

MODEL OF COLLECTIVE SPORTS GAMES

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Abstract

Collective sports game in the substantive sense of a complex phenomenon in the real world and takes place in the implementation of the plan. The plan applies to players as the stakeholders and the structure of the environment. On multifaceted manner using scientific contributions areas such as sociology, linguistics, biology, mathematics, computer science, especially in the field of artificial intelligence, robotics and philosophy we have clarified the issues associated with this phenomenon, which eventually resulted in a model of collective sports games. The model consists of three basic components and these are: the player, the collective of the match. Model player is multifaceted and there layers emerge one from another. Layers model players: play, strategy, flow, global-tactics, positions, communication, local-tactics, stigmergy, technique games, player profile, playground, game rules and background. Model collectives based on the configuration of the player's position determined by the chosen tactics. Basic types of players by type are: goalkeepers, defenders, the midfielder / playmaker and attackers. Players are assigned roles during the game experiencing transformation whose dynamics is determined by possession, the area of the field (field) and the tactics of the game. The model matches we expressed a relation where the outcome is a function of the clash of two collective team tactics in a defined environment and according to set rules. Possession is a central parameter determining the behavior of the kind which can be an attack, transition and defense. Constructed model has the characteristics of modern ecological approaches and presents the research basis for the planning and design of new experiments in the field of kinesiology collective sports games. The research for this approach is transferred to the interaction of players, collectives and the environment.

Key words: Sports, Model, Player Position, Collective, technique games, tactics, Game Plan, and Complex Systems, Communication, Stigmergy, Rules, Sport Science

Introduction

This paper deals with the phenomenon of collective sports games. From the perspective of the set it is possible to delineate three planes structures and processes that make up the phenomenon of the match. These are models of individual players as participants of a team collective, the collective of the model matches. In order to produce models of a collective game will be considered separately, models respectively (players, teams and matches the model) as separate entities that can permeate and receiving targeted phenomenon. In terms of the concept of choice behavior entity models, player, team, game, made a choice between the solutions presented in the previous chapters. Possible choices were to opt for Agra, Newell and Simon, one of the socio-biological models, or one of the solutions in robotics, multi-agent system models or teams in the RoboCup competition in which the various parts and functions of the model can choose different solutions. For an element of the game that are trained and practiced individually, offline, possible solutions are based on algorithms, neural networks and genetic algorithms. For others the functions, such as the game itself, selectable AI procedures relating to the collectives-agent systems or other swarm. In this paper, the purpose of the analysis and formalization of the proposed model in such a way to emphasize the structural, functional and phenomenological characteristics important for the

Selection of approaches and procedures for the implementation of algorithms models. It is evident from the experience of others, that the final solution will be a conglomeration of different approaches and algorithmic solutions. In the most general sense, the model is a conceptual architecture model of collective game which in any way wants to portray and faithfully represent something existing. Models are constructed to help us understand what we represent. When we introduce a concept or a number of related concepts we use the conceptual model. Concepts are processes relevant processes that occur in the brain. Represent human intentions or semantics. Conceptualization observation of physical reality and conceptual modeling agents are and the way that man must think and solve problems. They are used to transfer the semantics of the different ways of human communication using natural language. As the chosen concept can join different semantics is a necessary choice explicit formalization for the identification and location of the target on a conceptualization, among several possible candidates. In this way avoids confusion or misunderstanding. Models of the concept of most cities made analyzers that are not primarily interested in the truth or falsity of the concept that are modeled. Specifically, an analyst who builds model is not interested whether the model is true. The condition is that the experts confirm whether the model is correct or not.

Mathematical models can take several forms. Examples are statistical models represented by systems of differential equations, dynamical systems, and game theory. These or some similar models can be overlap and so set different abstract structures. The statistical models are functions of probabilities and that produce certain results / data. Depending on the model, a parametric or nonparametric, probability functions have parameters such as mean and standard deviation, in parametric (non-parametric bootstrap in). Models may be constructed on the basis of the process or mental or physical events. For example statistical modeling of the behavior of a player at a given position on the team can be a conceptual model, but the statistical model, a goal, a model of the concept. From the entire spectrum of conceptual models, such as the social and political models, here are interesting models of draft information systems, especially models regions (domains). Logical - linguistic models for this work is of primary interest because they can best portray the model level and extent of engagement with the chosen approach. The model system architecture is conceptual model that describes and represents the structure, behavior and multifaceted view of the system. Systemic conceptual model may provide more insight into the system using two different approaches. The first is no architecture and the other with her. Comprehensive analysis, in which they consulted: philosophical, sociological, biological, mathematical, computer, and physical education insights and approaches to the issue of collective sports games, constructed a conceptual model of the architecture of the collective game. The proposed model is the result of reflection problematic areas of the game, the collective, and modeling. The model is a construct containing two structures, namely: one game, and the terms of their relations or ontology and others, multi-layered model matches the collective sports games. Model collective games (basketball, football, handball, water polo) were constructed at such a level of abstraction that does not exclude other team sports. Constructed model can be used for simulations which have the advantage in limited circumstances, can provide insight into the emergence (emergence) phenomenon at the macro level of action at the micro level (Conte, Gilbert, 1995). In this way, simulating the interaction of entities (teams) can provide insight into the characteristics of the collective athletic games at a higher level of abstraction (egg Nowak & Latane, 1993; Axelord, 1995).

Model

Collective sports game is a very complex phenomenon. It can be viewed as composed of interconnected parts: a model player, or a team collective model and the model matches. These components will be considered as separate entities to eventually offer an algorithm for the flow of the match and formally define the model of the phenomenon of collective sports games.

