

Social media for e-learning of citizens in smart city

Jerzy Balicki^{1,*}, Honorata Balicka², Piotr Dryja³, and Maciej Tyszk³

¹Warsaw University of Technology, Faculty of Mathematics and Information Sciences, 75 Koszykowa St., 00-662 Warsaw, Poland

²Maritime University in Gdynia, Faculty of Management and Commodity, 81-87 Morska St., 81-225 Gdynia, Poland

³Gdańsk University of Technology, Faculty of Electronics, Telecommunication and Informatics, 11/12 Narutowicza St., 82-230 Gdańsk, Poland

Abstract. The rapid development of social media can be applied for citizens' e-learning in a smart city. Big cities have to cope with several open issues like a growing population or a traffic congestion. Especially, a home and public space is supposed to be used in more efficient way. Sustainable homes and buildings can be planned with using some modern techniques. Even currently, there is a huge problem with a lack of key resources like water and energy. So, an efficient management of resources is strongly required. What is more, a global warming and carbon emissions are considered as some critical factors for living conditions in many cities, too. A vision of a smart city is related to a better protection of a natural environment and a more efficient use of it. Moreover, citizens expect an efficient and sustainable transportation in livable city. To present some solutions on above issues, this paper outlines the methodology of using social media to provide necessary knowledge by citizenship training systems. In particular, some selected e-learning applications have been characterized. They are related to pedagogical agents in e-learning. In addition, some advanced meta-heuristics have been proposed with particular emphasis on genetic programming, artificial neural networks, neuro-evolution algorithms, support vector machines, and some collective intelligence algorithms. Finally, cloud services are discussed regarding a smart city management and training.

1 Introduction

The development of an idea related to smart city requires a systematic education regarding the opportunities and facilities offered by modern information technology for several important matters in the region. The mobility of citizens is becoming more intense and because of the wide variety of requirements and services, an adaptation to a new location be long-lasting, cumbersome and ineffective. Moreover, the level of computerization of the metropolis is usually very diverse, which is reflected in the significant difference in the integration of information infrastructures [1].

* Corresponding author: J.Balicki@mini.pw.edu.pl

In a smart city, the way of city management is changed by using information obtained basically from smartphones. In addition, this is another stage in the evolution of the information society towards the society and the knowledge-based economy. The role of computers, computer networks, sensors and actuators is related to provide almost instantaneously reliable information, and decision support. It should be stressed that the local TV programs and access to crucial information contained on the web portal of the city office is far too little in intelligent region. We can laboriously search the web pages of doctors-specialists in the event of illness, plan infrastructure networks, pay tax, apply for ID card, look for work or control the quality of water. However, we now expect much more, to make it easier to deal with such matters and taking into account the full set of data. It is more important to achieve a better quality of life by a more complete computerization [2].

On the other hand, with so many web portals that provide information about a city, it is difficult to control important changes. If the city council during the session at the universities provides information about grants for students, this information would not reach the beneficiaries. Although the next call will be submitted more likely, the deadline for applications should be considered as a major drawback of this system. It is worth noting that the article is not about a traditional education based on schools and universities with courses that are not aimed at adapting residents to effectively living in their region. They can, if possible, support education. Some tasks also carry information from the media. A better idea is to separate urban educational centers, which will be remotely educated residents using the most modern technology [3].

The article is organized in the following way. Section 2 discusses the role of social media in smart city. However, in Section 3, a role of e-learning is characterized. Section 4 is devoted to reflection on the various intelligent agents program in education and tangential residents. Section 5 relates to some methods of the artificial intelligence that can be applied in the smart city, including metaheuristics and machine learning. Finally, Section 5 discusses the cloud computing and a proposed optimization method ELSA, which are dedicated for intelligent e-learning.

