Business Whitepaper

FOXSY AI

Foxsy AI supports the advancement of AI & robotics via web3 technology & culture

[Business whitepaper - release 1 - revision 1]
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Abstract. *The Foxsy AI project envisions a future where AI and robotics seamlessly integrate with everyday life, and its ambition is firmly rooted in RoboCup's goal of developing a team of fully autonomous humanoid robots capable of defeating human soccer champions by the middle of the 21st century. By harnessing the competitive nature of soccer, Foxsy AI aims to accelerate advancements in artificial intelligence, machine learning, and robotics. Foxsy AI leverages the $FOXSY token to fuel its ecosystem, providing millions of soccer fans and AI enthusiasts the opportunity to engage with the RoboCup mechanics in an entertaining and valuable way. The project's unique combination of blockchain technology and AI-based innovations will not only further the RoboCup mission but will also serve as a new standard for advancing the broader field of robotics and AI.*

1. Introduction

Foxsy AI was born out of a passion for advancing AI and robotics by integrating cutting-edge technologies with the globally loved game of soccer. The project is rooted in over two decades of participation in RoboCup, one of the most important AI and robotics competitions in the world. Foxsy AI's vision is to drive advancements in artificial intelligence (AI), machine learning (ML), and autonomous robotics by combining the competitive and strategic elements of soccer with blockchain technology.

Our ultimate goal is to contribute significantly to RoboCup's official challenge: to create a team of fully autonomous humanoid robots capable of defeating the human soccer world champions by the middle of the 21st century. To achieve this, Foxsy AI leverages the $FOXSY token, which serves as the engine behind the entire ecosystem, incentivizing participation, innovation, and development within the project.

At the core of Foxsy AI is the Oxsy team, founded in 2002 by Sebastian Marian, which has consistently ranked among the top performers in RoboCup's Soccer Simulation 2D League. The Oxsy team has earned 1st place in the Cooperative Challenge and placed 3rd in the world four times in the main RoboCup competition. With this deep background, Foxsy AI is well-positioned to push the boundaries of AI in soccer.

By combining AI, robotics, and blockchain, Foxsy AI will attract millions of soccer fans and AI enthusiasts to participate in tournaments, engage with AI mechanics, and contribute to the development of intelligent systems capable of challenging and eventually surpassing human abilities on the soccer field.

2. Project Overview

Foxsy AI was created to train robot brains to defeat human soccer players on the field. With two decades of research and development within the Soccer Simulation League, Foxsy AI aims to bring advanced AI and robotics technology to a mainstream audience, making it accessible and engaging for soccer fans and tech enthusiasts alike. Some of the core features are the following:

Online Tournaments: Participants can build and train their own AI soccer teams using Foxsy AI's tools and compete in online tournaments for rewards. The tournament framework is based on RoboCup's official rules, scoring systems, and gameplay mechanics.

Foxsy Store: Players can customize their teams and environments, purchasing unique and collectible items to enhance their experience and support the project's ecosystem.

$FOXSY Token: This native token powers the Foxsy AI ecosystem, allowing users to earn rewards, participate in tournaments, and engage with the project's various features.

Foxsy AI's approach combines AI, robotics, and blockchain in a way that encourages both learning and competition, providing opportunities for both technical research and casual entertainment. By integrating AI training systems and blockchain-based incentives, the project provides a platform that not only entertains but also advances the future of robotics.

3. The Problem

The RoboCup competition, a globally renowned AI and robotics event, has set an audacious goal: by the middle of the 21st century, a team of fully autonomous humanoid robots will defeat the human World Cup champions. While this goal may sound like science fiction, it embodies the true potential of AI and robotics integration. However, there are significant challenges in achieving this vision.

Technical Complexity: Developing robots that can rival humans in terms of decision-making, strategic thinking, and physical coordination requires immense breakthroughs in AI, machine learning, and robotics engineering.

Resource Barriers: Many research teams face financial and logistical hurdles. Transporting robots across continents, managing travel costs for team members, and sourcing the necessary hardware and infrastructure to participate in competitions can be prohibitive, especially for underfunded academic institutions.

Lack of Engagement: While AI and robotics enthusiasts may understand the significance of the RoboCup's mission, there is a clear need to broaden the audience and bring more people into the field. A large and engaged community is vital for accelerating innovation.

Limited Cross-Disciplinary Interaction: The fields of AI, robotics, and blockchain technology are evolving rapidly, but they often operate in silos. There is a lack of integration between these technologies, which could otherwise lead to faster progress.

4. The Solution

Foxsy AI is designed to address the core challenges facing the RoboCup mission while simultaneously advancing the fields of AI, robotics, and blockchain. By leveraging a decentralized model and community-driven engagement, Foxsy AI aims to build a future where robots not only compete but also win against the human soccer champions, pushing the limits of technology and human innovation.

AI and Robotics Development: Foxsy AI integrates cutting-edge AI and robotics research to develop autonomous soccer-playing robots. With over 20 years of RoboCup participation through the Oxsy team, the project offers a proven track record in developing highly competitive robot teams. Our advancements in multi-agent systems, machine learning, and decision-making algorithms directly contribute to achieving RoboCup's ambitious goal.

Community-Powered Ecosystem: Foxsy AI fosters a massive community of soccer fans, AI enthusiasts, and developers who are incentivized to contribute to the project. By integrating blockchain technology and the $FOXSY token, we enable a reward-driven system that encourages participation in online tournaments, strategy development, and community voting. Users can earn rewards while advancing the project's goals.

Bridging AI, Robotics, and Blockchain: Through the power of blockchain, Foxsy AI offers decentralized governance, transparency, and incentivized collaboration. Blockchain enables secure, tamper-proof records of game strategies, decisions, and performance metrics, which can be analyzed and improved upon over time. Moreover, the $FOXSY token provides liquidity and value for the community, facilitating further investment in the project.

Accessible Platforms and Tools: To make participation in the RoboCup mission easier and more inclusive, Foxsy AI offers various user-friendly tools such as the Team Formations Creator and the Game Viewer. These tools allow users, without any coding experience, to build and manage their robot soccer teams and analyze game performances in real-time.

5. Why Blockchain?

Blockchain technology plays a pivotal role in the Foxsy AI ecosystem. It not only powers the $FOXSY token but also provides transparency, decentralization, and trust to the entire system. Here's how blockchain adds value to the Foxsy AI project:

Transparency and Trust: The decentralized nature of blockchain ensures that all transactions, including game results, rewards distribution, and governance decisions, are transparent and publicly verifiable. This eliminates the need for a central authority and builds trust among participants.

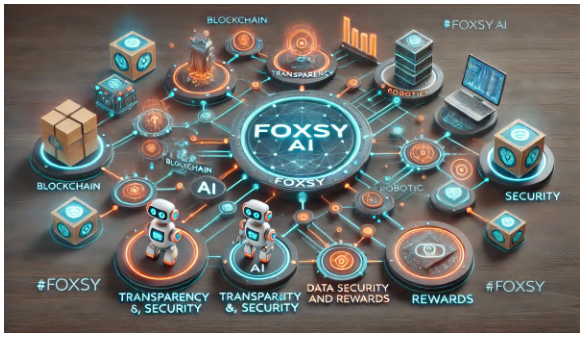
Incentivization and Rewards: The $FOXSY token serves as the fuel that drives engagement within the ecosystem. Players, developers, and contributors are rewarded for their participation in tournaments, strategy development, and governance. This tokenized economy encourages continuous involvement and innovation within the community.