Player model

Player is analytically decomposed into several sections which are later subdivided. Organizationally, this is the whole model is broken down into its layers. Therefore, the model is determined by cluster layers with the property hierarchy and emergence. Emergence as a characteristic of the emergence of the next lower layer, which is formed again, again as an emergent, the lower it. The layered structure of the model consists of thirteen emergent levels. Relations between the layers have the property that the higher layer represents the accumulation of the lower classes and the fact that the lower layer does not necessarily anticipate and fully his upper layer. During the match may be such that the arrangement of layers does not correspond to the model because some of the layers, and it will subsequently be analyzed with such a dynamics in the time that do not always have the same hierarchical order. This mainly refers to the layers such as local tactics, positions or collective tactics.

The model will be explicated with description layers from top to bottom. When it comes to model one member of the team (players) are determined by three main composite layers. These are the environment, the game, and the game, with hierarchy and emersion as ordered. Layer environment refers to properties that have been set and the course of a game is constant. These are the foundations on which to play, lines and signs of certain rules of the game in the playground, and the properties and capabilities of players. Capacities players are given at the beginning of the match, however, they are not constant during the game because the game development and performance of action capacities decrease as a function of the quantity of participation in the game. This process leads to a reduction in the intensity and amount of movement, but also in terms of reduction of the repertoire of actions. However, we will assume that this trend is approximately constant for all players as a function of the flow of time left so that the players are equal in spending capacity.

This is of course in contradiction with experience, but after we have defined it, the future is (applied) research to determine the course of the game influences the spending capacity and as to by how different players in general and as players at certain positions (role playing) and how it affects the individual players in terms of reducing the intensity and quality of his performances. Next structured layer contains layers that are changing during the game, those that allow the dynamics and outcomes of the match. This complex layer we'll call heuristic dynamic - since it is influenced by developments in the game. So at the lowest level are: * game space, surface, game rules; * the next players, tactics, stigmergy, position in the game, the collective, the flow of the game, and at the top by various; * kind of competition, strategies and play phenomenon.

Play

The game is a game that takes place in our own space and time in the duration of the game is not connected with the real world. By converting, the special situation of excitement (alea, mimicry, vertigo, ilinx), and guided Agon (Caillos) the player during the match under the constant influence of these phenomena. These phenomena are for each player in the game constantly alternate, but are always present. In relation to this fact players differ. For some, the primary, for example Agon and alea, while others will be more than mimicry or vertigo. It would probably be given to determine the different positions in the game have different attitudes towards these structures. For example, the defender is less likely to be left alei, but on the other hand it can be a very important characteristic of a good attacker scorer. Throughout the course of the game, and in certain phases exchange priorities will be the impact on the one hand and on the other ludic toys - paidia - component. It is likely that this may be important to plan experiments to demonstrate the hypothesis of relationships and share these structures in both individuals and with the team.

Strategy

The strategy is a long term game plan or a collective team in terms of annual or Olympic cycles, sometimes tied to a year's work of the same coach. Strategies are often recognizable in-game representation of individual countries or regions in the world. So we recognize the Brazilian, English or German "school" or football, American and European basketball. Strategies can vary significantly in terms of "philosophy" approach to the game, putting the focus of the game on offense or defense in some parts of, or in terms of tactical game plan in the game.

During the match

Run of play is typical and may depend on the stage of the game, the flow of time left, movement results. It may also be dependent on the type of competition - different in tournament or the league competition when the motivation and gain varied and manifest themselves differently in each game. Basic phases of the game are attack, defense and transition between these phases U each stage is different goals and means to achieve the objective. While in the stage of an attack aimed at player's escape-release of influence Players of the opposing team, the defense is just the opposite. Accordingly, the assets of the game, techniques and tactics are different; the same applies to positions in the game. The attack is the focus of the game one team (Trninić, Perica & Pavičić, 1995) at half rival and front of the goal Funds games, and techniques of the game, in the attack phase, along with the movement for the purpose of conquering space and escape from an opponent, and handling the ball for transfer in the field of implementation, and shot - making.

The phases of the game are due to limitations of the ball rules (except in football) regularly distributed between rival teams. Possession may be important to distinguish between the teams, especially in football, depending on the tactics, but the tie team due to their quality. Therefore, although the possession condition for the achievement points, the length of the ball may not always be positively correlated with the number of points scored. Tactics team can vary in setting goals tactics game with a focus on defense or attack. The winner of the match is the one who scores more goals, but also, from another perspective, one that receives fewer hits. The aim of one's is possession and others realizations. In this context it is interesting to analyze the flow of the game in the context of earlier Sensing Simon and Newe, and their concept of bounded rationality (Simon & Newel, 1965), or the latest research of Nobel Prize winner, economists (Tversky, 1973; Kahneman, 1993; lóval, 1993; Kahneman, 2011) as well as fast and frugal (Gigerenzer & Goldstein, 1996). These contributions are saying that man is a real-time forced, and it seems to choose in a given problem situation that a solution that is given the time limit as possible and not one that has given it the best or optimal. So the decision is made the choice that is limited to only a couple of possible solutions because the dynamics of the flow of time left, and consequently the state of the game does not allow otherwise. This important conclusion is directly determined not only by the processes of learning and training players, but also speaks of extraordinary importance of situational training.

It is interestingly interpretation of space at different game phases. Derived from analysis (Eco, 1973), which distinguishes the centripetal and centrifugal organization of space, identified with all known areas café-bars, where everything is focused on the bar, and that is centripetal, on the other hand the organization of the restaurant, which is centrifugal, where such an orientation does and distributed all over the space and all the tables in the room. In this way organizations run the game space is under attack centripetal - geared towards the subspace to achieve the goal, ie, centrifugal in the defense where the aim of the game stretch to a larger space and the space of scoring. The questionnaire should emphasize the importance of the contribution Agre and Chapman (Agre & Chapman, 1987; Agre, 1988; Agre & Chapman, 1991). They talk about the importance of the components of the game that players are commonly called Vision. Hence, the importance of which in the game for a player has the ability to recognize signs of certain spatial and temporal situations. This is a slang called "read the game". In this regard, there is little research in the area of dealing with these issues and hypotheses derived from them. The point is to understand, in the most general possible form, the connection between properties: players (agents), playgrounds (environment) and all possible forms of their interactions.