2 Social media in a smart city

Ten years ago, Department of Communications in Roanoke in the U.S. state of Virginia had launched a modest social media, and when a heavy snowstorm hit in the winter of 2014, citizens frequently used the city's Facebook page to get information about snow removal. Moreover, photos were viewed by more than 400,000 people on Facebook. Suddenly, social media from a side project have become an important channel for communication. The number of followers grow from about 22,000 on Facebook and Twitter to more than 100,000 per a year. Social media pages are connected to all city departments via an integration icon, now. News streams from Facebook and Twitter are visible by citizens as well as some view posts from a selected agency. It is permit to browse and see the city's videos and news releases via some social media platforms, such as Instagram and Flickr. Getting and sharing information from all the city's departments is much easier. Social Media Center works in more effective way than a phone hotline 311 regarding some criteria related to query, complain or ask for help. Another advantage is to give an economic boost in the form of increased tourism traffic. Publicity generated by photos and Facebook advertising attract tourists that give on average 450 additional "likes" every month [4].

To deal with some new tasks caused by social media, a city has announced a set of policies, which contain obeying the law and nonparticipation in creation some contentious remarks. An administrator of social media in a city department can cooperate with a consultant to improve many Facebook pages, point out the pros and cons of them, and propose references for upcoming posts. Moreover, some regular classes are carried out to

review the effectiveness of pages, to deliver more training, and to discover more examples of new choices and tools. These conferences can also play a role of some brainstorming sessions. The main drawback of the social media approach is the high amount of an required effort with the constant entering of data. High-profile departments, such as communications, recreation, parks or police, usually post on a daily, and the others post less repeatedly.

From Roanoke case study, we can observe that social media can support a smart city as a model of metropolis, which integrates a number the information systems with the use of the Internet of Things to efficient management of urban resources, including services like: informative, educational, safety, labor, business, and commerce. Moreover, law enforcement, health care, food, and also transport services have to be consider. Finally, an energy distribution as well as the network of water supply can be controlled. Smart city stems from the fact that several modern cities, especially the largest ones require overcoming crises in various areas, which mainly interfere [5].

In response to the need to meet the new challenges, models of a smart city have been created, in which residents are very well informed about the current situation. They have a great knowledge about the city, and are able to communicate about each other. Some pioneering projects have been applied in New York, Boston and Baltimore, too. Another reason of a smart city development is that 84% population in the USA lives in 363 metropolis. New York with 19 million inhabitants is still spreading to incorporate a part of New Jersey and a part of Pennsylvania. Boston has absorbed the southern part of New Hampshire. With regard to education, it is worth noting that the 13,500 school districts in the US different do not always correspond to local government districts [3].

A goal of intelligent city is to improve the quality of life using information technology to increase the efficiency of the citizens by an identification some expectations of them. Smart city is a model of integration of several dozen IT systems and real urban systems, which interactively shares data with millions of inhabitants. An emphasis is placed on the connections between millions of stakeholders, sensors and actuators, and therefore the Internet of Things plays an important role [6].

In the smart city, the network of connections between the domain systems and new ones is more important than the analysis of separately functioning urban systems. It may be happened that the construction of the airport will fail due to the lack of tourists, which is not prepared for a comfortable accommodation facilities, attractions to visit or ecological environment. Therefore, synergies should be achieved by balancing and cooperating between government, local government, education and business. Decisions should be the result of understanding the needs of residents, take into account their needs and preferences for decision-making criteria.

3 The role of e-learning in a sma city

Information systems enable city authorities to interact directly with citizens to monitor what is happening in a city, how the city evolves, and how to get a higher quality of life. Using sensors in real-time, data is collected from residents and devices, and then data is processed and analyzed. Acquired knowledge is crucial for effective solving problems, and supports wider consideration of the needs of residents. It is assumed that security, welfare, and cohesion must result from different cultures, and use advanced technologies [7].

Common platforms for data sharing about the problems of security increase the level of safety in each agglomeration. In addition, these platforms "warn" like virtual sensors about problems that have arisen in one metropolis, and may occur in another. If every few minutes in the selected metropolitan comes to serious crimes, the data about them are

important observations. It is therefore not only inform and integrate a system: police, municipal police and the prosecutor's office, but also the services responsible for security.

