Erzsébet Fejes – Iván Futó

Artificial Intelligence in Public Administration – Supporting Administrative Decisions

Summary: Artificial intelligence (AI) is an increasingly popular concept, although it is often used only as a marketing tool to label activities that are very far from AI. The purpose of this article is to show what artificial intelligence (AI) tools - expert systems - can actually be used for administrative decision in public administration. The end of the administrative decision must be justified in detail according to the legal regulations. Expert systems do this. The other large group of AI tools, solutions based on machine learning, act as black boxes, mapping input data to output data, so the reason for the solution is unknown. Therefore, these tools are not suitable for direct, administrative decision, but can support office work with expert systems. In this article, we present the operation of expert systems through examples.

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The appearance of digitalisation and new technological solutions, as well as the accelerating technological development present serious challenges to public administration, too. Development activities carried out in the area of public administration should keep up with general development. In addition to contributing to the efficiency of operation, up-to-date solutions – through the services extended by them – stimulate other areas, too, from technological aspects. This also means that the low level of technologisation in public services hinders the digital transformation of other areas. This is why it is extremely important to make sure that efficient, economical, digitally advanced and up-to-date public services are available to both private individuals and the players of business areas. The new digital world offers a possibility for building more efficient and more successful connections among authorities, citizens and businesses. Even if there was some resistance to digital transformation before, the past period with the Covid–19 epidemic situation made the importance of digital transition clear to everyone. The situation enforced development

E-mail address: futoivan@t-online.hu

and the introduction of new solutions. It is not easy to keep up with increasing demands and expectations. We need to find methods and tools to accelerate development. Artificial intelligence and its areas, including expert systems, may help us in this.

Our article briefly reviews the six dimensions of digital state as defined by the OECD, the approach used by the EU, the index measuring digital development (Digital Economy and Society Index – DESI) and Hungary's evaluation according to this index. Then we will examine what role could be played by artificial intelligence in the case of electronic public services, which are of key importance from the aspect of the digital development of a country. We will describe expert systems in more detail, and mention machine learning and specific domestic and international solutions, too.

INTERNATIONAL OUTLOOK

Technological development is accelerating, new technologies are related to each other and integrated, and, as a result, newer and newer solutions are born. It is a huge responsibility to make sure that developments, rules and methodologies implemented and worked out in the area of public services and public administration – through the sharing of knowledge and data, too – inspire and support the digital development of the country.

The planning and implementation tasks related to the establishment of the e-government and the digital state are fairly complex. The OECD's Digital Government Policy Framework (DGPF; OECD, 2020) is a tool that facilitates the planning of an efficient strategic approach to the transition to a higher level of digital maturity. For the complete implementation of digital transformation, it is necessary to proceed from e-government to digital governance. Earlier the sector introduced IT solutions to improve efficiency – to support its internal processes –, but now the objective is the digitalisation of the whole public sector. The objective is the transformation of services and the high-level provision of cooperation with stakeholders. The OECD analysis (OECD, 2020) talks about six dimensions in relation to digital state.

Digital by design. Digitalisation is not only technology, but a transformation element to be embedded in processes related to policies. 'Digital' way of thinking should be integrated into processes and operation, it has to be taken into consideration in planning, in the establishment of services and in re-thinking the related internal processes, too.

Data-driven. Digital governance is based on data. Data is required for the provision of services, the planning of measures and the analysis of their impacts. The availability of good-quality data is a basic condition of using artificial intelligence. Measures need to be taken for the efficient and ethic use of data and for the implementation of data control. Among other things, it is necessary to ensure cross-sectoral data standards, data infrastructure and tools.

Government as a platform. The government has to provide clear and transparent guidelines, tools and solutions to make sure that user demands can be satisfied. At government level, the focus should not be on individual services, but on the setting up of a government platform that allows various service providers and non-government parties to get involved in the provision of services that satisfy user demands.

Openness. Openness, access to data and procedures, and the provision of their transparency are basic requirements. Citizens and businesses should have access to the necessary information, should be able to

attend to their business and should have access to government services.

User-driven. User-controlled services need to be established. A successful digital transformation allows the public administration sector to operate efficiently and successfully in a digital environment, and extend simpler and more efficient public services that satisfy user demands.

Proactivness. The state should be able to identify people's demands – in a proactive way – and quickly react to them. This might as well prevent the initiation of complicated administrative processes. Proactive public administration – building on the outlined dimensions – will answer questions *'not even asked yet'*.

Governments need to think in a 'digital' way, incorporate new technologies into their policies and services already from the planning phase. Artificial intelligence is available to governments to build the new generation of public services – that are proactive, predictive and user-friendly.

The EU also gives high priority to digitalisation. The Tallin Declaration of ministers accepted in 2017 (European Commission, 2017) laid down the key principles of the e-government action plan (eGovernment Action Plan 2016–2020).[1] It emphasized that digital transformation may strengthen trust in governments. The signatories committed themselves to establishing open, efficient, border-free, customised and user-friendly digital public services, for both private persons and businesses.

In 2020, one of the six priorities defined by the European Commission (2019-2024) is digital transition. The objective is to promote the comprehensive introduction and spread of key digital technologies such as artificial intelligence based applications (European Commission, 2020a). AI allows for more advanced analytical abilities, and helps the better understanding of real-time processes in economic, social and natural environments. Artificial intelligence may improve interaction among citizens and the government through communication systems, interfaces, multi-language services and automated services. In 2020, in the Berlin Declaration, Member States were encouraged to spend some funds on the establishment of public services applying artificial intelligence, and to give high priority to developments facilitating the more efficient supporting of evidence based decision-making (European Commission, 2020d).