Consistent with this thinking is necessary to answer the questions: What is the role of players in different environmental conditions? What conditions a player must meet to maintain its role in the circumstances of the environment and thereby maintain continuity in the role that he is the default. Since certain aspects of the environment affect the ability of the days of players because the very environment has certain properties and variable? Which of interactions allow learning? How to construct a workout that will, through the interaction of players and the environment to enable optimal learning new skills? Explore the interaction of agents and environments are structured in two sets of ideas; aimed at planning and others, focused on the reaction of planning problems in the real world. (Lashley, 1951) connected with the operation of the human brain to understand the cognitive processes through the structure of the language.

The sequence of actions (in terms of carrying out a specific plan in the game) cannot emerge through a simple concatenation by SR - rules. Must be used and internal resources such as memory and intelligence, and concludes that the understanding of human action can be based on models of language. For Newell and Simona implementation of the plan is realized by searching the space of possible sequences of "operator", some of which correspond to the desired state (situation) and which may be accepted in terms of the steps in approaching a solution or a solution to a problem or achieving the final goal. "Nested search space" goes well with formal complex hierarchical decomposition action (Miller, Galanter & Pribam, 1960). The plan is seen as a hierarchical process in the body that allows you to control the order in which the sequence of operations to be performed. It indicates a relatively fixed repertoire of commonly used structures stocks or library plans. Plans are hierarchical in their structure and can be stacked as parts of larger structures. The significance of the plan is a hierarchical structure or process that provides a sort of ongoing transcription in the overall behavior.

Chomsky uses the results of the language to try to develop anti-behavior and anti-empiricist conclusions about the nature of the human mind that go beyond the borders of the linguistics (Chomsky 1969, according to JR Searle, 1982). For Chomsky's syntax is directly related to the organization and architecture of the human brain that is genetically determined. The problem of semantics is still with Chomsky is not resolved and the subject of ongoing debate and attempts to further scientific contributions of various linguistic schools. The course of any game in team sports it is possible to describe the sequence of simple sentences spoken language. In this context, the match could well be described as a story (opening, the plot, the epilogue). So we have the interesting Chomsky (Chomsky, 1979) because in syntactic terms (game plan - which directly depends on the

organization and architecture of the human brain and is therefore genetically defined) and semantic terms (implementation of the game), and from it we can get the tools and platform to another analysis and look at the game to present day approaches. In everyday life, most people are not concerned with solving the problems already routinely (Agre & Chapman, 1987; 1991). Thus, the player has the experience and lessons of the game processes for solving a given problem, therefore, routinely selecting those solutions that impose its current interaction with the situation in the game. The behavior of players it is realized through more routine and requires no intellectual strain (already has a ready-made solutions). From this perspective can be explained by the fact that he needed a long period of training for peak performance in team sports. The game is essentially a set of simple actions but the amount of situations in which action should be chosen as solutions to specific games is really great.

Global tactics

Global Tactics is always subordinate to the overall objective in each stage of the game (offense / defense). It also greatly depends on the players that are available to the team for the purpose of carrying out the game plan. The team whose composition is such that it has the mighty invaders and worse defensive players will adapt to tactics such fact. Tactics (mostly) determines coach (in the role of "constructor" with a view from above), and it controls and modifies as an observer, one who is not immersed in the game and that is off the court, and that therefore only has access to development of the game throughout the course. The player, of course, has access to only the part that is directly around it. Therefore, it is an important moderator of the game, coach. Each player in a game situation has a dual perception of the game. As the man inherent reflection, we can say that, but by the same self-awareness and the situation around him, he at the same time observer and participant in the game. At the level of the participants his behavior is controlled by the given situation and its role (debit), behaves, as we have seen, the lowest level of the reactions to the situation (local tactics), and carried out the plan. However, at the same time, he can play, thanks to reflexivity, seen as an observer. As a result he has the awareness of the moment of the game as a whole (and those parts that he was not in sight) and anticipates the possible developments of the game.

There is a distinction between what he knows about the situation player (agent) and that he knows his coach (designer). It is enough that the coach (designer) spent some evidence in a general form earlier. The essence is that the player (agent) knows the facts that allow its mission fails. Always there must be a connection between the set of skills a player (agent) and coach (designer). The player is always facing in a certain direction and its surroundings are certain artifacts.

Its material embodiment in action real important distinction between the view from below ("frog perspective") (ground view) and coach's views from above (areial) ("bird's-eye view). Coach (designer) always has a view from above of the position of a player in action this view is from a frog's perspective. Discrimination of this knowledge is necessary due to the sharp conceptual separation players (agent) and coach (designers). This allows the formation of special features of the player (the agent) relationship with the environment and interacts with a variety of artifacts and the environment.

Position in team

Position in the team is conventionally assigned the role of player. Players are expected throughout the course of the game performs tasks that are predominantly determined position and thus contribute to the collective dimension of the team. Each role has its own profile. It is awarded to the player based on the identified and confirmed its characteristics arising from the experience of his previous games. To play in a certain position are characteristic strictly certain types and lines of movement in which the player has their own area of activity in the field (Pavičić, 1999).

The player must perform all the functions of their positions. In the game, it happens that due to some partial or emergency situation that detracts from the player, but immediately afterwards returned to his role at his position. For the realization of the collectivity are specified roles in the game. Such role playing in defense is: goalkeeper and back, in transition are: back and wing, and attack the center, wing and external attacker. The distribution of the positions has more sophisticated functions (sub-position) characteristic of each collective game that depend on the size of the game space and the number of players.