Remote work is the key to reducing unemployment. In IBM approx. 40% of the time of work is related to the activities performed at home of residence. In the US, on average, every ninth day is devoted to work remotely. Especially, if jobs are very distant from the places of residence of the population, such solutions are very effective, because it increases the level of the happiness of workers, forcing learning new technologies, and also some responsibilities. It reduces some labor costs, traffic, and consequently the pollution [8].

In this context, the classic centralized model of jobs in the region based on a large center seems to be inadequate for a decentralized model in a smart city. Decentralization requires the introduction of many virtual workplaces, which is associated with the increase of the level of secure access to company's servers and higher capacity of communication links. In the case of consortia, access to documents should be done through virtual offices, which are a kind of middleware between the system and the system of management and the execution of a task. Because it is crucial the training of employees, the number of courses can be done online [9].

A common problem is the lack of agglomeration complete information about public. High school students, athletes in selected age groups, tourists arriving for a few days to the region, or members of the specific organization or agency should have access to comprehensive information adapted to their preferences. Identifying the information needs of the resident is a difficult issue and requires the use of artificial intelligence methods. Current data may indicate events in the immediate area, danger zone, and experts needed.

Sharing repositories for different purposes makes it easier to solve many important problems. For example, the address of the owner address of real estate majesty and the land register should be consistent with adequate address in ID card. The relationship can be extended to bank accounts or tax repository. The stakeholder should have an access to this class of data through a standard graphical interface.

A large number of organizations that collect variety of data lead to cost increase and duplication of the data. Redundant streams of input data about the people and processes can be reduced by sharing data services in a cloud. This requires training of the employees of the administration in using cloud resources. While the entering data about residents is associated high costs, the use of "open" data in the community's media is characterized by much lower costs. Moreover, they are a source of information about the expectations of months of load receptor introduction of good practices and decisions by the authorities of that city [10].

Undoubtedly, the big dilemma of the agglomeration is the lack of orientation of residents regarding the strategic impact on their lives of services provided by the authorities. Important are therefore indicators of the development of the local community and the data describing sustainable development. It is necessary to assess independent organizations in achieving the intended goals, which should be made available on the network [3].

The consequence of the development of democracy is the weakening of civic leadership, which manifests itself in criticizing the decisions taken by the elite in relation to a large population. There are necessary dialogues with the inhabitants of the virtual video conferencing web. Decisions must result from frequent voting of residents over important matters. The preferred form of referenda is online voting, which requires secure applications. Voting results should be widely reported, pointing to the positive and negative effects, as well as the opportunities and threats for the community. The authors hypothesize that the common decision-making by the votes is an effective form of self-organization of society and even verify the intensity of a progress in a relation to the acceptance of

important social indicators. An adequate example is Switzerland, where frequent referenda as a control strategy is effective development of society.

Social isolation of residents is a key dilemma, which is also being attempted by the smart city model. Monitoring the health of residents by means of sensors measuring temperature, pressure, pulse, sugar level or blood parameters enables shortening of help in the event of a heart attack or stroke [11]. It can also signal the need for a visit a doctor or doing additional research. Social isolation prevents extensive information about the neighborhood in terms of geographical and virtual with particular emphasis on social networking sites. An important role is played by e-auctions and barter exchange portals that refer to the residents' area. Libraries should also act as a virtual educational sites, and perhaps even the editors of magazines and regional developments. Remote learning also prevents incendiary by providing attractive activity plans on smartphones and tablets [12].

From the above analysis it shows that the traditional training methods of urban residents are not compressed with the new challenges due to the mass character's different and parity data and processes, also complex interactions between them that require intentional communication. That's why this paper proposes a system that the use of intelligent agents in a remote learning.

4 Intelligent agent systems for educating residents

A *smart city* resident who wants to master several e-courses usually feels the lack of competent support. Understandably, he cannot consult officials or teachers at any time he wants. The role of a smart guide or a friendly partner in learning can be played by intelligent pedagogical agents IPAs, by activating, and increasing interactivity and involvement of residents in the virtual smart city environment. In particular, 3D educational simulators offer advanced visualization combined with the possibility of cooperation with other residents. *Open Wonderland* has such properties - it is *open source* software written in Java [13].