Digital Economy and Society Index (DESI)

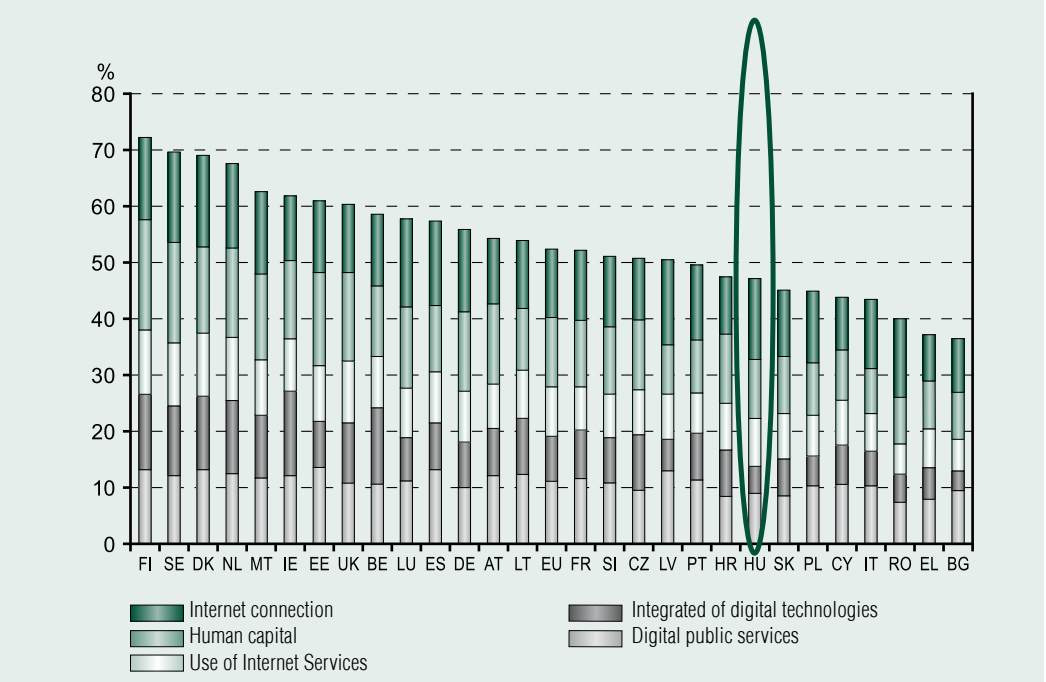
Since 2014, the European Commission has been monitoring the digital development of Member States with reports on the index measuring the advanced status of digital economy and society (Digital Economy and Society Index – DESI) (European Commission, 2020b). The five dimensions of evaluation *(Figure 1)* are logically related, the dimensions cannot be made independent of each other, but their methodological separation allows for the examination of the complex social phenomenon of digitalisation. Based on the DESI of 2020, Hungary takes the 21st place among the 28 Member States of the EU.

Hungary performs best, over the EU average, in the respect of the (broadband) internet access. The Covid–19 epidemic proved how important it was to establish a reliable and advanced basic infrastructure. On the other hand, the country is still rather behind with the implementation of digital public services (5th dimension).

However, the country started to catch up with other EU Member States by establishing related legal regulations and central services,

Figure 1

RANKING IN 2020 ACCORDING TO THE (DESI) INDEX SHOWING THE DEVELOPMENT STATUS OF DIGITAL ECONOMY AND SOCIETY



Source: European Commission, 2020c

and by improving the quality and extending the range of services *(Figure 2)*.

The creation of Act CCXXII of 2015 on the general rules of electronic administration and trust services (e-administration act) was a major milestone, as it created the possibility of introducing and using e-administration in an extensive way (Sántha, 2018). Pursuant to legal regulations, as of 2018, central and local government bodies have been obliged to provide the possibility of using electronic administration, and certain clients are now obliged to maintain electronic contacts with the authorities. More and more good quality services are available on Hungary's Central Administration Portal.

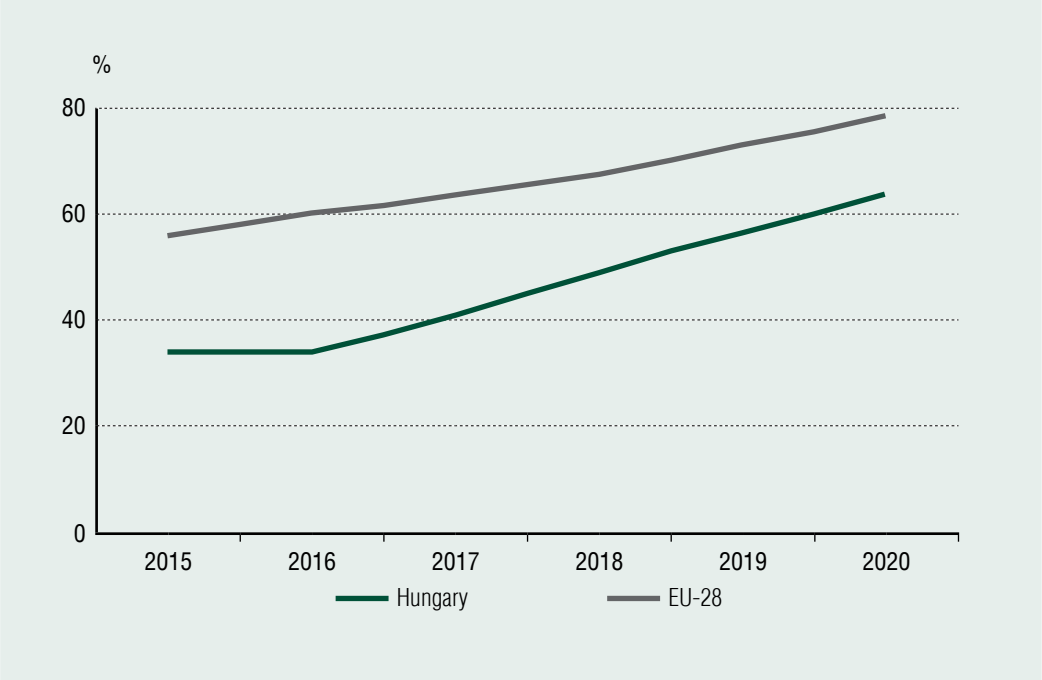
The established electronic contacts and the electronic services implemented with the introduced Regulated Electronic Administration Services (REAS) offer examples and solutions for the setting up of additional public e-services. It is important to know that while central services are available for electronic contacts, individual institutions need to carry out major developments for the complete in-house electronisation of various e-services.