Comparative analysis of the position in a game that tasks players in football, handball, basketball, water polo is possible to conclude the following: First what is common to all four sports games is that they all have the characteristic profile: defender, midfielder and striker: 1) Apart from basketball to football, handball and water polo are the gatekeepers; 2) names for specific roles in the game are generic and are given in a general sense, regardless of stage of the game; 3) quotient field size and the number of players in the field is different for each of these sports games and directly affects the definition of positions and tasks in the game; 4) The right tool in terms of the tasks for these generic definitions of the positions to be defined in the context of the phases of the game (attack, transition, back) as they are essential for the precise definition of the tasks in the game by assigned roles. For practical reasons, we will skip the phase transition and the differences sports we explain the cases when the attack or defense set.

Attack

There are marked similarities first game in attack in water polo and handball. Both sports have specific roles in positions of center pivot water polo and handball, the roles of the two wing players and the role of three external attackers: 1) In basketball, each player has a role (such as: outside shooter, high or low center and two wings); 2) In football defensive back formations row virtually no involvement in the attack but these players fuses a possible counter-attack opponents; 3) Wings are strictly positioned with a throw line and depend on whether they are in possession or not; 4) Midfielders distributes the ball and makes organizational preparation for a potential shot on goal in soccer. In water polo midfielder role in the transition phase take two wing players. In basketball and handball midfielders do not exist; 5) Attacking the attackers are fighting for position, which can be achieved properly receive the ball and make it for a shot on goal. The characteristics of these positions are similar in all four sports with the specifics of these sports.

Defense

It is as follows: 1) Defenses dictated the tactics of the attacking team. The defense generally is set as a zone, as a defense man-man in their half of the pitch or the entire site or "to press" (drastic variant man-to-man defense in the entire field with aggressive early foul without serious offense, ie the tendency of revocation time and opponent attack). Can be selected and combined method "pressing zone," which requires a perfectly functioning in a defensive assignment; 2) there is a considerable difference between the four sports games in performing defensive duties. This is a direct consequence of the pitch surface and the number of players in the game. In football tie line obstructing the flow of the ball. Defenders (central defender, libero, defense and wing defense) made direct interference with the opponent attackers on admission, handing the ball or a potential shot for goal. In basketball, such a situation does not exist because each position in the attack potential opportunity to send a shot at the basket. In water polo and handball, special attention is paid to circle player in handball and water polo center. All other players are obstructing the free flow of balls but at the same time undermine kicking by opponents.

Communication

Communication between all participants left the necessary means and feature of the game, communication as a means of ensuring coherent behavior of the collective. To establish a collectivity is necessary communications. Players communicate using one hand to support his game, and on the other to support the collective game. Communication can take two forms. One is verbal and non-verbal.

Table 1. Communications

Communication		
	Direct	
		Verbal
		Special game dictionary
	Indirect	
		Visual
Stigmergic - Koordination without communications		
	In the team	
	With an opponent	
	Between teams	
	With a judge	
	With an audience	

Verbal communication is specific and agreed within each team. The amount and intensity of the verbal communication varies depending on the situation in the game. Nonverbal communication is realized agreed signs. Communication serves supporting the development of the game according to the agreed plan and for support in parts when making some special situations. Communication is a public act, which they see or hear all the participants including the match referees and coaches' audience. Therefore collective's teams often use their special languages bargaining. Communication is an essential factor for success in the game collective. In communication between people we can distinguish between the function and meaning of the messages and at two levels simultaneously. Since the message is expected to have meaning, and contains information. Events in the "living world" (life-world - Habermas, 1981) and their reflections in social communication interact in numerous ways. The connection between these layers is a priori asymmetric and asynchronous. "Situational meaning of" interaction can be changed regardless of the participants - actors and emergent context can be so for the actors involved to become an event.

Local tactic

Local tactic applies to ad hoc solutions to specific situations in the game. The player is constantly in a situation of decision-making. In the local situation, these are decisions that concern only him and he still does not consult multiple levels or tactics. These are actually "play the game" where it competes with one or more opponents. Executing local tactics directly affects the development of the game; it can affect other players, but still not necessarily aligned with the tactics of the collective. The success in this layer contributes significantly to the game's final course of action and thus the outcome of the game. H.Simon (1957, 1965) found that the organization compensates for the shortcomings of their members ("bounded rationality").

Organizations, as Simon noted, compensates for limited working abilities of individuals. The division of labor and allocation of specialized tasks to individuals compensates for their limited ability to learn and perform new tasks and compensates individual limited capabilities. At the same individual hierarchical structure of bureaucracy compensates for the limited capacity of individuals, therefore, "structure in the world compensates for the weakness of the cognitive architecture," says Simon, "Administrative behavior." Lashley is pointed distinction of cognition that occurs in the agent and the world, located outside of him and says that for this purpose it is necessary to determine a concept that crosses the line between what is outside and what's inside, claiming that the world is not what the agent sees the inside but also what what is out there and the interaction of these two factors determines the behavior. The coach of a team in a collective sport (controller) in a multi-year work with the team controls the effects produced by the actors match (players - sport mode). Long-term follow-up will reveal that the behavior of converging to some values (results) and that the team has with some oscillation amplitude and frequency. Do you coach produces this behavior? Does it cause teams? The behavior is actually the result of the interaction of both. Culture forms a realization of the interaction and they in turn provide guidance and leadership in the process of adaptation to our complex world.

Stigmergy

Empirical categories of collective sports games that are top players, the vast majority, already well penetrated in the twentieth year of life, and great players have been in "advanced" age of 30 years. From this it may follow that the training time and the experience of playing games, it is necessary to achieve top results for a long time. The analysis of the complexity of the game and skills which the player needs to master, teaching and training techniques, learning and playing certain tactical game plan, however, is not so tricky to fully explain the lengthy process to achieve outstanding levels of achievement.