Decentralized Governance: Through decentralized voting mechanisms, the community has a say in the direction of the project. Key decisions regarding tournament rules, rewards distribution, and even future development paths are determined by the holders of $FOXSY tokens. This ensures that the project is always aligned with the interests of its community.

Data Integrity and Security: By leveraging blockchain, all performance metrics, game strategies, and decisions are stored in a tamper-proof ledger. This ensures data integrity and allows participants to track progress and analyze results without the risk of manipulation or fraud.

Seamless Integration: The blockchain component of Foxsy AI integrates with existing AI and robotics technologies, providing a secure platform for data sharing, collaboration, and monetization. Whether it's through staking, farming, or in-game purchases, the blockchain infrastructure ensures that all interactions within the ecosystem are efficient and secure.

Scalability and Cross-Chain Compatibility: As the project grows, Foxsy AI is designed to scale across multiple blockchains, starting with MultiversX and expanding to other ecosystems like Solana, Ethereum, and Binance Smart Chain. This cross-chain compatibility allows for greater flexibility, liquidity, and reach within the crypto and AI communities.



6. $FOXSY Token

The $FOXSY token is the central piece of the Foxsy AI ecosystem, driving various functionalities within the project. As a utility token, it has numerous use cases that support the project's goals of integrating AI, robotics, and blockchain technology. Below is an overview of the key aspects of the $FOXSY token:

Total Supply: The $FOXSY token has a maximum theoretical supply of 1,978,082,104 tokens. However, due to the built-in burning mechanism, this total supply will never be fully reached, ensuring that the token follows a deflationary model over time.

Community Focus: 20% of the maximum supply is allocated to the community. This allocation is distributed over 5 years, rewarding the community for their involvement in various products, competitions, and staking opportunities within the ecosystem.

No Private Rounds: Unlike many other blockchain projects, $FOXSY does not have a seed, private, or public round. Instead, the project has offered a price discovery Pre-Launch event, ensuring that the token distribution remains transparent and fair.

Utility and Rewards: The $FOXSY token powers all major aspects of the project, including:

- ***Metastaking***: Stake your $FOXSY tokens to earn rewards with high APRs and APYs, depending on the amount of energy used in xExchange.
- ***Farming***: Add liquidity to the $FOXSY-EGLD pool on xExchange and participate in the farming mechanism to earn additional rewards.
- ***Online Tournaments***: $FOXSY tokens will be used as rewards in online tournaments where participants can test their strategies against others.
- ***Customization and Purchases***: Within the Foxsy AI Store, users can buy various items using $FOXSY tokens to customize their teams, players, and more.

Burn Mechanism: The Foxsy AI project implements a token-burning mechanism that will ensure the continuous deflation of the $FOXSY token. A percentage of the collected fees in competitions and store purchases will be burned to increase the scarcity of the token over time.

Metastaking and Liquidity Pools: $FOXSY token holders can participate in metastaking with high APR/APY opportunities as well as liquidity pools that offer attractive returns for long-term supporters of the project.

7. Roadmap

The roadmap of Foxsy AI outlines the strategic development and milestones that will propel the project forward. By combining AI, robotics, and blockchain technology, Foxsy AI aims to create a dynamic and engaging ecosystem that supports the RoboCup goal of autonomous soccer-playing robots. Below is an overview of the key phases and milestones of the project:

Phase 1: Project Foundation and Early Development (2024 Q1 – Q2)

- ***Formation of Foxsy AI****:* The project was officially founded in 2024, building on the legacy of the Oxsy team and its two decades of RoboCup experience.
- ***Launch of $FOXSY Token****:* The initial offering of $FOXSY tokens occurred through the Pre-Seed and Pre-Launch rounds, with 100M tokens allocated in the Pre-Seed round. The community was actively engaged during this phase.
- ***$FOXSY Token Listings****:* The $FOXSY token was listed on multiple decentralized exchanges (DEXes) and centralized exchanges (CEXes), expanding liquidity and accessibility.

Phase 2: Platform Expansion and Community Building (2024 Q3 – Q4)

- ***Launch of Metastaking****:* The Foxsy AI metastaking program was launched, allowing users to stake their $FOXSY tokens and earn rewards with high APR/APY.
- ***Initial Platform Development****:* The project focused on building the initial components of the Foxsy AI ecosystem, including core AI algorithms, the team management platform, and basic integration with blockchain technology.
- ***Community Engagement****:* Through targeted marketing and community-building efforts, the Foxsy AI project gained traction, increasing the number of users and early adopters.

Phase 3: RoboCup Collaboration and New Tournaments (2025 Q1 – Q2)

- ***First Online Tournaments****:* The initial online soccer tournaments will be introduced, allowing participants to build their teams and strategies using the Team Formations Creator tool.
- ***Enhanced Analytics Tools****:* Development of advanced analytics tools, including the Game Viewer, to allow users to analyze game data in more depth and improve their strategies.
- ***RoboCup Integration****:* Foxsy AI will strengthen its collaboration with the RoboCup community, contributing to the broader mission of creating autonomous humanoid soccer players capable of competing against human teams.

Phase 4: AI and Robotics Integration (2025 Q3 – Q4)

- ***Global Tournaments****:* The online tournament platform will be expanded globally, with larger-scale competitions offering significant rewards in $FOXSY tokens and attracting a wider audience.
- ***AI Training Enhancements****:* Foxsy AI's core AI technology will be further developed, improving the strategic depth and performance of the autonomous soccer-playing robots.

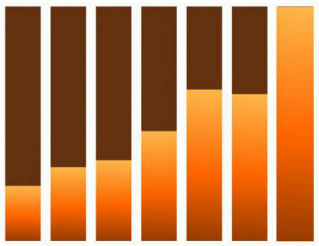
- ***Launch of the Foxsy AI Store****:* The first iteration of the Foxsy AI Store will be released, enabling users to customize their teams, players, and strategies using $FOXSY tokens.

Phase 5: Autonomous Humanoid Soccer Players (2026 Onward)

- ***Mass Adoption and Mainstream Involvement****:* Through continued innovation and community involvement, Foxsy AI aims to become a mainstream platform, engaging millions of soccer fans and AI enthusiasts around the world.
- ***Further Integration of Blockchain and AI****:* Foxsy AI will continue to push the boundaries of AI and blockchain integration, creating a sustainable ecosystem where technology, entertainment, and competition converge.

8. Tokenomics and Governance

The $FOXSY token plays a central role in the Foxsy AI ecosystem, acting as the fuel that drives engagement, rewards, and governance within the platform. With its unique tokenomics and governance model, Foxsy AI is designed to be both community driven and deflationary, ensuring long-term sustainability and growth.



