partial f}{\partial A}\Big|_{(J^*,A^*)}, g_J^0 = \frac{\partial g}{\partial J}\Big|_{(J^*,A^*)}, g_A^0 = \frac{\partial g}{\partial A}\Big|_{(J^*,A^*)}$,

$f(J, A) = rJ - \alpha JA$ and $g(J, A) = -sA + \beta JA$.

The characteristic equation that corresponds to the system of Eqns. (2) is

$$\lambda^2 - (f_J^0 + g_A^0)\lambda + (f_J^0 g_A^0 - f_A^0 g_J^0) = 0. \tag{3}$$

The stability of the equilibrium point depends upon the nature of the eigenvalues (λ_1 and λ_2) of the characteristic Eq. (3).

5.1 Stability of E_1

For $E_1 \equiv (0, 0)$, we have

$$f_J^0 = \frac{\partial f}{\partial J}\Big|_{(0,0)} = r, g_A^0 = \frac{\partial g}{\partial A}\Big|_{(0,0)} = -s,$$

$$f_A^0 = \frac{\partial f}{\partial A}\Big|_{(0,0)} = 0 = g_J^0 = \frac{\partial g}{\partial J}\Big|_{(0,0)}.$$

Thus the characteristic Eq. (3) reduces to

$$\lambda^2 - (r - s)\lambda - rs = 0. \tag{4}$$

The eigenvalues of Eq. (4) are $\lambda_1 = r > 0$ and $\lambda_2 = -s < 0$ as $r, s > 0$. Therefore, $E_1(0, 0)$ is a saddle point and hence unstable.

5.2 Stability of E_2

For $E_2 \equiv (s/\beta, r/\alpha)$, we have

$$f_J^0 = \frac{\partial f}{\partial J}\Big|_{\left(\frac{s}{\beta},\frac{r}{\alpha}\right)} = 0 = g_A^0 = \frac{\partial g}{\partial A}\Big|_{\left(\frac{s}{\beta},\frac{r}{\alpha}\right)}$$

$$f_A^0 = \frac{\partial f}{\partial A}\Big|_{\left(\frac{s}{\beta},\frac{r}{\alpha}\right)} = -\frac{\alpha}{\beta}s,$$

$$g_J^0 = \frac{\partial g}{\partial J}\Big|_{(s/\beta, r/\alpha)} = \frac{\beta}{\alpha}r.$$

Consequently, the characteristic Eq. (3) takes the form

$$\lambda^2 + rs = 0. \tag{5}$$

The eigenvalues of Eq. (5) are $\lambda_{1,2} = \pm i\sqrt{\kappa}$; $\kappa = rs$. Consequently, $E_2(s/\beta, r/\alpha)$ is identified as a center point, thereby implying stability. The motion encircling E_2 exhibits periodic behavior, depicted in Fig. 2, with a characteristic time-period $T = 2\pi/\sqrt{\kappa}$. With increasing κ, the time-period diminishes, while a decrease in κ yields an elongation of the time-period, as illustrated in Fig. 3. Consequently, for lower κ values, the completion of one cycle requires more time, whereas for higher κ values, the cycle duration is markedly shorter (Fig. 4). This observation underscores the influence of κ on the temporal dynamics of the system.