DOMESTIC STRATEGIES – ARTIFICIAL INTELLIGENCE IN PUBLIC ADMINISTRATION

The acceptance of the National Digital Strategy (NDS) is presently in progress at expert and policy level, under the supervision

Figure 2

CHANGES IN THE DEVELOPMENT OF DIGITAL SERVICES (DESI – 5TH DIMENSION)
DIGITAL PUBLIC SERVICES



Source: European Commission, 2020c

of the Ministry of Technology and Innovation. The NDS provides a uniform framework for the future vision and tools defined in government documents produced so far about digitalisation. The Strategy pays special attention to the area of public e-services, and in the case of the 'Digital public services index', it sets a significant improvement (from 57.8 per cent to 75 per cent) by 2030 as a target, for which AI tools are intended to be used, too (NDS, 2020, p. 107).

A number of countries have worked out their strategies related to artificial intelligence, these are nicely summarised by the IVSZ[2] study (IVSZ, 2019) or by an OECD material (OPSI, 2020). In September 2020 Hungary joined the club of countries that have their own AI strategies. The document titled 'Hungary's Artificial Intelligence Strategy 2020–2030' (HAIS)[3] was produced by the AI Coalition[4] under the supervision of the Ministry of Technology and Innovation. Within the AI Strategy, separate points discuss the automation of public administration processes with the help of AI, and systems supporting the supervision of financial and taxations processes (HAIS, 2020; p. 38).

Our article presents the AI tools that are available to implement the above objectives.

As presently it is mainly machine learning that we mean by AI tools, and we talk less about expert systems – symbolic AI (OECD, 2019a; OECD, 2019b, p.19; UKRI, 2020; Wikipedia, 2020) –, we will describe the latter in more detail (Futó, 2019).

The reason being is that substantive decisions

on AI basis in the public sector can only be made with expert systems. Our article will explain the reason for that, too. Their application is mentioned by the HAIS as 'online self-service administration with the support of an expertise system' (HAIS, 2020, p. 15).

BASIC ACTIVITIES OF PUBLIC ADMINISTRATION INSTITUTIONS

The application of the tools of AI is examined from the aspect of the basic activities carried out by public administration institutions (Futó, 2020). AI solutions may be used in the area of defining institutional policies/strategies, making administrative decisions and providing information, as well as for other institutional activities and internal daily routine tasks. Administrative decisions, which may be initiated by both citizens and authorities, form an area of high priority in our article. Administrative decisions always involve the making of some kind of decisions. We can talk about cases without deliberation (normative regulations), and cases with deliberation. The concept of decision is defined by Article 81 (1) of Act CL of 2016 on general public administration procedures:

'The decision shall contain all data and information required for the identification of the competent authority, the clients and the case (…), ascertained facts of the case, the evidence available, explanation for the specialist authority's assessment, the reasons for deliberation and the decision, and the specific statutory provisions on the basis of which the decision was adopted.'

THE AI SET OF TOOLS

The simplest way to present the set of tools used by AI is the diagram titled 'AI conceptual overview' produced by the AI Coalition *(Figure 3).*

The diagram illustrates that we can basically talk about two types of AI tools, the machine learning system (Machine Learning – ML), and the expert system (Expert System – ES).

However, it is worth noting that 40 per cent of developments called AI have nothing to do with artificial intelligence (Schulze, 2017).

Machine learning

Machine learning is considered as a subset of artificial intelligence. Machine learning algorithms build mathematical models based on sample data, and make predictions or form opinions without being explicitly programmed to do so.

The most important machine learning methods are *(Figure 4):* supervised learning, unsupervised learning, reinforced learning, deep learning (Burns, 2020).

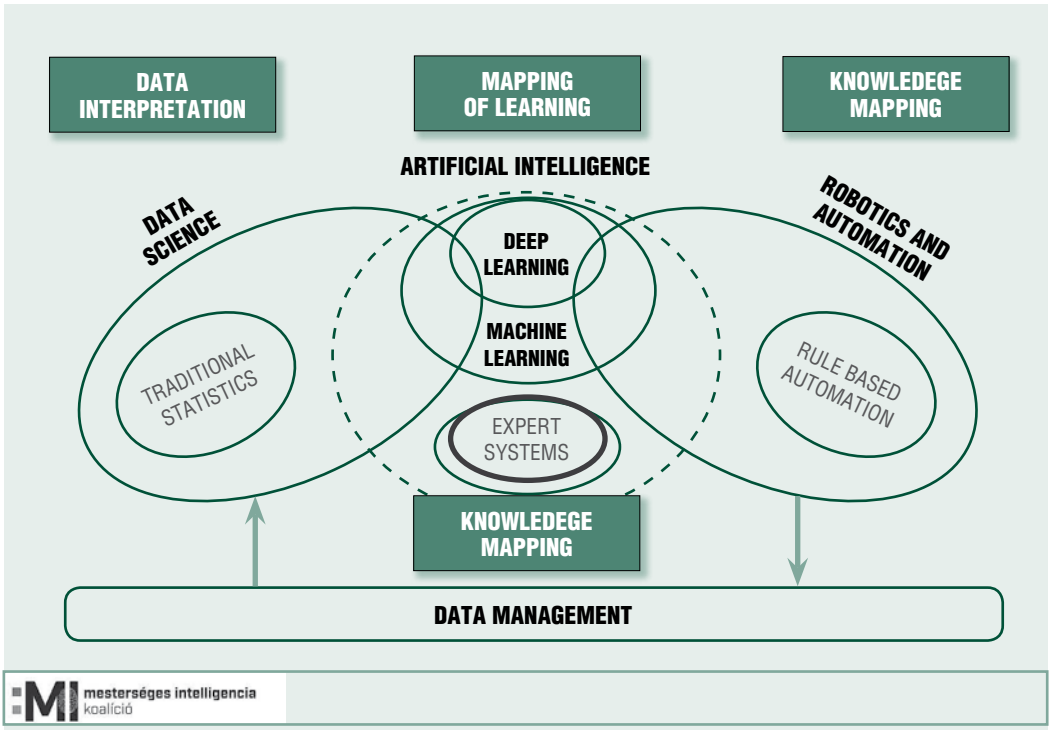
Machine learning algorithms map input data to output data, but do not show the method of mapping, they operate as black boxes.