8.1 Token Allocation

The allocation of $FOXSY tokens is carefully structured to support the development of the platform, incentivize early participants, and fuel long-term community engagement. Below is an overview of the token allocation:

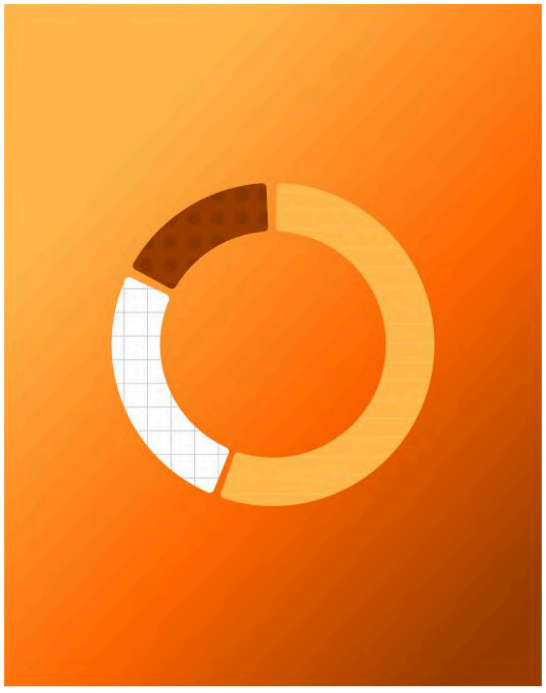
Maximum Supply*:* 1,978,082,104 $FOXSY tokens (subject to burning mechanisms)

Pre-Seed Round*:* 100M tokens allocated, with a vesting period of 3 years

Community Allocation*:* 20% of the maximum supply, distributed over 5 years to reward users based on their involvement in the ecosystem through staking, participation in tournaments, and other activities

Liquidity Provision*:* A substantial portion of tokens is dedicated to maintaining liquidity across decentralized and centralized exchanges, ensuring ease of access and minimizing price volatility.

Development and Marketing (Ecosystem)*:* A portion of tokens is reserved for ongoing development, marketing campaigns, and strategic partnerships to ensure the project's continuous growth and visibility.



8.2. Deflationary Model

Foxsy AI's tokenomics model is designed with long-term sustainability in mind. By incorporating deflationary mechanisms, staking rewards, and governance incentives, the project ensures that $FOXSY tokens retain their value over time while promoting active community participation. The primary mechanism for achieving this is through token burns, which are triggered by key platform activities such as:

***Staking Rewards**:* Paid out in $FOXSY will incentivize long-term holding, while a portion of rewards will be burned to maintain deflationary pressure on the token.

***Tournament Fees**:* Entry fees for online soccer tournaments are collected in $FOXSY tokens. A portion of these fees is burned to reduce circulating supply.

***Store Purchases**:* When users buy items from the Foxsy AI store (e.g., player skins, stadiums, custom strategies), a percentage of the transaction is burned.

By consistently burning tokens, Foxsy AI creates a deflationary pressure, ensuring that the maximum supply is never reached, and token scarcity increases over time. As the ecosystem grows, new use cases for $FOXSY will be introduced, including partnerships with other projects and integrations with DeFi platforms.

8.3 Governance

As a community-driven project, Foxsy AI allows $FOXSY token holders to participate in the governance of the platform. Governance decisions are primarily related to the following aspects:

***Proposal Submission**:* Token holders can submit proposals for changes or additions to the Foxsy AI platform. These proposals can range from new tournament rules to changes in staking rewards or platform development priorities.

***Voting**:* Token holders have the ability to vote on key governance proposals. The more $FOXSY tokens a user holds, the greater their voting power. Governance votes ensure that the community has a say in the future direction of the project.

***Transparency and Accountability**:* All governance decisions are executed on-chain, ensuring transparency and accountability. The results of governance votes are visible to all token holders, and the outcomes are automatically implemented through smart contracts.

8.4 Staking and Rewards

$FOXSY token holders can earn rewards by participating in various staking programs within the Foxsy AI ecosystem. These programs are designed to incentivize long-term participation and loyalty:

***Liquidity Farming**:* Liquidity providers can earn rewards by adding $FOXSY-EGLD liquidity on platforms such as xExchange. In addition to LP fees, liquidity providers receive staking rewards in $FOXSY tokens.

***Metastaking**:* Token holders can participate in metastaking, which allows them to stake $FOXSY tokens in a liquidity pool while earning additional rewards. The current APR for metastaking is over 140% APR / 304% APY (with energy).

***Hodl & Earn Programs**:* Foxsy AI offers special Hodl & Earn programs, such as those launched on Gate.io, where participants can lock their $FOXSY tokens and earn up to 200% APR.

***Future Staking Programs**:* As Foxsy AI expands to new chains, staking and farming opportunities will include >200% APR through various partnerships and DeFi platforms.

By offering multiple avenues for earning rewards, Foxsy AI creates a vibrant ecosystem where token holders are incentivized to remain active and engaged, further contributing to the project's growth.

8.5 Future Token Utility

As the Foxsy AI platform evolves, the utility of $FOXSY tokens will continue to expand. Planned future utility includes:

***In-Game Tournaments**:* $FOXSY will be the primary currency for entering tournaments and earning rewards, making it integral to the competitive ecosystem.

***Advanced Analytics**:* Premium access to advanced analytics tools and data within the platform will be available for $FOXSY holders, helping users refine their strategies and improve performance.

***Foxsy AI Store**:* The ability to purchase exclusive customizations, strategies, and player gear within the platform.

By continually expanding the utility of the $FOXSY token, the project ensures its relevance and importance within the broader ecosystem, giving users more reasons to hold and use their tokens.

9. Foxsy AI: Competitive Landscape

Foxsy AI is pioneering a unique approach by combining artificial intelligence, robotics, and blockchain technology within the framework of soccer simulation and strategy games. In doing so, the project addresses an untapped niche in the intersection of entertainment, technology, and decentralized finance (DeFi). Let's explore the competitive landscape and Foxsy AI's key differentiators.

9.1 Competitors Overview

While there are several established projects in AI, robotics, and blockchain individually, Foxsy AI's unique value proposition lies in its ability to merge these domains. Below are some key areas where Foxsy AI differentiates itself from competitors:

***AI in Gaming**:* Projects like DeepMind have explored the use of AI in strategic games, but their focus is more on academic research and less on direct user engagement through an interactive platform like Foxsy AI.

***Robotics in Sports**:* RoboCup itself is a key competitor in terms of robotics research, but it lacks the blockchain and community-driven elements that make Foxsy AI's approach more accessible and scalable to a wider audience.

***Blockchain-based Games**:* While many blockchain-based gaming platforms exist (e.g., Axie Infinity), these platforms focus more on NFTs and simple gameplay mechanics. Foxsy AI goes beyond this, offering a deeper, AI-driven strategy with complex multi-agent systems.

Foxsy AI's platform provides a rare opportunity for soccer fans and tech enthusiasts alike to actively participate in the evolution of robotics, while also earning rewards for their contributions.

9.2 Key Differentiators

***Robotics Meets Blockchain**:* Unlike traditional AI or gaming platforms, Foxsy AI integrates robotics into the blockchain ecosystem, providing users with a dynamic and evolving platform that bridges two revolutionary technologies.

***Community-Driven Tournaments**:* Users can participate in tournaments, develop strategies, and train their AI-driven teams to compete, earning rewards in $FOXSY tokens. This model incentivizes both fun and practical learning in AI and robotics.

***Educational Value**:* By making cutting-edge AI and robotics technology more accessible, Foxsy AI encourages education and innovation in these fields, allowing users to learn and improve their strategies as they engage with the platform.

***Long-term Vision**:* The Foxsy AI project is underpinned by the ambitious goal of contributing to the broader RoboCup objective, developing autonomous humanoid robots that can defeat human soccer teams by 2050.