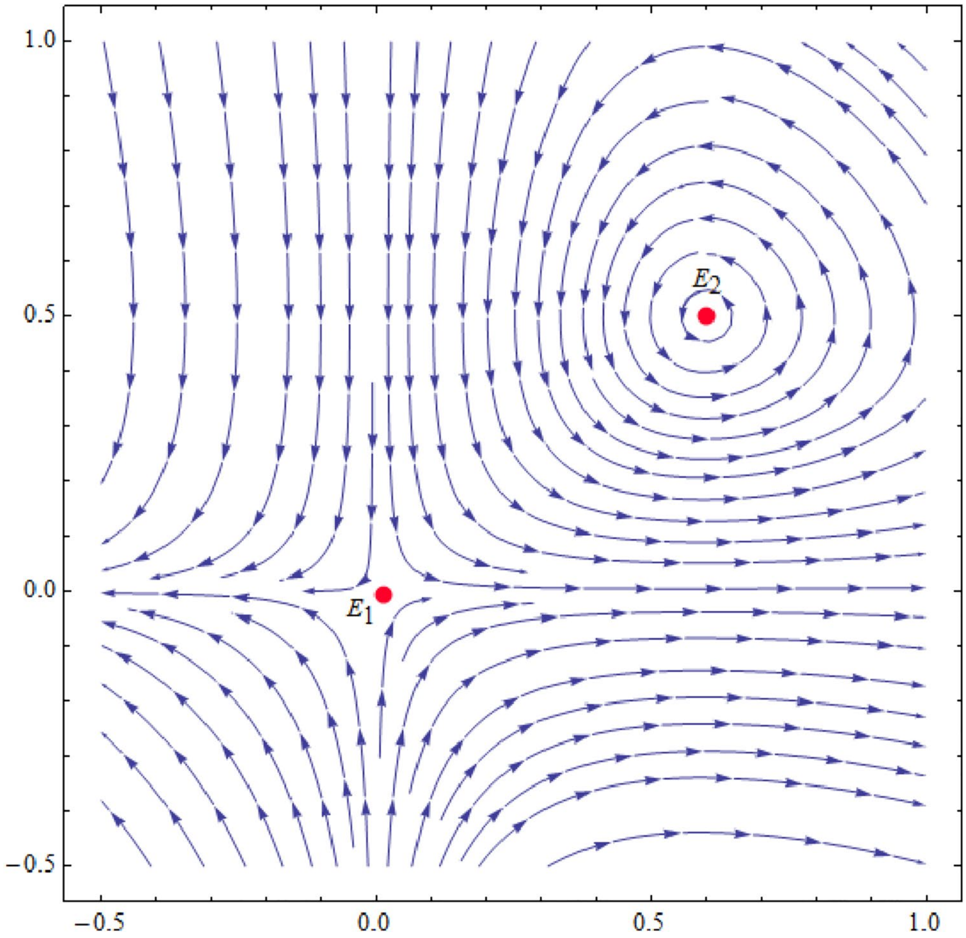


Fig. 2 Trajectories around E_1 and E_2

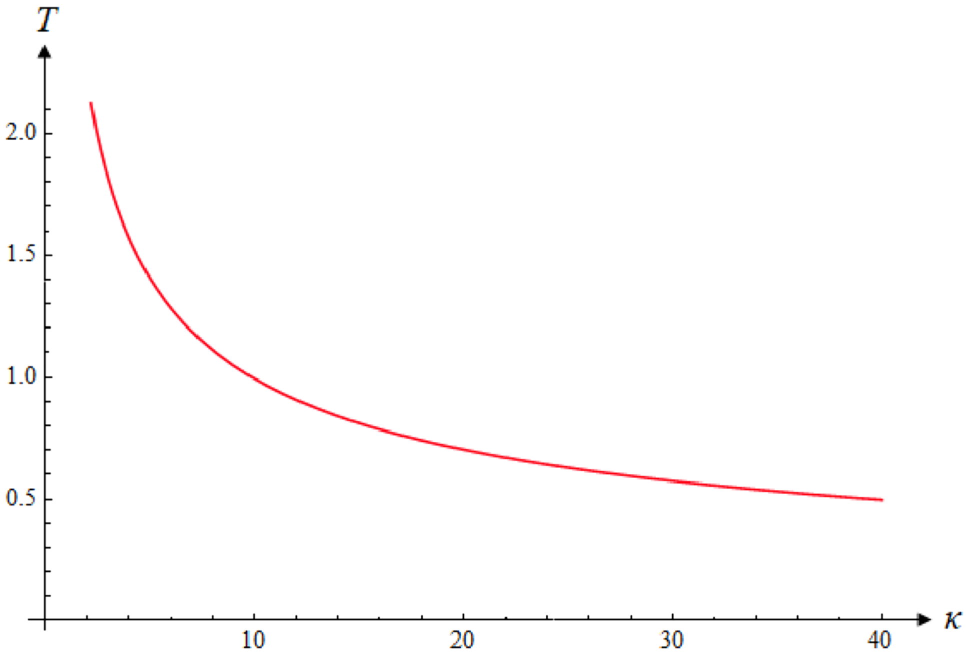
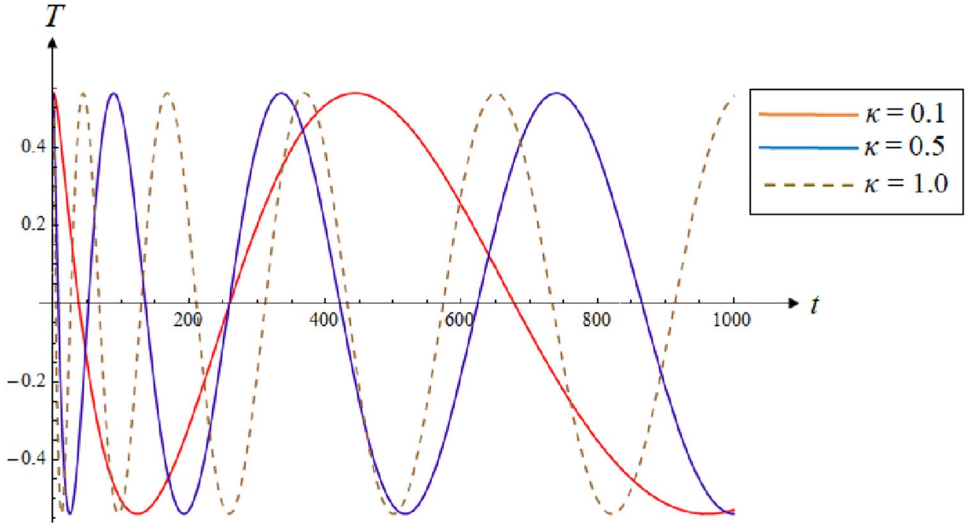