Consequently, they are not suitable for making direct and independent administrative decisions – see the earlier definition of administrative decisions – but may do the preparations and offer support.

Substantial funds are already being spent on the so-called XAI – Explainable AI projects – and the amount will increase in the future – in order to get explanations regarding the results of machine learning (Grunning, 2017; Horizon, 2020). However, it remains to be seen whether or not these efforts will be successful. The HAIS identifies '*Developing a reliable AI'* as a research direction, where the focus is on making the models' decision-making mechanisms explicit or on the development of hybrid models (interpretable decisions), so

Figure 3

AI CONCEPTUAL OVERVIEW



Note: It was presented on the first professional day (12. 02. 2019) of the AI Coalition.
Source: own edited

that the technology could be used in critical decision-making situations, too.

Models based on machine learning are often used for producing predictions. The point in predictive analysis is to analyse our data and – learning from history data by using statistical and machine learning solutions, and based on past behaviour and events – to declare whether future events are probable. Considering the results achieved this way, we can take steps to assist or hinder the emergence of the expected events. Predictive analysis allows us to predict future events. It is possible to reverse it, too, as we can find out what basic conditions are required to make sure that a future event happens.

For a high-quality machine learning model it is imperative to have good data. Learning should be based on good quality input data, and the correct nature of predictions should be checked with continuous feedbacks. Staying in the area of public administration, this can be greatly strengthened if the data is used by as many people as possible, as their feedback would improve the quality of data.

If we see the data held by authorities about us (either taxation, or medical data), we are able to indicate the errors. We know best whether data recorded about us is correct or not, and it is mainly our interest to correct the data. Feedbacks are important within the operation of authorities, too. For instance, if we use the results of a risk identification model and the input data in the audit conducted, we can immediately indicate possible differences or errors. The world of data and the relations

Figure 4

MAIN TYPES OF MACHINE LEARNING

Machine learning			
Supervised learning	**Unsupervised learning**	**Reinforced learning**	**Deep learning**
It requires human intervention, it is necessary to specify what output variables - values, classes - belong to the input data of the learning set - "labelled data".	There is no need for "labelled" data, when the end result is provided on the basis of former observations, teaching the model.	The computer application performs a task in interaction with the environment. In the course of the interaction, the environment gives feedbacks, as a result of which the application modifies its behaviour to better adapt to the conditions.	The concept of deep learning algorithms was inspired by the biology of the human brain, this is why deep learning is often mentioned together with Artificial Neural Networks (ANN).
Regression	*Grouping*		*Artificial neural net*
It helps in predicting target variable values	It attempts to find data groups (clusters) in the data set that are not immediately obvious for the human observer because of the large number of variables.		They usually use nets with two or more hidden layers. The input layer receives the input data, each neuron receives one particular type of data. The hidden layers perform mathematical calculations on their inputs, they usually add up their values. *(Figure 5).*
Classification:	*Association data mining*		
It tells us the category a new data point will belong to.	It attempts to find rules and connections - relations - among the elements of large data sets.		
	Main component analysis		
	This procedure transforms multiple independent variables to a lower number of new independent variables.		

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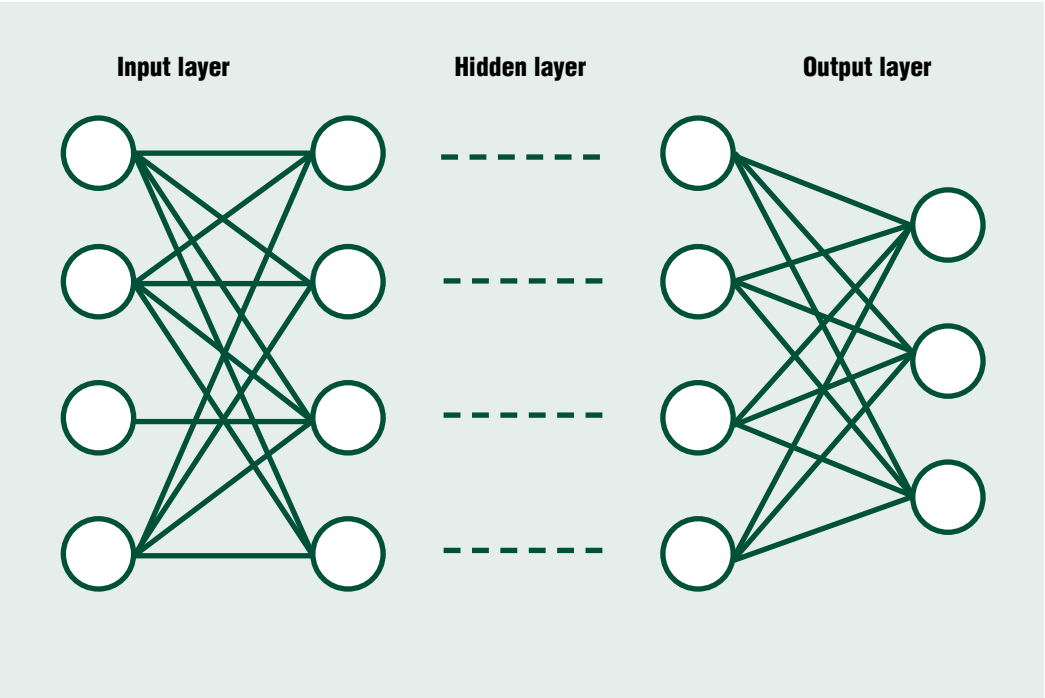
Figure 5

THE ARTIFICIAL NEURAL NET



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among data items map reality 'in some way', and the question is how accurately?