***Governance and Transparency**:* With $FOXSY token holders having a say in key governance decisions, Foxsy AI is not just a project but a community-driven endeavor that allows participants to shape the platform's future.

9.3 Market Opportunity

The global market for AI in sports is growing rapidly, fueled by advances in machine learning, data analytics, and robotics. With the increased interest in decentralized finance and play-to-earn models, Foxsy AI is well-positioned to capitalize on several converging trends:

***Growth of eSports**:* The rise of eSports and competitive gaming has attracted millions of users worldwide. Foxsy AI taps into this market with its AI-driven soccer tournaments, providing a unique experience that traditional eSports platforms do not offer.

***AI Research and Development**:* Foxsy AI contributes directly to AI and robotics R&D, attracting interest from both academic and commercial sectors.

***Blockchain and DeFi**:* With staking, liquidity farming, and rewards baked into its ecosystem, Foxsy AI combines entertainment with DeFi, offering users tangible incentives to participate in the platform's growth.

10. Partnerships and Strategic Collaborations

The success of Foxsy AI is not solely based on its groundbreaking technology and tokenomics model but also on the strong partnerships and vibrant community that drive the project forward. By working with key partners in the blockchain, AI, and robotics sectors, Foxsy AI aims to build a robust ecosystem that accelerates its mission to outfox human soccer players with AI. As of today, Foxsy AI has partnered with several key players in the blockchain, AI, and robotics space, including:

MultiversX: As the core blockchain supporting $FOXSY, MultiversX provides the technical infrastructure that powers the platform, ensuring scalability, security, and transaction speed.

RoboCup: A long-standing participant in RoboCup, Foxsy AI is deeply intertwined with this international robotics competition. Foxsy AI's involvement in RoboCup brings real-world AI advancements to the blockchain space, creating an unprecedented bridge between academia and decentralized technology.

Pulsar Money: Pulsar Money has been a crucial partner in the recent $FOXSY Airdrop campaign, contributing to the project's community growth.

Gate.io: Foxsy AI has partnered with Gate.io to provide liquidity and staking solutions for $FOXSY token holders. Gate.io's Hodl & Earn campaigns offer participants exceptional APRs, incentivizing long-term engagement with the token.

Foxsy AI continues to seek strategic partnerships that will help expand its reach and enhance its ecosystem. Some of the most important partnerships in the blockchain niche, in addition to those outlined above, are as follows:

11. Long-Term Vision

The long-term vision of Foxsy AI is deeply aligned with the RoboCup mission, to develop fully autonomous robots capable of competing against human soccer teams by the 2050s. By engaging millions of soccer fans, AI enthusiasts, and blockchain users through innovative tournaments and incentives, Foxsy AI aims to play a pivotal role in advancing AI research and development.

Full Decentralization: As Foxsy AI grows, the project will transition toward full decentralization, with $FOXSY token holders having greater governance powers, including voting on key project decisions and tournament rules.

AI-Driven Innovation: Foxsy AI will continue to push the boundaries of artificial intelligence by developing more sophisticated models and collaborating with academic and commercial AI research teams.

Expansion Beyond Soccer: While soccer remains the core focus, Foxsy AI plans to expand its AI-driven tournament framework to other sports and strategic games, increasing user engagement and the scope of the project.

Contribution to Global AI Research: By generating valuable AI datasets and fostering a community of innovators, Foxsy AI will contribute to the global advancement of artificial intelligence, helping shape a future where AI seamlessly integrates with society.

12. Community-Driven Growth

Foxsy AI vision places a significant emphasis on community involvement, believing that the true power of any project lies in the strength and dedication of its community. Through a variety of engagement programs, Foxsy AI incentivizes users to actively participate in the ecosystem, contributing to its development and long-term success.

Tournaments & Competitions: Foxsy AI will organize regular online soccer tournaments, offering players the chance to build their own AI-powered soccer teams and compete for $FOXSY token rewards. These tournaments not only provide entertainment but also serve as a testing ground for Foxsy AI's advancements in robotics and AI.

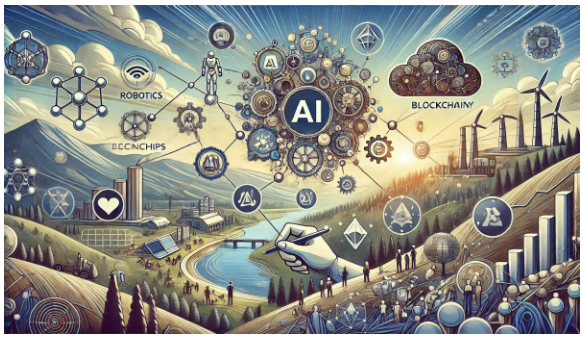
Community Proposals & Governance: As mentioned in the governance section, $FOXSY token holders will have the ability to propose and vote on important project decisions, making the community an integral part of the project's evolution.

Ambassador Programs: To further grow its community, Foxsy AI will launch an Ambassador Program. Ambassadors will help spread the word about Foxsy AI, organizing local meetups, webinars, and promotional events. In return, they will receive exclusive rewards in $FOXSY tokens.

Content Creation & Bounties: Foxsy AI will encourage community members to contribute to the project by creating educational content, promotional videos, and more. Bounty programs will reward these contributions, further aligning community interests with the project's growth.

13. Conclusion

As Foxsy AI continues to grow, the project will focus on expanding its partnerships and deepening community engagement. Future developments include launching on additional blockchain networks, expanding staking and farming programs, and continuing to innovate in the field of AI and robotics. By fostering strong relationships and building an engaged community, Foxsy AI is well-positioned to achieve its bold goal.



Foxsy AI is more than just an ambitious project at the intersection of AI, robotics, and blockchain; it's a community-driven mission with the potential to revolutionize both sports and technology. The combination of a deflationary token model, innovative staking and governance mechanisms, strategic partnerships, and a highly engaged community provides the foundation for long-term success.

Together, we are outfoxing the future, one game at a time.

Technical Whitepaper

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[Technical whitepaper - release 1 - revision 1]
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Abstract. *The Oxsy team was founded in July 2002 as a graduation project by Sebastian Marian in the field of Multi-Agent Systems at Lucian Blaga University (Sibiu, Romania). Over the past two decades, the team has evolved from a modest academic initiative into a competitive force within the RoboCup Soccer Simulation League and has made significant contributions to AI, robotics, and multi-agent systems, continuing to evolve with each iteration of the RoboCup competitions. The team's ongoing mission is to push the boundaries of AI and robotics, leveraging new techniques and technologies to stay at the forefront of soccer simulation.*

1. Introduction

Since our first appearance in 2003 at the RoboCup competition in Padua, Italy, where we won the first round [2], Oxsy has participated in every RoboCup 2D Soccer Simulation League competition [3]. Our team steadily improved its performance, reaching milestones such as 3rd place finishes in Graz (2009), Singapore (2010), João Pessoa (2014), Nagoya (2017) and most recently, 1st place in the cooperative challenge of the 2023 RoboCup competition, held in Bordeaux, France.

In recent years, we have focused on refining our tactics [16], strategy, and AI-based decision-making systems, placing great emphasis on adaptability in both offensive and defensive phases. With 20 consecutive participations in RoboCup, Oxsy has grown into a key player in the global AI and robotics landscape, striving to push the boundaries of autonomous soccer agents.