Pedagogical methods are key determinants that affect the interactivity and support service for residents, improving the resident's self-confidence, his commitment to community affairs, and provide support in understanding the environment. In e-learning, an avatar can represent a resident. The computer games model activates learners, introduces an element of competition and cooperation, and also compensates for the sense of duty to satisfy the fun [14].

The use of intelligent agent systems in residents training is particularly beneficial when the training process is asynchronous. This model does not require the simultaneous presence of involved parties, which considerably widens the group of potential recipients (Fig. 1.).

If immediate contact with a coach is not possible, his role may be fulfilled by intelligent agents that support the training process. Program modules characterized by autonomy, mobility and the ability to both reactive and proactive behaviors are used in expert systems and can successfully perform the role of an expert in remote training of residents as well. The program components are available to course participants at any convenient time for residents.

Intelligent agents can operate in a manner that is personalized in terms of requirements of a resident. In systems based solely on contact with the coach, such adaptation to the pace and learning method of each recipient is not possible to be achieved while maintaining the mass nature of a message, when it would require an individual approach of the coach to each member of the community.

Based on information on the recipient's current progress, intelligent agents can browse through knowledge resources gathered on the e-learning platform and map the subgraph

knowledge of a course participant in the information graph that makes up the entire course. This allows determining which elements have not yet been assimilated and setting further directions of education. This way, agents become responsible for controlling the excess of information and picking up the most important issues for the recipient.

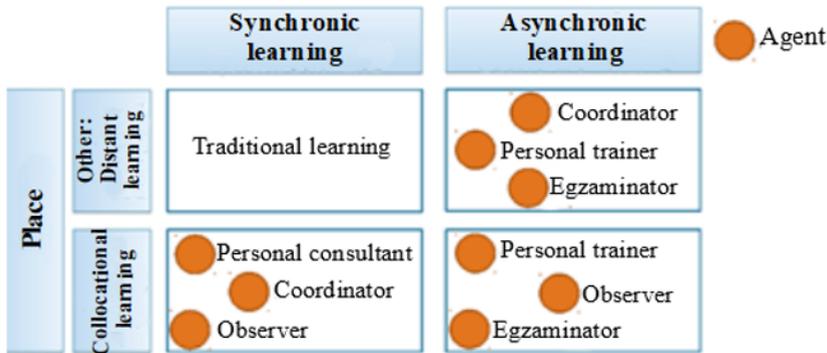


Fig. 1. Types of program agents depending on the training type and its place.

One of the possible approaches is the use of intelligent agents based on the BDI architecture (*belief-desire-intention*). This allows transforming information on the recipient's progress, obtained from a platform that performs remote training to actions of an agent who is to support this process. The use of intelligent agents in remote training brings many benefits to all stakeholders engaged in this process. Not only can they take over the role of officials but also indicate places where the contact between the recipient and the coach should be strengthened [15].

5 Metaheuristics in machine learning for a smart city

A citizen-centered approach to education in the smart city requires using some modern artificial intelligence approaches like machine learning. A high speed, pervasive network infrastructure bargains the break for ubiquitous mobile learning to develop a reality. The smart city can support the supplementary learning: unintended or unintentional education that takes place in any place, in everyday life, at any time, with the city background. This is a result from other activities. It is not novel, but it can be captured as it happens, reinforced at the point of requirement, and used more effortlessly for following reflection and additional learning. Mobile devices are become influential tools for learning. For many citizens, language learning is a serious educational dilemma. It can be sustained within contextual learning by mobile devices and also social networks consisting of other residents, organizations and native volunteers. Successful development involves diverse domain experts to come together like educators, city planners, and technology providers.