Good quality decisions are based on good data, and this refers to both human decisions and decisions supported by artificial intelligence.

Within public administration, where can we use machine learning in a targeted way? We have to add 'in a targeted way', because nowadays we can meet the tools of AI in everyday life and in business life without even noticing it. Applications utilising AI tools have been incorporated into daily work, they have become parts of our daily activities – just think of various search engines or smartphones. We are starting to use AI solutions in the way we use electric energy – we do not care where it comes from and who produces it. What we have to see, though, is that the necessary standards do not exist yet.

In public administration, AI tools were introduced at places where the work – considering the large number of cases, their complexity, the availability of extremely large volumes of data – requires or – so to say – forces the introduction of new technologies (see the section About a few AI systems implemented/ under implementation abroad and in Hungary).

Expert systems

An expert system is a computer application emulating the decision-making ability of a

human expert. It is designed to solve complex problems by reasoning through bodies of knowledge represented as *if-then* rules (if>then, then<if) rules. These applications are able to explain their questions and deduced results – *'why and how, why not and what if'* functions. When asked, they show how they came to a question or a statement, and they are able to present the provisions of legal regulations used by them (expert system 4.0). However, it has to be noted that it is not only the programming with *'if>then'* rules and the provision of the *'why, how, why not and what if'* functions that make an application an expert system, but also the fact that it has a logical deduction mechanism.

Expert systems are built with Expert System Shells, which automatically ensure the above characteristics (Multilogic, 2007; Exsys, 2016; Oracle, 2010; Multilogic, 2020).

Now we are going to review the key services of a typical expert system – in this case, it was produced with the Emerald Shell (Szőke, Förhécz, Kőrösi, 2013) *(Figure 6)*.

The Document Store contains the documents that form the basis of building the knowledge base: books, articles, expert's compositions, training materials, legal regulations etc. The Document Store has a time machine, and maintains the individual versions of documents.

Thesaurus – Glossary, allows for the uniform usage of terms, as well as integration with other systems and databases. The so-called ontology structure is used for the presentation of terms (Gruber, 2009).

The Annotation in our case is the allocation of the basic units of a source document (paragraphs) to one or more terms or rules (services). Explanatory notes may be added to the documents. It is also possible that the expert system implementing the interpretation of documents refers to relevant parts of documents to support results/partial results, facilitating the better understanding of conclusions or deduced solutions.

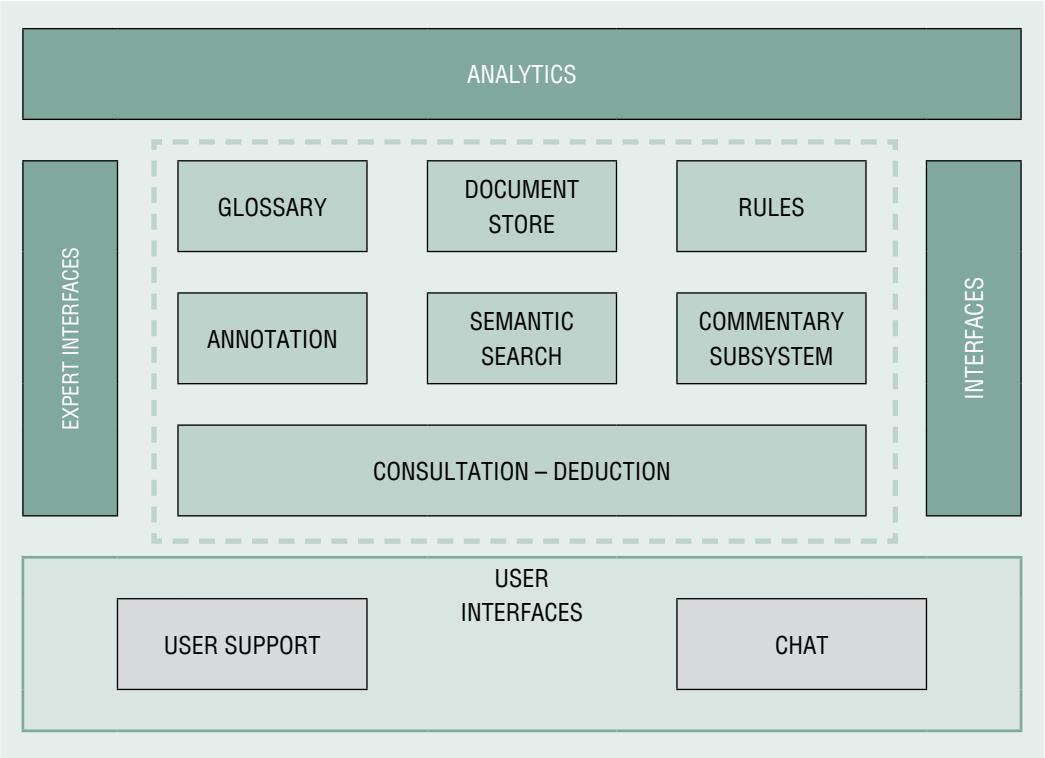
The Commentary subsystem supports the sharing of knowledge within the organisation. It is necessary in many organisations to search for information regarding legal regulations, to share knowledge, to transfer information and it is often necessary to interpret individual sections of legal regulations. It has a double function: on the one hand, it offers comments to legislators – written by their own community –, i.e. it is a knowledge-sharing platform, and on the other hand, it allows legislators to monitor the emerging practices related to individual legal regulations (especially the new ones) in 'real time'.