2. Increase Ball Possession through Accurate Kick Ball Decision

Having a comprehensive world model of the opponent player's position is critical when controlling the ball. In soccer, teams with better ball possession generally have more scoring opportunities. In this section, we present our improvements in decision-making related to ball possession.

2.1 Creating a Player Map's Positions

To predict opponent player movements, we designed a positional map that simulates potential locations based on previous known data from visual ("see") and auditory ("hear") messages. The map updates after every cycle, creating a broader range of possible locations when information about the opponent is unavailable. Our system limits map complexity by setting maximum cycles (10) and constraining movement directions to 45-degree increments. This allows us to generate real-time responses while efficiently calculating probable opponent positions.

2.2 Adjusting the Player Map's Positions

Adjusting the positional map is vital to producing a reasonable estimate of opponent locations. If visual information shows that an opponent cannot be in certain areas, our system will eliminate those options from the map. This reduces uncertainty and improves the accuracy of future decisions. Players then have a clearer sense of where opponents may be located, even if some data is incomplete.

2.3 Reshaping the Player Map's Positions

Based on real-world patterns of player movement, we introduced reshaping factors, such as reaction time and ball speed. Dividing the map into four quadrants, we prioritize movement based on ball position and speed, thereby reducing the number of possibilities and focusing on more probable movements. Our analysis shows that this reshaping process significantly improves the accuracy of predicting player locations in critical game situations.

Fig. 1: *A visual representation of strategic positioning and ball control, emphasizing the creation of dynamic player maps to predict opponent movements and improve possession efficiency.*

3. Adaptive Route for Achieving the Goal

Our next innovation involves using adaptive strategies for offense, where the coach dynamically adjusts player actions [15] based on the evolving game environment. This section describes how our system clusters the pitch and selects the best possible route for scoring a goal.

3.1 Clustering the Pitch

We divided the soccer pitch into 24 clusters (6x4 grid) to analyze player routes and their effectiveness across multiple games. Each cluster stores route data, which is generated when our players pass the ball through a given area. These routes are scored based on their effectiveness in helping players advance toward the goal.

3.2 Selecting the Best Route

Once the pitch is divided into clusters, the player in possession of the ball must select the best route based on available routes within the cluster. The coach helps determine this decision by offering a ranking of possible routes, factoring in the position of teammates and opponents.

3.3 Scoring and Re-scoring the Route Achievements

Each route is scored based on how well it moves the ball closer to the opponent's goal. The coach continually observes and updates the route scores, making adjustments based on in-game changes. For instance, if the opposing team alters its strategy, routes that previously had high scores may need to be downgraded, while new routes are identified and upgraded.

Fig. 2: *Illustration of adaptive strategies for achieving soccer goals, displaying a segmented soccer field with clustered sections representing possible routes to the goal. Each route showcases strategic paths that players can select based on effectiveness and scoring potential, emphasizing dynamic adjustments to optimize scoring.*

4. RSA Accumulator for Tactical Adaptability

In this section, we explore the use of RSA accumulators [9] to handle dynamic tactical shifts during gameplay. The RSA accumulator is a cryptographic method that allows us to "remember" successful strategies in specific game scenarios and adapt team formation based on accumulated patterns.

4.1 Implementing the RSA Accumulator

The RSA accumulator [10] enables us to store a "memory" of successfully handled situations, allowing the coach to adjust the team's strategy dynamically. For example, when a specific offensive or defensive move is successfully executed, the coach creates a map with the key being the opponent's action pattern and the value being the optimal formation to counter it.

4.2 Adapting Team Shape in Real-Time

Changing the team's shape during a game can be crucial for handling specific situations, such as facing

an opponent with a strong offensive or defensive setup. With the help of the RSA accumulator [11], our coach can recall previously successful formations in similar scenarios and apply them instantly.

4.3 Example: Dynamic Formation Change Using RSA Accumulator

Let's consider an in-game example where our team is facing an aggressive offensive play. The RSA accumulator [12] detects that the opponent is using a familiar pattern that has been successfully countered before. Based on the stored key-value pairs in the accumulator, the coach orders a formation change to counter the attack.

As the formation shifts in real-time, the team is better prepared to handle the offensive push, leading to a more effective defense and possible turnover. This quick adaptation makes a crucial difference in high-stakes moments.

Fig. 3: *The image illustrates a strategic soccer AI decision-making system, highlighting tactical adaptability through an RSA accumulator framework. Formations and player positions shift dynamically within zones, with arrows indicating real-time adjustments and decision-making points as the game progresses.*

5. Holonic Multi-Agent System Architecture

In this section, we discuss the implementation of the holonic [6] multi-agent system architecture in the Oxsy team. This architecture allows for flexible, self-regulating control within the system, making it suitable for dynamic environments such as RoboCup soccer simulations.

5.1 Holonic System Overview

The holonic system is based on the concept of a "holon," which is both an autonomous whole and a part of a larger system. In the context of the Oxsy team, holons represent individual players, while the entire team operates as a holarchy—a hierarchy of holons.

This holonic architecture allows each player to act autonomously, making decisions based on their perception of the game, while simultaneously functioning as part of the team strategy. The holarchy is dynamic, meaning the structure can change based on the situation, allowing the team to adapt fluidly during a match.

5.2 The PROSA Model

Our holonic architecture [7] is based on the PROSA model, which was originally developed for Holonic Manufacturing Systems (HMS). In this model, holons are divided into four types:

Product Holon: Represents the process and product knowledge, ensuring that the game strategy is followed.

Order Holon: Represents tasks or objectives during the match, such as a pass or defensive move.

Resource Holon: Represents physical components, such as a player's abilities (e.g., speed, stamina).

Staff Holon: Provides additional support by assisting in tactical decisions and maintaining cohesion within the team.

Each holon type plays a distinct role in the overall team strategy, working together to achieve objectives. The staff holon, for example, supports the entire system by adjusting the strategy in real-time based on game developments.

Fig. 4: *PROSA model diagram showing the interaction of Product, Order, Resource, and Staff holons in a soccer match.*

5.3 Dynamic Tactical Adjustments

One of the key advantages of the holonic system [6] is its capacity for dynamic tactical adjustments. As the game progresses, each holon can respond to changes in the environment (e.g., opponent movements, ball possession) and adjust its behavior accordingly.

For example, during a defensive phase, if the ball moves towards our goal, the holons representing defenders will shift their focus to intercepting the ball while maintaining a coordinated team shape. This adaptability ensures that the team remains cohesive, even in high-pressure situations.

The holonic system also allows for decentralized decision-making. While the coach holon provides high-level strategic guidance, individual player holons can make decisions based on their immediate environment, optimizing their performance in real time.

5.4 Holon Communication and Coordination

Communication between holons is crucial for maintaining team cohesion. Holons communicate with each other via a combination of "reactive" and "deliberative" layers:

Reactive Layer: Handles immediate responses to environmental stimuli, such as an opponent moving towards the ball or a change in the game's phase.

Deliberative Layer: Involves more complex decision-making processes, such as analyzing the game strategy and deciding the next tactical move.

The combination of these layers ensures that the holons can react quickly to immediate threats while also making informed decisions based on the overall game plan. The staff holon helps facilitate this communication, ensuring that all holons remain aligned with the team's objectives.