Fig. 3 T versus κ

Fig. 4 Oscillation around E_2 for different values of κ



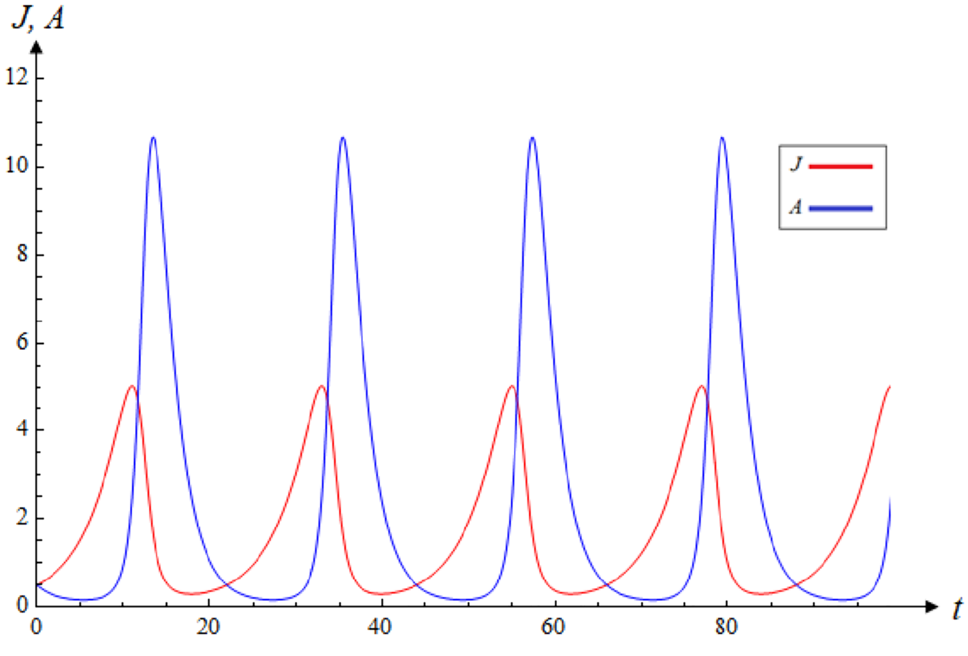
6 Dynamics of Job displacement and AI Evolution

In this section, we delve into the intricate dynamics of job displacement and the evolution of artificial intelligence (AI), examining how they interplay across various values of key parameters: r, α, s and β. These parameters hold significant sway over the trajectories of job markets and technological advancement. We consider here the following cases:

Case I: $r > \alpha$ and $s > \beta$

In this scenario, the rate of growth of AI is more than the rate of growth of jobs, leading to a gradual but steady decline in the availability of human employment opportunities relative to the expansion of AI-driven automation, depicted in Fig. 5. The parameter r representing the growth rate of jobs is outweighed by α, the rate at which AI displaces human jobs. Similarly, the decay rate s of AI is slower than β, the rate at which human jobs stimulate the growth of AI-driven automation. Consequently, despite some ongoing job creation, the overall trend favors a shift towards a more automated workforce, resulting in increasing job displacement and a progressive transition towards a society where AI plays a dominant role in various sectors of the economy. This scenario underscores the importance of carefully managing the pace of technological advancement and implementing policies to mitigate

Fig. 5 Job displacement and AI evolution dynamics for $r > \alpha$ and $s > \beta$



the adverse effects of job displacement, such as retraining programs and social safety nets.

Case II: $r = \alpha$ and $s = \beta$.