Semantic search is a modern search service, and there are high expectations in connection with it (Precognox, 2010). The same search result should be provided for the various grammatical (morphological) versions of words. The programme must be able to identify the synonyms of expressions, and the answer given to a searched expression should be determined not only by matching words, but by exploring broader conceptual relations. It is necessary to manage searches and questions entered in natural languages, and a proper reaction is needed when the user defines the required term in the form of a question. The answers should be found by analysing the sources, and not on the basis of user indications, links and artificial accessories, i.e. should not be based on statistical observations or user behaviour. The definition of the sequence of items found should not be based on artificial measurements (popularity, user reactions etc.).

The Consultation service is an expert application built on *Rules*, and allows the replacement of human expert knowledge with the tools of artificial intelligence in certain cases. By using semantic technologies (OWL, 2012; and SWRL, 2004) it is possible to

Figure 6

SERVICES OF AN EXPERT SYSTEM SET UP WITH THE EMERALD SHELL



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represent the identified rules with IT tools. *Figure 7* shows examples for the rules.

Rules. The first rule is a general statement saying it is possible to register for the small taxpayers' itemised lump sum tax (KATA) if the business is eligible for KATA and there are no grounds for exclusion.

The second rule defines what kind of businesses are eligible for KATA.

The Inference mechanism plays a special role in the consultation service. Traditional programmes work with a so-called top down strategy. This means that the original target – procedure call – is matched with a procedure in which the consequence part – head – may be made identical with the target call, and once the matching is done, execution continues with the procedure calls in the body of the matched procedure. This continues until we get statements – facts – with empty bodies, or questions that need answers.

However, there is another, a so-called bottom up strategy, too. In this case, facts without 'if' parts – which are always true – or the questions to be answered are taken. Then they search for rules, the preconditions of which can be matched with such facts, or expect an answer to a question. They are matched – 'fired' – and the consequence is entered into the knowledge base as a new statement of facts. This continues until a statement of facts that can be matched to the original objective is received.

Up-to-date expert systems, such as

Figure 7

RULES

LEGISLATION		MODEL
EXACTLY WHEN the business may register for KATA IF the business is eligible for KATA NO business 'there are grounds for exclusion'		
3. Article Businesses eligible for KATA a) private entrepreneur, b) sole proprietorship, c) limited partnership with private person members only d) unlimited partnership with private person members only e) law office	→	EXACTLY WHEN the business is eligible for KATA IF OR form of business = ‚private entrepreneur' form of business = ‚sole proprietorship' form of business = ‚limited partnership with private person members only form of business = ‚unlimited partnership with private person members only form of business = ‚law office'

Source: own edited

Emerald, which is used for our article, use the two strategies in turns for deductions. In the first step, they start from the top and go down, then, in the next step, they use the bottom up strategy, proceeding toward the solution, using both strategies in turns, which in theory leads to an optimal solution, so no redundant questions are asked.

Naturally, the above description of the strategies is rather general, and they can be refined in practice.

Thus, in the course of solving the problem, the expert system goes through a *deduction* chain: starting from the objective which is *'The business may register for KATA'* in our case. Then we search for a rule the consequence of which – *'EXACTLY WHEN'* – can be matched and made identical with this goal. It is obvious that our first rule is like that. After matching, a new series of goals are created, *'the business is eligible for KATA'* and *'NO there are grounds for exclusion'*.

Then, changing for the *'bottom up'* strategy, we look for a statement of facts or a question to be answered. In our case, this is the *'sole proprietorship'* answer, so the '*form of business=sole proprietorship*' will be recorded in the knowledge base. At the same time, the precondition of the second rule is also satisfied, and the *'business is eligible for KATA'* statement is recorded in the knowledge base as a consequence of the second rule. The *inference engine* now returns to the *'top down'* strategy, and as the precondition of the first rule can be matched with the newly recorded statement of facts, it proceeds to prove the

second condition, (6) *'NO business 'there are grounds for exclusion'* see *Figure 8*.

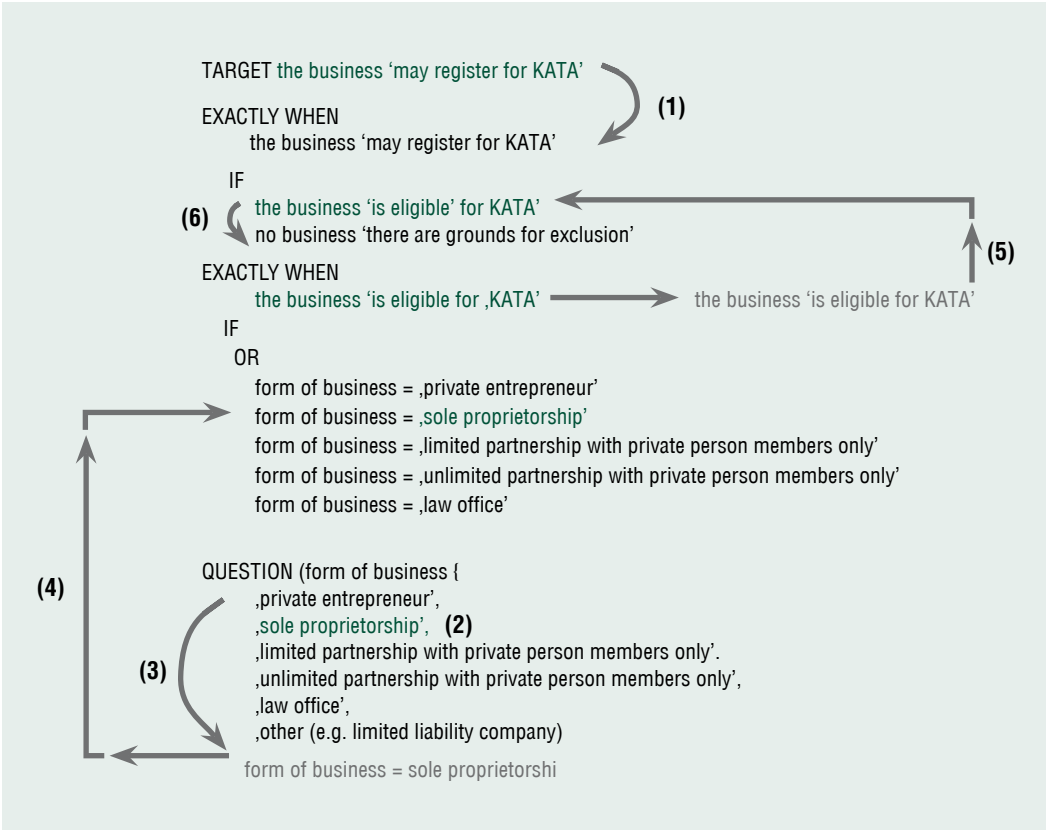
Another advantage of using such an inference engine is that in the course of creating a model, there is no need to walk through the search tree in advance and explicitly specify the method of walk-through – deterministic programming –, but producing the 'model rules' according to certain parts of legal regulations, the inference engine matches them in the way described above – non-deterministic programming.