A smart city may allow learning everywhere. Mobile education can be combined with incidental learning to propose a powerful new method for city residents. The smart city is an efficient background for ubiquitous learning because some advanced ICT infrastructures are seen as central to the concept of a smart city. It could afford new ways of informing its residents. However, this infrastructure and software require some new techniques like metaheuristics that can applied for machine learning to complete some educational tasks.

Particle swarm optimization PSO, an ant colony optimization algorithm ACO and an artificial bee colony algorithm ABC were inspired by different phenomena, and they have different purposes [4]. Besides some differences in those algorithms, they also share some similarities. They are methods of a swarm intelligence. These algorithms are designed to use decentralized, self-organizing agents and share their knowledge.

PSO, ACO and ABC have a great number of applications. Their implementations may also significantly differ. The algorithm based on PSO and K-means for text documents clustering [15]. It was designed to help an end-user to organize and navigate a large number of documents.

Kurilovas, Zilinskiene, and Dagiene proposed a new learning paths recommendation based on ACO [10]. Finding appropriate learning paths is based on students' needs in terms of their learning styles. It can improve learning results and save their learning time. This fact indicates that ACO for personalizing learning units is practically applicable in e-learning and enhances the learning quality. Hsu, Chen, Huang and Huang proposed the ABC based method for learning resources recommendation that are integrated with Facebook as the e-learning platform for smart city citizens [8].

6 Cloud computing in e-learning in smart city

Cloud computing by providing a service known as VaaS (Virtual Laboratories as a Service) can expand the range of functionality of remote teaching platforms. It enables an educational process in which the teaching block includes laboratory classes using specialized software [14]. For example, each participant can get access to a virtual machine tailored to the requirements of the task. With the help of virtualization, there is a possibility of insight into the learning progress of each participant and the ability to quickly respond to failures in the implementation of tasks that may result in a significant delay in relation to the entire agglomeration community [16].

The above example uses a cloud computing scheme under the name IaaS (Infrastructure as a Service), i.e. providing scalable virtual hardware depending on the needs. This is not the only model that can be used by the smart city e-learning community. A very interesting scheme is also the HaaS (Hardware as a Service) model. This may consist in the provision of specialized equipment by internet connectors, thanks to which the resident will have a chance of encountering the operation of the given device and from processing of results depending on the settings made.

The approach that is used on a large scale is the ability to share a web application. However, these types of applications have their own computing constraints, because they are most often performed on a server machine. Cloud computing provides another model called SaaS (Software as a Service), by means of which it is eliminated by limitations related to the computational capabilities of web applications [17].

The above possibilities lead to the design of a new type of e-learning applications that use already known mechanisms of distance learning systems and cloud computing mechanisms. In this way, you can conduct training courses and adaptation of residents consisting not only of lectures, but also from necessary practical simulations and even laboratory classes.

An important part of e-learning cloud dedicated for informing and learning citizens of a smart city is an efficient infrastructure of the city cloud. We propose a method called ELSA *E-Learning Smart Approach* for improvement the efficiency of a smart city cloud. Decision makers can select criteria to define a goal of optimization. We consider four criteria that should be minimized: \hat{Z}_{max} is processing workload of the bottleneck CPU [s], and \hat{Z}_{max} is communication workload of the bottleneck node [s]. Moreover, we consider E – cost of hosts [\$] as well as E – energy consumption [Watt]. These criteria have some upper constraints that have to be respected to guarantee some project requirements like the balancing of computer load, the balancing of communication traffic, a budget and an energy saving.

Fig. 2. shows a representation of Pareto-suboptimal solutions $\{P_1, P_2, \dots, P_{200}\}$ obtained for four criteria in a criteria space cut $(\hat{Z}_{max}, \hat{Z}_{max})$. Points $P_5, P_6,$ and P_7 are Pareto-

optimal duo to two criteria $(\hat{Z}_{max}, \check{Z}_{max})$. ELSA found a compromise solution characterized by ω^{sal} and the smaller distance 0.49 to an ideal point P^{inf} in the four criteria space than P_5 with the distance 1.32. The normalized distance is $\sqrt{2}$ between P^{inf} and the nadir point N^* .