In the context where the growth rates of jobs and job displacements due to AI are balanced ($r = \alpha$) and the rates at which each influences the other are equal ($s = \beta$), a stable equilibrium is reached, fostering a harmonious coexistence between human workers and AI-driven automation as illustrated in Fig. 6. This equilibrium sustains balanced growth for both human employment and AI-driven automation, ensuring that technological progress occurs without significant disruptions to the job market. As human jobs stimulate the growth of AI at a rate matching the displacement caused by AI, and vice versa, a sustainable path for technological advancement emerges. While this scenario suggests a promising balance between human employment and AI, careful policy considerations remain crucial to manage the impact of technological advancements on the workforce, emphasizing the importance of investing in education, retraining programs, and fair labor practices to maximize the benefits of AI while minimizing potential drawbacks.

Case III: $r < \alpha$ and $s < \beta$.

In the circumstance where the growth rate of jobs is lower than the rate at which AI displaces them ($r < \alpha$), and the

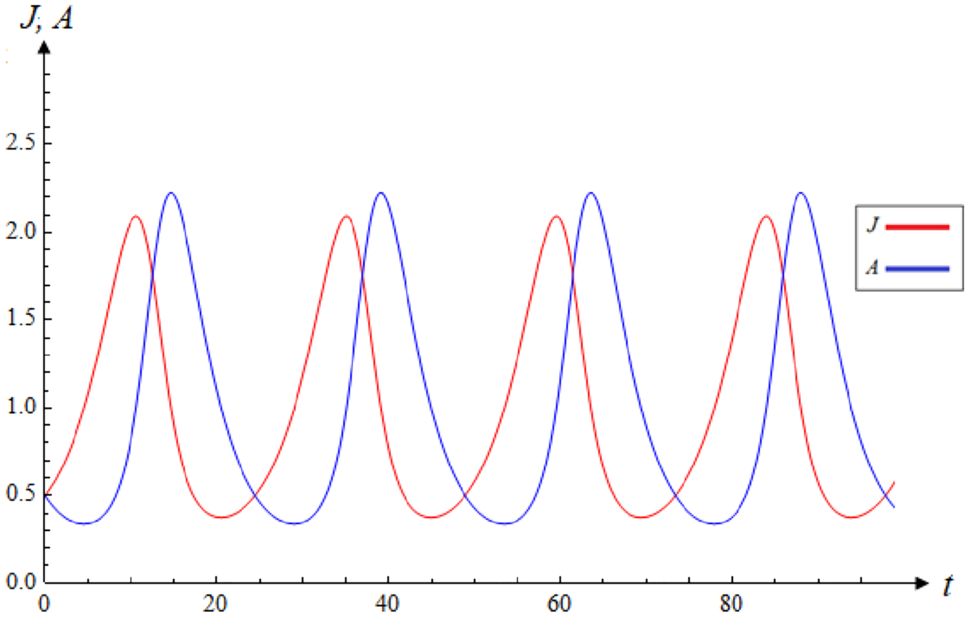


Fig. 6 Job displacement and AI evolution dynamics for $r = \alpha$ and $s = \beta$

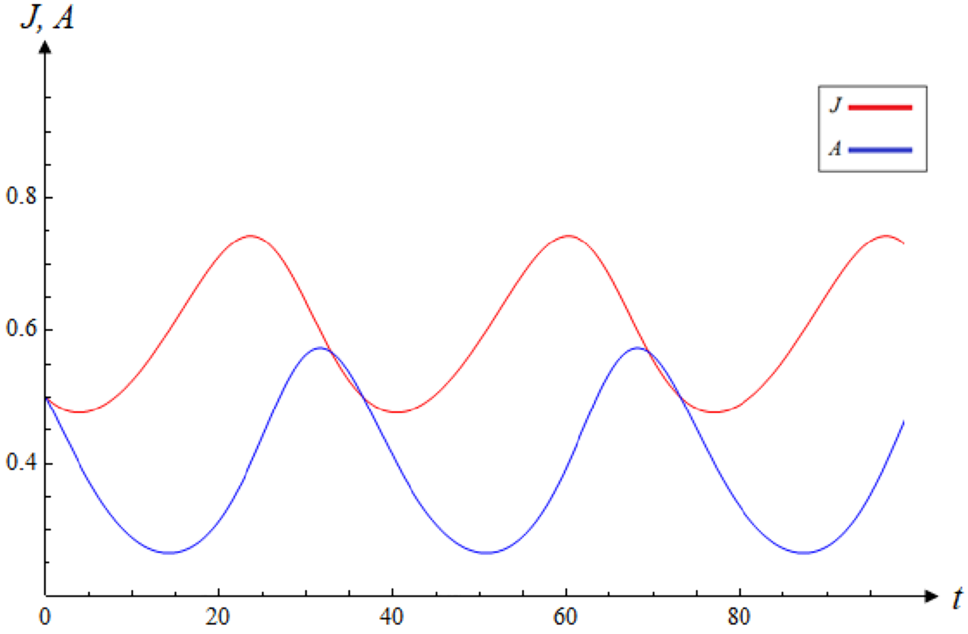


Fig. 7 Job displacement and AI evolution dynamics for $r < \alpha$ and $s < \beta$