5.5 Future Enhancements for the Holonic System

As the RoboCup simulation environment evolves, so too must the holonic system [8]. Future improvements could include the integration of more advanced machine learning [4] algorithms, allowing holons to learn from past matches and improve their decision-making capabilities over time.

Additionally, as the complexity of RoboCup scenarios increases, we may explore multi-level holarchies, where holons operate at both macro and micro levels, handling both individual player behaviors and overall team strategy.

Fig. 5: *Illustration of a holonic multi-agent system architecture in soccer AI. Each player operates autonomously as a holon within a dynamic team holarchy, showcasing adaptability, communication, and real-time coordination on the soccer field.*

6. Adaptive Strategy with Neural Networks

Oxsy leverages adaptive strategies based on neural networks to continuously improve player decision-making and overall team performance. In this section, we explore the integration of neural

networks into the team's tactical framework and how they contribute to real-time decision-making in both offensive and defensive phases.

6.1 Neural Networks for Offensive Strategy

Neural networks are used to evaluate a range of options during offensive plays, particularly in determining the best next action, whether to pass, dribble, or shoot. The neural network model processes real-time data from the match, including:

- Player positions
- Opponent movements
- Ball trajectory
- The current game phase

By analyzing these inputs, the neural network predicts the most effective action to take in any given situation. This approach ensures that the players are constantly making informed decisions, improving the likelihood of scoring.

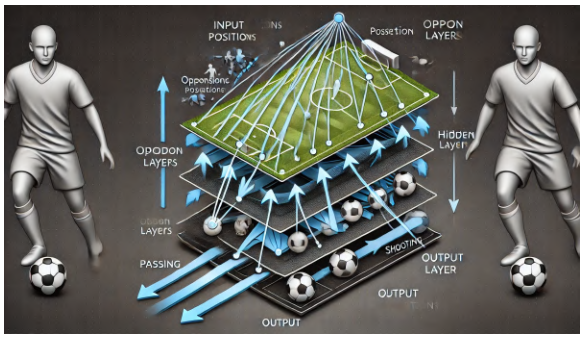

Fig. 6: *Neural network diagram analyzing offensive strategy with ball possession.*

6.2 Neural Networks for Defensive Adaptation

In defensive phases, neural networks are used to predict opponent strategies and adjust the team's defensive formation accordingly. By analyzing patterns in the opponent's movements, the network helps anticipate where the ball will go and how the opponents are likely to attack.

For instance, if an opponent consistently pushes forward through the wings, the neural network can adapt the defensive structure to apply more pressure in those areas. Additionally, the system helps identify opportunities for counter-attacks by analyzing spaces left open by the opponent's offensive plays.

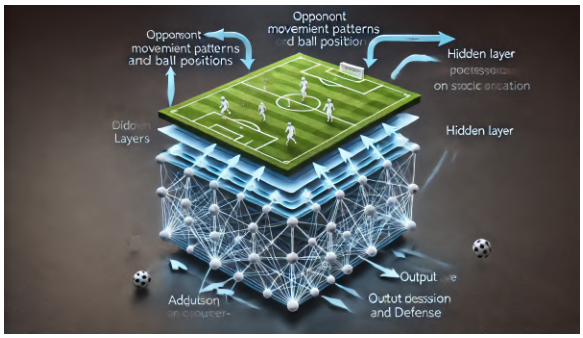

Fig. 7: *Example of a neural network adapting defensive strategies based on opponent movement patterns.*

6.3 Future Developments in Neural Networks for the Oxsy Team

Looking ahead, the Oxsy team plans to enhance its neural network capabilities by incorporating more sophisticated machine learning [4] techniques. This includes:

Deep Reinforcement Learning: A more advanced version of reinforcement learning that will allow the system to make even more nuanced decisions.

Meta-Learning: Allowing the network to adapt faster by learning how to learn, further reducing the time it takes to adjust to new opponents and strategies.

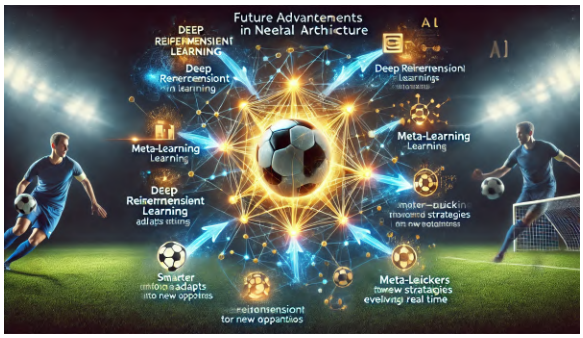

Fig. 8: *Visual representation of future advancements in the Oxsy team's neural network architecture*

These developments will make the Oxsy team's strategy even more dynamic, ensuring that the team remains competitive in future RoboCup competitions.

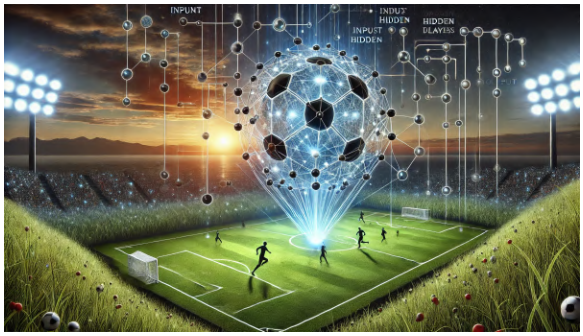

Fig. 9: *Illustration of a neural network system analyzing player positions, ball trajectories, and opponent movements to inform real-time decision-making, optimizing soccer strategies for both offensive and defensive scenarios..*

7. AI Learning Mechanisms and Neural Networks in the Oxsy Team

The Oxsy team utilizes advanced AI learning [4] mechanisms, including neural networks and reinforcement learning, to continuously improve its team's performance in RoboCup competitions. These systems allow players to learn from past matches, refine their strategies, and adapt to new opponents in real time.

7.1 Reinforcement Learning for Soccer Strategies

Reinforcement learning (RL) is one of the core AI methodologies used by the Oxsy team. In RL, agents (players) learn optimal strategies by interacting with their environment and receiving feedback in the form of rewards or penalties. The goal is to maximize cumulative rewards over time.

7.2 Neural Networks for Decision-Making

Neural networks are employed to enhance the decision-making capabilities of Oxsy's players. These networks enable the players to recognize complex patterns in the game, such as predicting opponent movements or identifying the best passing options.

Input Layer: The input layer receives information from the environment, such as player positions, ball location, and game phase (offense, defense, or transition).

Hidden Layers: The hidden layers process this information, allowing the neural network to learn abstract representations of the game dynamics.

Output Layer: The output layer generates a decision, such as selecting the best action (pass, shoot, or dribble) based on the current game state.

The architecture is designed to be highly flexible, allowing it to process a wide variety of game scenarios in real-time. This flexibility is crucial for adapting to the constantly changing dynamics of a RoboCup match.