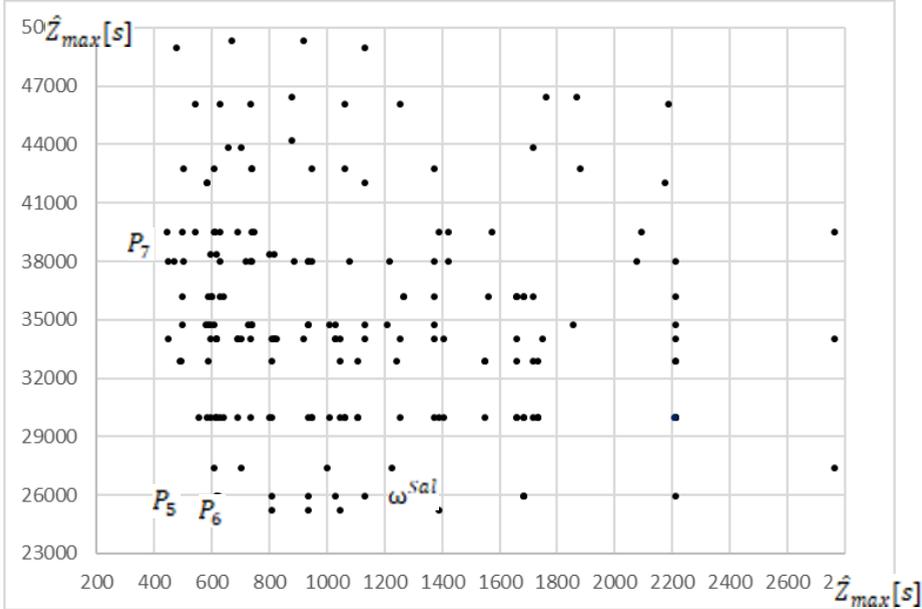


Fig. 2. Pareto front of some cloud resource evaluations for two criteria $(\hat{Z}_{max}, \check{Z}_{max})$

Fig. 3. shows 200 Pareto evaluations found by ELSA for the other cut $(\underline{\mathcal{E}}, \underline{\mathcal{E}})$. The compromise point ω^{sal} has much better evaluations than P_5 . The Pareto front representation X^{sel} is a subset of a set of Pareto solutions X_P^s . Coordinates of an ideal point and a nadir point are calculated regarding the following formulas:

$$P_n^{inf} = \min_{x \in X^{sel}} F_n(x), \quad n = \overline{1,4}, \tag{1}$$

$$N_n^* = \max_{x \in X^{sel}} F_n(x), \quad n = \overline{1,4}. \tag{2}$$

A compromise solution can be selected from the set X^{sel} due to the smallest p -norm value, as below [4]:

$$L_p(x^{komp}) = \min_{x \in X^{sel}} L_p(x). \tag{3}$$

The *Salukwadze's* solution x^{Sal} can be determined for $p=2$ in the normalized criterion space $\overline{\Omega}$, as follows [4]:

$$L_2(x^{Sal}) = \min_{x \in X^{sel}} \sqrt{\sum_{n=1}^N \left(\frac{F_n(x) - P_n^{inf}}{N_n^* - P_n^{inf}} \right)^2}. \tag{4}$$

The compromise solution $x^{p=1}$ can be found for $p=1$, as below [4]:

$$L_1(x^{p=1}) = \min_{x \in X^{sel}} \sum_{n=1}^N \left(\frac{F_n(x) - P_n^{inf}}{N_n^* - P_n^{inf}} \right). \tag{5}$$

The compromise solution $x^{p \rightarrow \infty}$ can be determined for $p \rightarrow \infty$, as follows [4]:

$$L_\infty(x^{p \rightarrow \infty}) = \min_{x \in X^{sel}} \max_{n=1,4} \left\{ \frac{F_n(x) - P_n^{inf}}{N_n^* - P_n^{inf}} \right\}. \tag{6}$$