Explanation is a distinctive feature of expert systems, as they explain the questions asked and the solution itself if requested, in the course of deducing the solution. What it means is that if an expert system asks a question, we can ask for the presentation of the steps that led to the need to ask the question. The same is true for results, too. Another option is to inquire and present the details of the document that is behind the individual steps of deduction and proves the correctness of the conclusion.

Let us assume that the task is to decide whether a sole proprietorship may register for KATA. In our case, this is done on the basis of Act CXLVII on the fixed-rate tax of low tax-

Figure 8

REASONING



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bracket enterprises and on small business tax. The solution is shown by *Figure 9, Figure 10, Figure 11* . Screen images produced with the Emerald system can be seen for instance at Futó (2020a, 2020b).

In the course of the consultation, the inquiring party answers the questions stipulated by the law.

To the question 'Does the business rent out its own property?', the answer was 'yes' , so the decision is that the inquiring party may not register for KATA, Figure 9.

But why not? If you click on (°), you get the answer in Figure 10, where you can see the process of deduction – which shows that there are grounds for exclusion. In this case it is that 'the business rents out its own property'.

Now we would like to know the legal basis of the decision. If we click on the rule that is important for us in the explanation – *there are grounds for exclusion* – the expert system shows the affected part of legal regulations (Figure 11).

The use of the consultation services of the expert system may be supported by a chat function. The chatbot is a computer programme or an artificial intelligence application, which conducts a voice-based or written (text) chat with a communication partner (Shevat, 2017; Szűts, Jinil, 2018; Magnucz, Baksáné Varga, 2020). These programmes are designed to convincingly simulate people's behaviour during a conversation. Chatbots are usually used in dialogue boxes to collect information, or at customer service units to answer questions. This is where the various AI solutions, expert and machine learning systems meet. The purpose of using chatbots with expert systems is to 'escort' the user to the dialogue environment of the expert system as soon as possible, where the inference engine can be used to directly ask questions leading to the solution of the problem.

Under the User support, the customer service officer is able to take over the history of the consultation conducted so far, and he can continue asking questions, while explaining the reasons for the questions or the terms used in the question if necessary.

Expert shells provide interfaces for administrators, experts 'teaching' the system, and advanced Analytics functions to managers and analysts. Integration with other, for example professional systems through interfaces is allowed by the applied XML structure, which is important to use to make sure that the information defined with IT tools (expert applications, term dictionaries) could be connected and interpreted with the usual natural language representation. (MetaLex, 2010).

WHAT KIND OF INSTITUTIONAL ACTIVITIES CAN BE SUPPORTED BY THE VARIOUS AI TOOLS?

Now we are going to examine what kind of activities in public sector institutions can be supported by AI tools – considering the grouping presented in the previous chapter –, and how we can use individual AI technologies for the IT systems of the public sector.

Support to the definition of institutional policy/strategy

Machine learning systems may facilitate the transformation of the large volumes of unused data held by institutions into decisions. They may define groups that show similar behaviour, so they can be targeted subjects of given programmes.

When combined with location and time data, the aggregation of data may lead to new recognitions in areas such as responses to

Figure 9

THE CONSULTATION

(*) Enter the form of business	× newly established business
	○ already working business
(*) What if the form of business?	○ private entrepreneur
	× sole proprietorship
	○ limited partnership with private person members only
	○ unlimited partnership with private person members only
	○ law office
	○ other (e.g. limited liability company)
(*) Does the business rent out its own property?	× yes ○ no

Result

(*) the business may not register for KATA

Source: own edited

Figure 10

EXPLANATION OF THE DECISION

(–) Not satisfied that registration for KATA is possible
the business may be registered for KATA
if
the business is eligible for KATA
and there are no grounds for exclusion

(–) Business there are grounds for exclusion
there are grounds for exclusion
if
or
the type of the business is newly established business
and the business rents out its own property
or
the type of the business is already operating business
and
or the tax authority deleted the tax number of the business in the year of reporting or in the 12 months before
or the business rents out its own property
or at the time of requesting registration the business is under dissolution, liquidation or forced deletion procedure
or the registration for KATA was terminated in the relevant year or in the year before