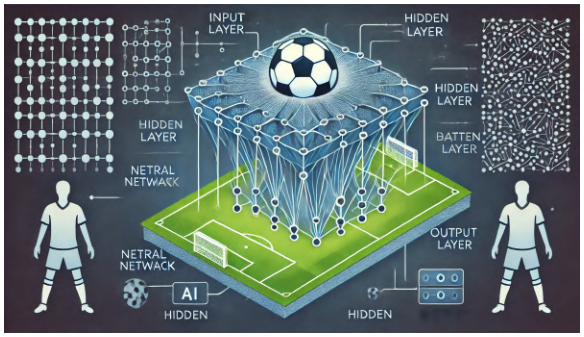

Fig. 10: *A diagram showing neural network architecture used for decision-making in Oxsy team.*

7.3 Learning from Opponents: Adversarial Networks

Oxsy incorporates adversarial learning to improve its ability to predict and counteract opponent strategies. In this approach, two neural networks—one representing Oxsy and the other representing the opponent—compete against each other. This helps the system learn how to adjust its tactics dynamically based on the opponent's behavior.

Opponent Modeling: By training against an adversarial network, Oxsy can develop a more accurate model of its opponents, learning their tendencies and weaknesses.

Dynamic Adaptation: As the opponent's strategy evolves, Oxsy can adapt its own strategy in real time, ensuring that it remains competitive throughout the match.

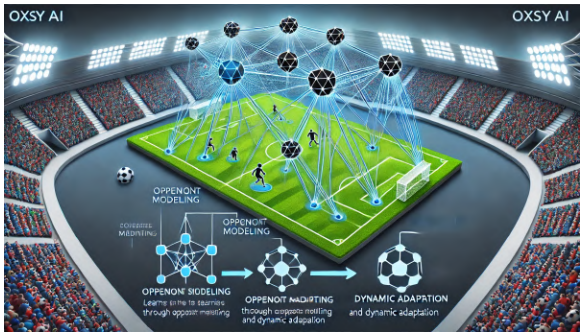

Fig. 11: *Adversarial network diagram showing Oxsy learning from an opponent's strategy.*

7.4 Self-Organizing Maps for Player Positioning

To optimize player positioning on the field, Oxsy uses self-organizing maps (SOMs). SOMs allow the system to identify ideal positions based on the current game state, such as the location of the ball and the positions of both teammates and opponents.

Zone Allocation: Players are assigned to different zones on the field based on the SOM, ensuring that the team maintains optimal spacing and coverage.

Positional Awareness: SOMs help players anticipate where they should move next, improving the team's overall coordination and reducing gaps in defense.

7.5 AI Coordination: Multi-Agent Learning

Oxsy's players must not only make individual decisions but also coordinate with one another. Multi-agent learning [1] allows the system to train players to work together, improving the team's overall performance.

Shared Objectives: Each player learns to balance their own objectives (e.g., scoring goals) with the team's objectives (e.g., maintaining possession or defending).

Collaborative Strategies: Multi-agent learning enables players to develop collaborative strategies, such as executing coordinated pressing [18] or setting up complex passing sequences.

7.6 Enhancing Tactical Flexibility with Neural Networks

Oxsy's neural networks are designed to allow for greater tactical flexibility. This means that the team can shift between different strategies based on the current game situation. For example, the system can automatically adjust its formation from a defensive setup to an aggressive counter-attack [17] depending on the flow of the match.

Tactical Awareness: Neural networks analyze the state of the game in real time, allowing players to make adjustments on the fly.

Adaptive Formations: By analyzing data from past matches, Oxsy can predict when it should switch formations or make other tactical adjustments.

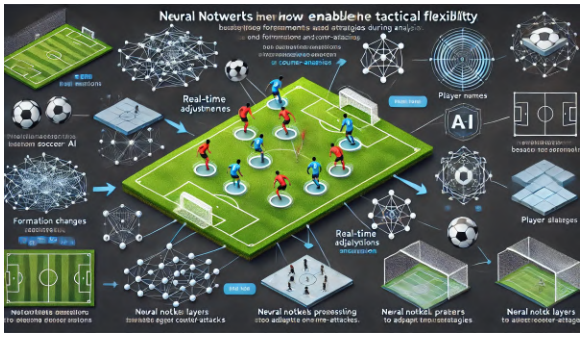

Fig. 12: *A diagram showing how neural networks enable tactical flexibility, allowing Oxsy to adapt formations and strategies during a match.*

7.7 Future Work in AI Learning

Looking ahead, Oxsy plans to enhance its AI learning mechanisms by:

Expanding Neural Network Capabilities: Introducing deeper neural networks to handle more complex decision-making processes.

Improving Multi-Agent Coordination: Refining how players collaborate, particularly in high-pressure situations such as counter-attacks or defending set-pieces.

Incorporating New Learning Algorithms: Exploring new reinforcement learning and neural network algorithms to improve the team's adaptability and intelligence.

Fig. 13: *Illustration representing AI learning mechanisms in soccer AI, highlighting interconnected neural network layers, real-time player positioning, and decision-making processes that allow players to learn and adapt strategies from game patterns dynamically.*

8. Future Work

For the future, we aim to continue enhancing our strategies, focusing on both offensive and defensive phases. We plan to expand the role of the coach, integrating advanced AI techniques to enable real-time decision-making and adaptations during gameplay. Our focus will include:

8.1 Defensive Strategy Enhancements

We plan to improve our offside traps and defensive coverage, using AI to predict opponent behavior with greater accuracy. We will also focus on improving player positioning and marking techniques, dynamically adjusting based on the opponent's offensive structure.

8.2 Offensive Strategy Improvements

Further refinements in offensive strategies will include developing more complex passing combinations and offensive structures. We plan to extend the decision-making abilities of individual players, allowing them to make more sophisticated decisions when in possession of the ball.

8.3 Expanded Use of Neural Networks

We will explore the integration of more advanced neural networks to enhance player adaptability. These networks will allow for real-time learning and strategy adaptation based on the evolving game situation.

Fig. 14: *A diagram showing advanced neural network integration in soccer AI, enhancing player adaptability and real-time strategy adjustments.*

8.4 Enhanced Multi-Agent Systems

The future of the Oxsy team lies in the continuous development of multi-agent systems [1], allowing players to coordinate seamlessly and execute complex strategies autonomously. These systems will become increasingly dynamic, enabling each agent to adapt its role based on the game's state.

8.5 Blockchain Integration

As part of the Oxsy team, we will continue exploring ways to integrate blockchain technology into our system, focusing on data security [13], transparency, and community engagement.

Fig. 15: *A diagram showing blockchain integration*

in soccer AI, focusing on data security, transparency, and community-driven innovation.

9. RoboCup Integration: Pushing the Boundaries of AI and Robotics

As an official sponsor of RoboCup 2024, Foxsy AI plays a pivotal role in supporting and advancing the RoboCup mission. RoboCup is one of the most ambitious and recognized competitions in the field of robotics and AI, where the ultimate goal is for fully autonomous humanoid robots to win a soccer game against human champions by the mid-21st century. Foxsy AI is committed to contributing to this vision by pushing the boundaries of AI and robotics through cutting-edge technology and strategic collaborations.

9.1 The RoboCup Challenge

RoboCup presents a unique challenge for AI and robotics developers: creating robots that can make complex decisions, move efficiently on the soccer field, and collaborate seamlessly as a team. These challenges are closely aligned with Foxsy AI's goals of integrating AI, robotics, and blockchain to create intelligent, autonomous systems.

Autonomous Decision-Making: Robots must be capable of making real-time decisions without human intervention, analyzing the environment and predicting outcomes.

Team Coordination: Effective team coordination is essential for success in RoboCup, and Foxsy AI's AI learning systems provide the foundation for this collaboration.