We assume and hypothesize that the addition part of the cause, or even a significant contributing factor, the phenomenon stigmergy. Stigmergy was observed, as a category of communication for the purpose of collective behavior in social insects (bees, ants, etc.), but also in higher animals: a flock of birds or fish, a pack of wolves, a herd of elephants and so on. Fundamental as the perception is that collectively intelligent behavior emerging from a plurality of very simple primitive behavior of individuals. Individuals generate a small number of very simple behaviors, guided by very simple rules, and at the level of the collective emerging behavior that can be interpreted as a complex and intelligent. Collectivity, through coordination in order to implement the plan, based on characters that are left in the environment.

Table 1. Player model - Survey of 1st layer model player, name, meaning, properties, and description

property	functional structure	Redni broj sloja	label	Layer name	description	phenomenological interpretation
intentional	Game goal	13	P(lay)	play	Game as spending time	(paydia, agon)
		12	G(ame)	strategy	The long-term strategy (seasonal plan)	
dynamically -- heuristic	game	11	G	tijek	Time flow fixtures and results	Same for both teams
		10	G	g-tactic	global - team agreement players and coaches	Same for both teams
		9	G	position	Role in a game	one team
		8	G	communication	symbolic communication both verbal and nonverbal - cohesion and coherence of - collective	svi učesnici
		7	I(individual)	I-tactic	Local tactic – game in a game	for a player
		6	I	stigmergy	communication via surroundings	For a player
		5	I	game technique	repertoire as a function of position in the field of game development	for a player
Constantly -- physical	conditions	4	I	profil igrača	Characteristics (anthropometry, conatively, sociology, physiology) and the ability of players	both teams for all
		3	D(etermined)	field	according to the rules - marked fields and other marks	“
		2	D	game rules	prescribed rules of the game	“
		1	D	base	ground on which the game takes place (parquet, grass, water)	Both teams for all

These signs may be temporary, such as a pheromone that evaporates and disappears after a certain time, or permanent, like termites in the building anthill preset small part determines the next set. In this sense, when it comes to people, there are relevant interpretations that all cultures and science stigmergic as it is transmitted through permanent artifacts books, magazines or various artistic artifacts (paintings, sculpture, books, sheet music). The standard conditions of competition on the field that matches the collective team conducted strictly prescribed rules of the game and controlled by the judges. There are standards to be met in order to match a regular. These conditions shall be maintained until the end of the match. From this it follows, that the game does not and should not be visible traces of the game on the ground. Neither one nor the other, stigmergic form (continuous or vanishing).

On the grounds is not permitted to place labels or gutted not to leave any traces. Pandant pheromone form of communication leaving traces in team sports, as it is known, has not yet been found. On the other hand, after analyzing in detail the emergence stigmergy can say that this element of communication in collective sports game is an important factor that is certainly present. It only has to disclose. This suggests that it is quite realistic to presume that for achieving superior achievement takes many years of experience (learning and playing experience) just in a specific stigmergy format which the player needs to master, under standardized conditions of

The game on the field, ie, with no possibility of leaving stigmergic traces which do not allow rules of the game.

Technique

The technique defines all the player movement for the purpose of executing the game plan. In principle, this is for any sports game finite set of existing elementary techniques of movement and manipulation of the ball. The techniques are divided arbitrarily given the stage play and position on court (Pavicic, Lozovina & Šimenc, 1988). The techniques are a means of games for the successful implementation of local and global tactics. In comparative terms, there are significant differences between the three sports games (football, handball, basketball) and fourth (water polo). This difference stems from the medium in which it is played water polo (water).

Capabilities, capacities and characteristics of players

Features and characteristics of players certainly significantly determine the course of each match. It is understood that all players are about the same with the abilities and characteristics that enable them to fully and in par with others, participation in the game. With this assumption has been achieved that the differences between the players, which is usually an important component of the game, orthogonal, or the same influence on the course of the game.

Field

The playing field is the space in which the game takes place, and the component parts of the game are just what is happening in this space. Golf has its own structure and is divided into sections (zones) to determine the course and manner of operation or action games. These are fixed or variable parts (zones). An example is the fixed parts of the box in football, or the dimensions of the goal. The handball was a space of 6m, which restricts players in attack and in defense of those. It is different for different collective sports games variable areas (zones). In football it's offside line which is moving from the center to the bar, depending on the position of the attacker relative to the last match-up moment to direct the ball. In water polo is a space 2m, in the context of the position of the attacker and the ball. In basketball the space defined by the racket, and the offense is determined by the length of the retention time in it if it comes forward or foul free throws when it comes to defending player. Each of these sports has defined the dimensions of the goal that hit the ball in order to achieve points. These are the dimensions of the goal in soccer handball and water polo and basket in basketball. Rules are governing the value of the points. .

In Table 2 depicts an arrangement and significance of certain parts of courts considering the longitudinal and transverse axis.

Table 2. Preview of the first game space, field, with meanings in the game

	L - SIDE	M - MIDDLE	L - SIDE	direction
F - FRONT				
A - C MIDDLE				^
P - C MIDDLE				
B - BACK				

The characteristic field is that it is a space that limits and conditions of interaction of players in it. It has topological features and the topology is an important factor influencing the interaction of agents by defining their behavior. In this sense, it is common playground divided into zones or subspaces vertically and horizontally (longitudinal and transverse). Longitudinally to the rear, middle and front space field and cross the center, left and right space. For example, the front central area is the room for kicking to the attacker. The same premise defensive player is the last central space that it imposes preventing the shooting. Left and right subspaces are characteristic of phase transition, while the middle central area characteristic for organizing the attack. Topological point of view where the player is in the field specifies what to do.

Game rules

Rules are a set of agreed rules that defines all possible behaviors of players and all officials to accurately indicated before the match and after the match as well as during the game within the game space.