In many presented outcomes from numerical experiments in the literature, there is determined one compromise solution, only [4]. However, there are four compromise estimations in the studied experiments regarding values of parameter p and the selection between a nadir point or an anti-ideal point. If we choose $p=1$ or $p=2$ a compromise solution is $\omega^{Sal}=(1,240; 25,952; 10,244; 11,630)$. If we select $p=2$ and an anti-ideal point $(3,600; 50,000; 87,500; 22,000)$, an assessment $y(2)=(1,404; 29,973; 13,455; 9,500)$ is equivalent to ω^{Sal} . A vector $y(5)=(1,105; 29,973; 30,352; 11,430)$ is a compromise evaluation for $p \rightarrow \infty$ and a nadir point. A point $y(13)=(1,254; 29,973; 30,895; 11,125)$ is an unexpected compromise evaluation for $p \rightarrow \infty$ and an anti-ideal point.

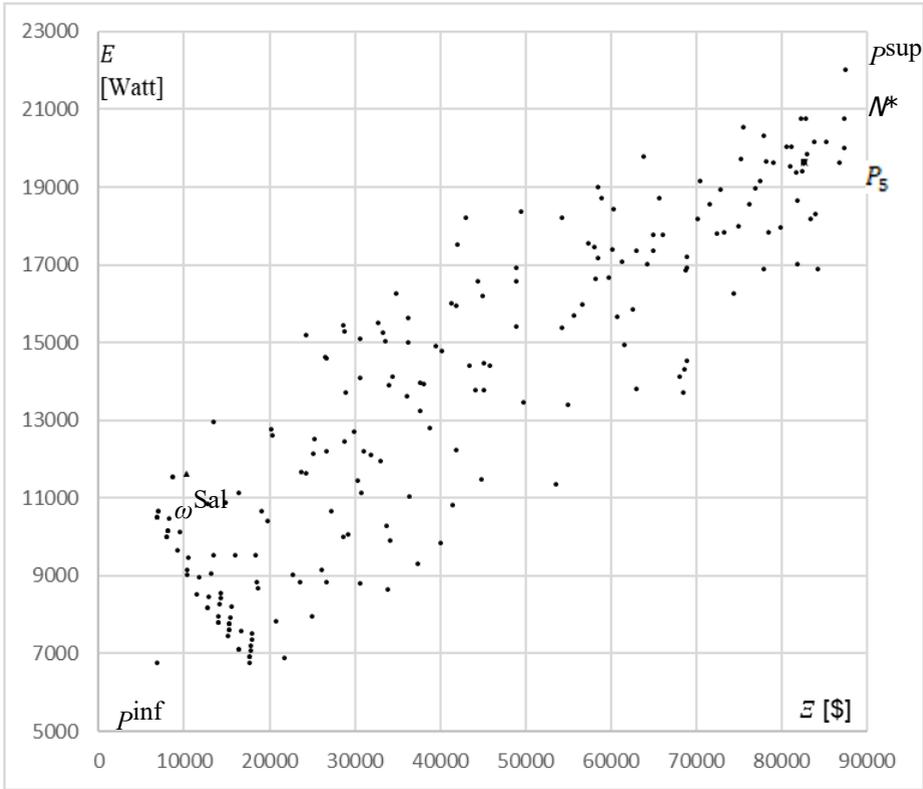


Fig. 3. Pareto front of some cloud resource evaluations for the criteria (E, E)

7 Conclusions

In this paper, social media and some intelligent agent systems have been used to support remote training of residents. References have been made to some selected artificial intelligence paradigms as well as the smart city supporting cloud. It highlights the important role of distance learning in relation to local community. In this case, it is important to identify needs of citizens, and then make the best decisions in a social and individual sense. It also aims to fully inform the public about the details of processes taking place in the immediate environment, as well as to collectively decide and indicate the directions of smart city development.

An interesting course of further research is the development, verification and implementation of selected concepts of artificial intelligence in terms of effective support of e-learning for residents of smart cities.

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