Physical Capabilities: Beyond AI, robots must possess the physical capabilities to navigate the soccer field, dribble, pass, and shoot the ball.

9.2 Foxsy AI's Contribution to RoboCup

As a core supporter of RoboCup, Foxsy AI contributes to the development of autonomous systems that can meet the competition's rigorous demands. The project's focus on combining AI with robotics and blockchain [14] has the potential to drive significant advancements in several key areas:

AI Strategy Development: Foxsy AI's neural networks and reinforcement learning systems help improve decision-making and strategic planning for RoboCup robots.

Robust Robotics: Through partnerships and technological innovation, Foxsy AI aims to develop robots that are physically capable of playing soccer at a competitive level.

Blockchain for Transparency and Security: Blockchain ensures transparency in data handling, providing secure and immutable records of AI performance, player statistics, and game outcomes.

Fig. 16: *Illustration showing Foxsy AI's contribution to RoboCup in AI strategy development, robotics, and blockchain integration.*

9.3 Strategic Sponsorship of RoboCup 2024

Foxsy AI's sponsorship of RoboCup 2024 underscores the project's commitment to advancing AI and robotics. As part of this collaboration, Foxsy AI actively contributes to the RoboCup initiative by providing cutting-edge AI and robotics research, and by promoting the integration of blockchain technology into RoboCup's framework.

Support for AI Research: Foxsy AI sponsors research initiatives aimed at improving AI decision-making and robotic performance.

Collaboration with RoboCup Teams: Foxsy AI collaborates with other RoboCup teams to exchange knowledge, refine strategies, and push the boundaries of autonomous robotics.

Promoting Blockchain Adoption: By incorporating blockchain into RoboCup, Foxsy AI enhances the security and transparency of game data, ensuring the integrity of AI-driven competitions.

Fig. 17: *Visual depicting Foxsy AI's role as an official sponsor of RoboCup 2024, highlighting its support for AI research and blockchain integration.*

9.4 AI and Robotics for Soccer: Key Developments

Foxsy AI is at the forefront of developing AI and robotic systems specifically designed for soccer, working towards RoboCup's ultimate goal of building robots capable of playing against human champions. Some of the key developments include:

Advanced Pathfinding: AI systems designed to optimize player movement on the field, ensuring efficient positioning and strategic decision-making.

Real-Time Adaptation: Robots equipped with the ability to adapt their strategies during matches, making them more competitive and capable of handling unexpected scenarios.

Collaboration and Communication: AI-powered systems that enhance communication between players, allowing for more coordinated and effective team play.

9.5 Future of AI and Robotics in RoboCup

The future of AI and robotics in RoboCup is bright, and Foxsy AI is committed to staying at the forefront of these advancements. By combining AI, robotics, and blockchain, Foxsy AI is helping to create a future where autonomous systems are capable of competing at the highest levels of sport.

Towards Humanoid Robots: Foxsy AI is working on the development of humanoid robots capable of competing in soccer matches, aligning with RoboCup's long-term goal.

Integration of Machine Learning and Robotics: Ongoing research focuses on integrating machine learning algorithms with robotic systems to create more intelligent, adaptable, and agile players.

Community-Driven Innovation: Foxsy AI's commitment to fostering a community of developers, researchers, and soccer enthusiasts ensures that the project remains at the cutting edge of AI and robotics innovation.

Fig. 18: *Vision for the future of AI and robotics in RoboCup, with humanoid robots competing against humans on a soccer field.*

10. Future Vision: Expanding Foxsy AI's Impact

Foxsy AI is not just about short-term gains in the blockchain and AI space. The project is guided by a long-term vision of becoming a leader in the intersection of AI, robotics, and decentralized technology, with a strong focus on contributing to global research and development in these areas.

10.1 Long-Term Goals

Foxsy AI aims to contribute significantly to the development of autonomous AI systems, particularly through its participation in RoboCup and similar global AI challenges. The project envisions a future where its technology will help bring fully autonomous humanoid robots to life, capable of

competing in international soccer tournaments like RoboCup.

RoboCup 2050 Vision: By 2050, Foxsy AI aims to support the creation of autonomous robots that can defeat human soccer players, contributing to the broader AI research and development community.

AI and Robotics Innovation Hub: Foxsy AI aims to become a hub for AI and robotics innovation, facilitating partnerships between academic institutions, research labs, and the blockchain community to further the development of these technologies.

Fig. 19: *A futuristic depiction of humanoid robots playing soccer, symbolizing Foxsy AI's long-term vision.*

10.2 Research and Development

Foxsy AI is deeply committed to R&D, working on breakthroughs in machine learning [5], robotics, and decentralized systems. The project aims to collaborate with universities, tech companies, and research institutes to push the boundaries of AI and robotics.

AI Research Collaborations: By partnering with academic institutions and AI research labs, Foxsy AI seeks to advance the development of intelligent systems that can operate autonomously in complex environments.

Robotics Innovation: Foxsy AI's focus on robotics goes beyond soccer simulations. The project aims to develop AI-driven robots that can perform real-world tasks, from automated manufacturing to autonomous service robots.

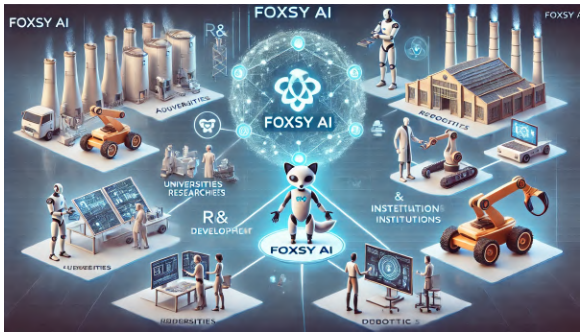

Fig. 20: *Diagram showcasing Foxsy AI's collaboration with universities and research institutions for R&D.*

10.3 Decentralized Ecosystem Growth

Foxsy AI envisions a fully decentralized ecosystem where the community drives innovation, decision-making, and growth. The project's governance model will evolve to accommodate new challenges and opportunities as the ecosystem expands.

Decentralized Innovation: Foxsy AI will continue to rely on community-driven proposals to innovate and improve the platform. The decentralized nature of Foxsy AI's ecosystem allows it to remain flexible and adapt to the changing landscape of AI, robotics, and blockchain technology.

Global Community Growth: As the platform grows, Foxsy AI plans to engage a global community of AI and robotics enthusiasts, further expanding its reach and impact in various industries.

Fig. 21: *A global map illustrating Foxsy AI's community growth and expansion plans.*

10.4 Autonomous Systems for the Future

Foxsy AI is committed to advancing the development of autonomous systems, including AI-powered robots capable of performing complex tasks independently. The project's long-term vision includes contributing to the broader adoption of AI technologies in industries ranging from healthcare to logistics.

Humanoid Robot Development: Foxsy AI aims to be at the forefront of humanoid robot development, creating intelligent robots that can interact with humans and perform tasks autonomously.

AI Applications Beyond Sports: While the project's roots are in soccer simulations, Foxsy AI envisions a future where its AI technologies can be applied to various industries, including healthcare, manufacturing, and smart cities.

Fig. 22: *A futuristic cityscape with humanoid robots interacting with humans, symbolizing Foxsy AI's broader vision for AI applications.*

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