Rules interpret and act upon them awards the official judge or judges. All decisions of the judges are final and must be implemented. The judge may change the decision made, but just before the sign to start again. The judge's decision may be: a sign of the beginning or end, foul, ball out of the field changes and time out. Each game takes place in the real world - environment which is subject to the laws of physics. Physical laws defined all the motion and thus the game in collective sports games. About these laws player thinks they are always present in each performance and are included in the decisions of each player. An example of this is the length of the flight of the ball. The player will not even try to make a pass if not sure of the success of this addition (range). The player will not try to "run over" an opponent in an attempt to conquer space, it must be bypassed. Each player will, therefore, on an unconscious level to respect the laws of physics.

Substrate

The lowest layer in the model's surface or medium on / in which the game takes place. Given the analysis of team sports are three types of surfaces: grass, hard (flooring, etc.) and water. Considering the physical properties of any of these media may be that in acute situations vary. These variations are in the range Hard-elastic-soft, fast-slow. Condition background in planning tactics or strategies is always a factor. Water might not be backing but is the medium in which it is played water polo match what makes polo significantly different sports game of soccer, handball and basketball.

Team model

This model is based on the configuration of the player's position determined by the chosen tactics. In all four sports are four basic types of players by type. Normally the primary composition of teams and, therefore, the role assigned players in the game to show the way to the team in the defense therefore out of the ball. In the model are: goalkeepers, defenders, the midfielder / playmaker and attackers. This "static" display of team members, with assigned roles during the game, experiences transformation becoming dynamic. This determines the dynamics of ball possession, the area of the field (court) itself tactics game. For example, as a quarterback in water polo at the stage of the attack, when his team possession, becoming one of three external attackers. Generally changing the phase of the game from defense to attack, changing the names and positions according to the function of that player in the attack phase. At the same basic structure and position in relation to other players remains active. Total change is the translation of the imaginary line of the field. Thanks to this translation of a same player as compared to other teammates retains the same place at the same time just by changing the role.

In a match tactics are scheduled tasks players to cover the entire area of the game. Looking at Figure 2 shows the structure of space and playgrounds subspace with respect to their influence on the game and the match. These sub-areas in terms of propagation and activities of players influenced the development of the match (Pavičić, 1991; 1996). Their propagation dynamic and influenced by several factors: the result, the duration of the game, chosen tactics in a given moment and stage games attack or defense. Every part of the game space has some properties of the gravitational type that support the position of the ball. The space summarizes and expands depending on the phase of the game and the position of the ball in terms of higher density buildings Players and ball ("Gravity") proportionally near the ball (Pavičić, 1991). In basketball, this is partly theoretically evaluated and defined in the model (Trninić, Perić & Pavičić, 1995). In the course of the game is an important component of the impact area on the repertoire of possible choices technique games which are processed in water polo and explained (Pavičić, Šimenc & Lozovina, 1988). In the attack phase, for example, the player can decide not to Pointing if it is in front of their goal / basket or opt to add if I'm in front of goal. Direction of the development of the game is directly dependent on the possession. Players determine the direction of the game and are generally focused on the ball or the player or for which they are "responsible" if they are not in possession or, according to his opponents' goal if you have possession of the ball. But this also depends on the position in the playground. An important feature of courses related to communication via the environment - stigmergy. According to the rules of the game features courses are standardized and may not be changed for the duration of the game. Players, except as may not alter the surface of the court may not place or drawn and redrawn some characters. However, as we have seen in the model of the player assumes, however, that there is a layer of the communication in the game there.

This is a fairly unexplored area which should not be the reason for the existence of stigmergy when playing a match simply ignore, as it does not exist. Given the research bio-sociology and computer science, we see that there are various methods and means to exploit stigmergic communication. One aspect that is safe and stigmergic sign are the markings on the playground (Agrre) which, as we have seen, have a dynamic component of meaning. It can be concluded that the dynamics of the meaning of the parts and label field for all participants of the match has stigmergic component that is equally available to all players in the game. However, "reading" the situation in the game is personally, individually. Players are considering this feature can very different. And the position of a player in the game is stigmergic sign, however, that this is a sign interpreted by each player and the team, according to their characteristics.

There is a clear distinction between non-verbal communication, which is carried out from a selection from the repertoire of the agreed signal, and stigmergic character. Meaning stigmergic marked with a context, and development of the match. So there is no pre-agreed message. A typical clause in a collective game of "reading" the situation in the game is largely the domain of stigmergic communication. These experimental works in our area for now, but there is no exposed provides a platform for the possible generation of new hypotheses and design experiments. One hypothesis is that the interpretation stigmergic characters can be divided into those that are visible to everyone, those who have seen one team, and finally those that are visible only to a particular player. It has been, one might say, a cultural phenomenon in terms of performance theory (Schechner, 2003). Given that the players are the people it is important to emphasize the phenomenon of reflection. So it is a double hermeneutic, in which the player both observer and participant - a node in the communications network, and games and teams. A player performs an action, acting as an actor play and in some ways at the same time, "looking" itself in the space game in the match. It is certain that the players are considering this phenomenon may vary significantly. You could set a hypothesis for example: the player greater opportunities (national team) and the dominant creator of the game has this relationship is different from the one that has the type of player the task (club player). Their perceptions, interpretations and understanding of games are different. The team is however always a composite of both types of players. Following this consideration it is possible to determine the position and role of the coach. In contrast to the player who is "immersed" in the game and that has limited access, it is he who watches his team from "above", has the broadest insight into the flow of the game. Its location is right and the function and importance of the match. The coach is the one, but because of its location outside the game space, as well as for his role as "constructor" team has the best insight into play in the game. Real events compared with the imaginary and the agreed tactics evaluates and controls the play of certain players, or formations, and teams. Consequently, based on communication, team is working, under normal game circumstances, as formed a cohesive whole - as a single entity participant of the game. Equally entity itself and match, say the level of attendance or commentators.

Model matches

The game has two teams meet-collective. The interaction of two collectives is finite duration. The outcome of the meeting is to gain or lose or tie. The winner is the team who scores the greater number of points. The game takes place in the space field. Control the flow of the game made officially delegated judges, according to the official rules apply.