decay rate of AI is slower than the rate at which human jobs stimulate its growth ($s < \beta$), leading to a gradual but steady increase in the availability of human employment opportunities relative to the expansion of AI-driven automation (Fig. 7). Consequently, despite ongoing automation, the overall trend favors a workforce where human labor continues to play a significant role alongside AI, resulting in decreasing job displacement and a progressive transition towards a society where humans and AI coexist in various sectors of the economy. This converse scenario underscores the importance of managing the pace of technological advancement to ensure that human employment remains viable and sustainable, along with implementing policies to support the integration of AI while preserving human-centric values and roles in the workforce.

7 Discussion

In this research, we have explored a sophisticated non-linear dynamical system to characterize the repercussions of artificial intelligence on job displacement. Employing a Lotka-Volterra model, commonly utilized in ecology to elucidate predator—prey dynamics, we have analogously interpreted it as the interplay between jobs (prey) and AI technology (predator). Two equilibrium points, denoted as $E_1 \equiv (0, 0)$ and $E_2 \equiv (s/\beta, r/\alpha)$, have been identified, representing states of stability where the rates of change for both jobs and AI technology are zero. $E_1(0, 0)$ signifies a state with no jobs and no AI technology, while $E_2(s/\beta, r/\alpha)$ signifies a balanced coexistence where job growth and AI development are in equilibrium, representing the maximum sustainable levels for both within the system dynamics.

The qualitative behavior of this dynamical system is visually presented in Fig. 1, where the Region I corresponds to $dJ/dt > 0$ and $dA/dt < 0$, suggesting job expansion despite a decline in AI technology. This may occur when job opportunities thrive even with reduced investment in AI technology.

Region II, with $dJ/dt < 0$ and $dA/dt < 0$, signifies a contraction phase where both job opportunities and AI development are decreasing, indicative of a recession within the modeled dynamical system.

Region III, with $dJ/dt < 0$ and $dA/dt > 0$, implies a scenario where job opportunities are contracting while AI continues to advance.

Region IV, with $dJ/dt > 0$ and $dA/dt > 0$. In this region, job numbers are increasing concurrently with the rise in AI technology, indicating a co-evolutionary phase characterized by a positive feedback loop.

It is noteworthy that for any positive values of parameters r, s, α, and β, the equilibrium point E_1 consistently exhibits instability, while E_2 remains steadfastly stable. This observation provides valuable insights into the overall stability and dynamics of the system under the influence of job displacement and AI evolution.

The scenarios presented in Sect. 6 offer a glimpse into the complex dynamics of job displacement and the evolution of artificial intelligence (AI). When the growth rates of human jobs and AI-driven automation are balanced ($r = \alpha$) and their influences are equal ($s = \beta$), a stable equilibrium emerges, fostering a sustainable coexistence between human workers and AI. This equilibrium suggests a promising future where technological progress enhances productivity without significantly disrupting the job market. However, in scenarios where human job growth outpaces AI ($r > \alpha$) and the decay rate of AI is faster than the rate of human job stimulation ($s > \beta$), rapid job displacement dominates, posing challenges for human workers and exacerbating economic inequality. Effective policy responses become crucial in such scenarios to mitigate the adverse effects of automation, requiring investments in education, retraining programs, and supportive measures for displaced workers. Overall, understanding these dynamics is essential for policymakers to navigate the challenges and opportunities presented by technological advancement.

8 Conclusion

In conclusion, this study employs a sophisticated non-linear dynamical system, modeled through the Lotka-Volterra equations, to explore the repercussions of AI on job displacement. Through qualitative and stability analyses, we identify equilibrium points and characterize the qualitative behavior of the system across different regions. The findings suggest a promising future where balanced growth fosters sustainable coexistence between human workers and AI, promoting technological progress without significant disruptions to the job market. However, challenges arise when AI outpaces human job growth, highlighting the importance of effective policy responses to mitigate adverse effects and maximize the benefits of technological advancement. Overall, this research provides valuable insights into the complex dynamics of AI-induced job displacement and underscores the necessity of proactive policy interventions to ensure equitable societal outcomes in the face of technological evolution.

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Declarations

Competing interest The authors declare that there is no conflict of interests regarding publication of this manuscript.

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