The game may be present viewers (fans) and media representatives. Competition two complex entity-team structures and how the players performed in the previous section. The dynamics of the game most expressive results determine movement and the passage of time from the start of the match. Basic important components of the match are the players of the two teams, the game room and the presence of judges. The previous sections of certain models of players and teams were formed. We will focus only on the model of the flow of the match. The game is for one team, implementation of the plan in the successive phases of the game on defense, offense and transition. Once you have made models of players approach to designing a simplified model matches.

The dynamics of the sequence of phase changes as a function of the game is the ball. The dynamics of the individual phases of the game can be further divided into sub-phases. Each phase separate "play" performed by all members of the collective. During the development phase can be influenced by the judge's decision. However, such decisions are, when not talking about changing the ball and scored goal indifferent to the course of the game due only to pause in the development of the game. Sometimes it can happen that such termination is essential to change the state of the game, but in this model will not be installed because they are special situations that can then be treated with various models. Nature is a collective sport; a game is such that it is for the player to an asynchronous sequence of events. Decisions of the game player I retain the times when the situation required. The player has no insight into the overall state of the game. The extent of his insight into the game space is limited to only a portion of the field and the only part of the players. Therefore, the decision, which makes the game players, determined with respect to time and situation Synchronization action player of the

team guided the development of the situation in the game. Such decisions and actions have two levels. One is local tactics, or play in a game where the player is in a position to "off" from other events in the field until the situation is resolved. Second is in the context of the global attacks carried out by the player when you are "waiting" to complete the phase of the local situation. In the player model, that is going on at two different levels of the model, strategy and game. During all this time the player is in terms of reflection, or double hermeneutics, the point in the network events the team at the same time observer of the situation in the game. The model for this player is in the domain of higher layers; strategy and game. Making decisions is essential and dependent on communication with other participants and the environment. Therefore, in the model of the game is appearing as emergent phenomena and consequences of players in team members. The ratio of two opposing teams, which makes the game, you can also determine the emergent relation Entity Relationship-collective confront two teams. The dynamics of these relationships we called during the game. It is a process of asynchronous activity and communication players on how to achieve coherence of individual action space game. Collective phenomenon emerges from single coherent action of a team player. In the same way the phenomenon of game emerges as a result of interaction of two opposing teams. The interaction of two collectives in the context of the flow modification phase of the game, ie., Attack, defense and transition. These phases each have a separate model. This plan of action and interaction in the game can be symbolically display graphics and formulas. Determine the variables of the game and their mutual relations assets or subsets and display them now in the form of diagrams and formulas. Basic categories have also left with a layered structure as shown in FIG third scheme.

Table 3. Game model scheme

			game		
(Play)	game			reflection	heuristic
(Team)		team		multiagent	
(Competitor)		competitor			adaptation
(Rules)			rules	Default -	
(Environment)			Environment	Environment	Deterministic

(P = play, G = game / game, T = a (global tactics repertoire> (technique, individual and local tactics)) / tactic, Rules = rules that controls and implements the judge / rules and the outcome, E = environment (playground with labels)

We have identified three related coherent whole. These are: a) game (play), b) conglomerate game containing teams and players, c) default and fixed categories of environment and rules. Relationships between these parts we shall express the relation:

$$G[\{T_{(1,2)}, P_{(1,m)}\}, E, R] = I_{(0,1)} \text{ (outcome).}$$

Thus, the game outcome (I) is in the left position (G), which includes two of (T) and which are collective marker (P).

The variables E and R will be treated in an idealized model as constants which are therefore not change throughout the course of the game. When you would like to include variability in these variables should determine the functional relationship of each of them with T and P and then treated as a special model these relationships. How and how changes in the environment or (application) rules are reflected in the T or P. The collective of T emergent phenomenon of interaction of players P, and these are separately specified in the preceding chapters.

Interaction between players and teams is a result of the actions of players. Effect of players is asynchronous in the order that cannot be predicted. The effect of all players is a continuous process where the coherence of such action, based on the choice of the global tactics, achieved a collective. In a game we notice dominated by two overarching objectives: achieving the goal and ball possession, which is a requirement for the goal. Consequently, possession is a central parameter determining the behavior of the team. The team is determined in its action ball possession - O (ownership):

$$G = f \{O (\text{Ball})\} \rightarrow \{A([\text{transition}] \text{ attack}) \mid D(\text{defence})\}$$

In the game (G) possession (O) implies A or D. Where A is a set repertoire of tactics game in attack and D is a set repertoire of tactics in defense. The game is a continuous sequence of changes A and D, which are defined with

$$A(a_1, a_2, a_3, \dots, a_l), l=1,2,3,\dots,m$$

$$D(d_1, d_2, d_3, \dots, d_k), k=1,2, \dots n$$

meetings of appropriate repertoire. "M" and "n" are number of elements that are tactics of attack and defense. The assumption is that these are finite sets that are defined earlier practice of playing. The process of forming behavior in the situation is under the regime of well-defined restrictions. Significant restrictor's choice of possible actions significantly determined to a position in the game, stage games and positions on the team. Therefore, succession in the chain of decision-making is fairly simple process than would be expected. The complexity of behavior in the game is still at a high level and competent successful players will need years of training to reach the required level. Play is the layer that is relatively independent of O, occasionally emerging as a result of the flow of the game, and it is therefore incalculable and does not appear in the given formulas.

The selection algorithm model of collective game

From the repertoire of existing algorithms candidates for use in this model was chosen class of algorithms known as TD - Time difference modeling of heterogeneous group of agents (Sutton, 1988; Tesauro, 1995; Boyan, 2002). Game player manages the plan. Among the presented solutions play collective sports teams can be put into the context of the theory exposed the plan (Agre, Simon, Shackey...). The plan consists of a set of actions. These actions can be qualified either as target or as a reaction to adapt to the situation. The game has its phases, which are symbolic significance, like a story or drama. It has a global structure opening, plot and epilogue in purely dramaturgical sense of embodiment (Schechner, 2003).

Interpretations of the same game and the state of the game, as emergent phenomena are different for each player and the team, their coaches and referees. Emerging from the coherence in the actions of players based on the agreement or the tactics common goal, the division of roles and positions in the game and strategy. The actions that the player chooses from a set of all possible actions are defined as ontologies games. Function operator dialing is characteristic of the position but also the very person of players. Stacking Plan (Agre, & Chapman, 1991; Simon, 1956; Simon, 1961) and RoboCup's (Asada et al., 1998; Kitano et al., 1997; Veloso et al., 1998; Pavičić, 1999) is a set of operator actions in a given situation, it is narrowed and priority applies only to the next step. A succession of such steps at the level of collective manifests itself as a coherent and produces intelligent behavior collectives- teams.

Conclusion

Collective sports games are a complex phenomenon. Solution to the problem of modeling we did decomposition collective sports games on the parts that are also each of them complex. The model consists of components: the player, the collective of the match. The problem is solved by modeling the player's decomposition of the ordered set of layers. Layers are of mutual relationship in a way that the upper crust in principle emerges from the lower. The concept of emergence means that there is a straightforward algorithm that could describe the relationship and the transition from one layer to another. At the lowest level are the layers of the environment that are given, fixed and invariable during the match.

They are followed by layers which are variable, and which are characterized by adaptation to a given moment during the game. At the highest level and in the upper layer are the strategies and game. The phenomenon of the collectivity of the model is defined and described as emerging from the division of roles in the execution of tactics. The achievement of collectivity enables game or rules controlled encounter two opposing teams. In considering the elements necessary for the construction of models in particular have studied the issue of planning and decision-making issues because the game itself that the plan is a sequence of decision-making. The planning problems in the real world we considered contributing authors Laskley, by Newell & Simon (1964), then Miller, Galanter & Pribram (1960) accessories, as well as particularly interesting "theory of generative grammar" linguistics as Chomsky. According to Simon, social organization compensates for the shortcomings of its members, which Simon called "limited rationality". By analogy, the division of roles in a team-collective is just a consequence of bounded rationality of players. Tasks that collective team during the game by undertaking a plan enabled the division of activities in different roles or positions in the game.

Another important feature is that decisions must be made, under the pressure of the dynamics of the situation in the game, in a very short time (Gigerenzer, 1996). This consequently means that the player can not consider all potential solutions in a situation where there is already decided by the assessment and the choice between two or three possible solutions. An important factor in achieving the collectivity of communication can be verbal and non-verbal, which may be direct or indirect. We believe it is of particular importance and also the least studied communication via the environment, or the phenomenon stigmergy we know for sure that there are plans to achieve in the game. For decision-making in achieving the plan's player in stigmergic sense, it is necessary to "read" their environment, ie. Marks on the playing field, the positions and behavior of the box and the opponent as well as permanently control the flow of time, and these are all signs stigmergic type.

We have stressed the fact that the player inherent reflectivity which is why he is also located in an observer, having self-awareness on themselves "see" in the game, both as participants, as an actor with a role in carrying out the game plan. Based on these considerations, we gave a solution to a mathematical formalization of phenomena match. We chose the algorithm from the class of algorithms known as TD - Time difference modeling of heterogeneous group of agents. Constructed model opens a new perspective and an exploratory basis for the planning and design of new experiments in the field of kinesiology collective sports games. This approach differs from the paradigm of the equation specifications sports activities to the most commonly used models in scientific research in kinesiology. The research is a new approach to transmit the interaction of players and the environment. In this sense, these approaches are referred to as environmentally friendly.

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MODEL KOLEKTIVNIH SPORTSKIH IGARA

Sažetak

Kolektivna sportska igra u sadržajnom smislu kompleksan je fenomen u realnom svijetu a odvija se provođenjem plana. Plan se odnosi na igrače kao nositelje aktivnosti i na strukturu okoline. Na višestran način korištenjem znanstvenih doprinosa područja kao što su sociologija, lingvistika, biologija, matematika, računalne znanosti, posebno u području umjetne inteligencije, robotike i filozofije rasvijetlili smo teme povezane sa ovim fenomenom što je u konačnici rezultiralo Modelom kolektivne sportske igre. Model čine tri osnovne komponente i to su: igrač, kolektiv ekipe i utakmica. Model igrača je višeslojan i u njemu slojevi izranjaju jedan iz drugog. Slojevi modela igrača su: play, strategija, tijek, globalna-taktika, pozicija, komunikacija, lokalna-taktika, stigmergija, tehnika igre, profil igrača, igralište, pravila igre i podloga. Model kolektiva temelji se na konfiguraciji pozicija igrača koju određuje izabrana taktika. Osnovne vrste igrača po tipu su: vratari, braniči, središnji igrači/organizatori igre i napadači. Igračima dodijeljene uloge tijekom igre doživljava transformacije čiju dinamiku određuje posjed lopte, prostor u polju (igralištu) i taktika igre. Model utakmice izrazili smo relacijom gdje je ishod u funkciji sraza taktika dvaju kolektiva ekipa u definiranoj okolini i po zadanim pravilima. Posjed lopte središnji je parametar određivanja ponašanja ekipe koja po vrsti može biti napad, tranzicija i obrana. Konstruirani model ima obilježja suvremenih ekoloških pristupa i predstavlja istraživačku podlogu za planiranje i dizajn novih kinezioloških eksperimenata u domeni kolektivnih sportskih igara. Težište istraživanja se ovakvom pristupu prenosi na interakciju igrača, kolektiva i okoline.

Ključne riječi: Sportske igre, Model, Igrač Pozicija, Kolektiv, Tehnika igre, Taktika, Plan Utakmica, Kompleksnu sustavi, Komunikacija, Stigmerija, Pravila, Sportska Znanost

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