Source: own edited

Figure 11

SECTION OF LEGAL REGULATION USED FOR THE DECISION

Not satisfied that registration for KATA is possible the business may register for KATA if the business is eligible for KATA and there are no grounds for exclusion **(–) Business there are grounds for exclusion** Then there are grounds for exclusion if or the type of the business is newly established business and the business rents out its own property or the type of the business is already operating business and or the tax number of the business was deleted by the tax authority in the year of reporting or in the previous 12 months or the business rents out its own property or at the time of requesting registration the business is under dissolution, liquidation or forced deletion procedure or the KATA registration of the business was terminated in the relevant year or in the year before	... businesses started during the year include business associations established by transformation, merger or separation, and selecting the taxation method specified in this act of law. (3) A business that had its tax number deleted by the tax authority in the year of reporting or in the 12 months before may not select this type of taxation. **(4) A business may not register for this tax if it had revenues from activities classified as 68.20 Renting out and operating own or rented property specified in the Activity list of self-employed businesses or in the TEÁOR 2008 (classification of economic activities) in the year of selecting this type of tax.** (4A) The business may not register for this tax if it is under dissolution, liquidation or forced deletion procedure at the time of requesting the registration. (5) The state tax authority informs small taxpayers about their registration for the small taxpayers' itemised lump sum tax in a letter. The information contains in particular *a)* the business's name, description, address of its seat and tax number; *b)* the start date of the registration for the small taxpayers' itemised lump sum tax; *c)* the name, address and tax identification number of the registered small taxpayer; *d)* in case of a full-time small taxpayer legal status, this fact; *e)* the amount of the small taxpayers' itemised lump sum tax to be paid ...

Source: own edited

emergency situations, environment observation, crime prevention, and may promote proactivity in administration too.

With the use of expert systems – simulation – it is possible in theory to predict the possible impacts of a planned act of law. Simulation means 'playing' with the expert system that models the act of law, and trying out different options by making modifications. Depending on the results, we can select the 'best' version (Futó, Várkonyi, 1993).

Support to administrative decisions

As we saw above, systems using machine learning are not able to give explanations – they are black boxes –, so they are not suitable directly for making administrative decisions.

Administrative decisions on citizens' initiative

These are the cases when citizens turn to administrative institutions with a request,

asking for a solution to their problem. Then, in the case of a procedure based on normative regulation – nondiscretionary decision making –, an expert system is able to act fully and legally, replacing the work of an administrator. As we can see in the Explanation part, an expert system, based on its services, is able to satisfy the provisions of Article 81 (1) of Act CL of 2016. What is more, it satisfies the provisions of GDPR[5] regarding electronic decision support systems, which stipulate that the possibility of giving explanations on request should be provided.

In case of discretionary decision making when the administrator has the possibility to choose between different solutions, the expert system can be used for consultancy only, not for decision-making. The decision – presenting the details of legal regulations applied, too – may be communicated to the applicant (see the section titled Expert systems).

If the expert system is directly connected to the back-office systems, it is able to do automatic administration.

Administrative decisions initiated ex officio

In this case, administration often consists of two phases. First, the scope of persons to be involved in the administration is defined, then individual transactions are carried out in connection with stakeholders. The scope of affected parties is defined with machine learning, while individual transactions may take place with the support of the expert system, see the previous section.

Generation of resolutions

Resolutions are always about some kind of decisions. As we have seen before, decisions need to be justified, therefore the applied provisions of legal regulations are always listed.

In practice, there are solutions where so-called 'templates' are produced for possible decision versions, the volume of which is several hundred, and they are identified, then 'filled in' at the end of the solution.

This is a rather 'laborious' solution, as every time a legal regulation is modified, the programme and the affected templates have to be modified.

In a proper expert system no templates are required, the applied section of the legal regulation is presented for the decision point.

If we 'print' all the sections of legal regulations used for the chain of deductions applied in decision-making, we get the proper justification of the future resolution in a dynamic way – depending on the decision. All this takes place without the application of individual templates, improving the maintainability of the application.

Provision of information

Both the expert and the machine learning systems may be able to provide information. In fact, the real thing is the combination of these two. With the support of machine learning, it is possible to produce natural language understanding and speech understanding applications and applications with machine vision (Amsler, 2019). The machine learning application in itself may be able to give answers requiring one-step deductions, e.g. opening hours, address etc. (Mándó, 2019, Juhász, 2020).

The real service may be provided by the citizen/administrator communication interface – the chatbot – and the expert system behind them, where the learning machine application asks the user to precisely explain his/her problem, then invites the proper expert system to decide if that can be solved.

Most chatbots already work that way; with machine learning they understand the question (natural language understanding and speech understanding), then, having identified the questions, call the programme behind

them – workflow – or a human administrator which/who 'solves' the problem (Vanda, 2020; EON, 2018).

This workflow may be replaced by an expert system that offers additional services.

Internal daily routine activities of institutions

These activities are supported by 'traditional' IT tools. Some of them could be replaced by expert systems, utilising the high level of modelling, but if no explanation is required, this is not necessary. In this case, it is possible to introduce applications using machine learning and RPA solutions[6] supported with AI, too (for instance, knowledge management, search engines, word processing etc.); see the section Pre-processing applications (robotic process automation – RPA) for more details.

ADMINISTRATION, MAPPING OF LEGAL REGULATIONS

In the case of transactions initiated either by the citizen, or the authority, the same systems may offer solutions for the same issues, along the same algorithms. This ensures that individual transactions – independently of the party who initiated them – are carried out in the same way, and the related information is correct, accurate and up-to-date.

In the public sector, legal regulations can be considered as the high-level specifications of IT systems. Earlier (see Figure 7) we presented how the model of a legal regulation or one of its rules may look like (programmes in the traditional sense).

Modelling with a rule-based expert shell has a number of advantages. Rule-based approaches and rule-based programming are not more complicated than implementation with traditional tools[7]. Public administration systems are usually based on normative legal regulations, which are relatively easy to adapt to rule-based applications. This way models are easy to understand for non-IT specialists, too. An automatically created rule graph makes the application easy to understand, and the spill-over impact of modifications can be immediately followed.

With a little investment, the details of underlying legal regulations can be allocated to the rules. In this case, changes in legal regulations can be automatically shown after the recording of the new version in the document store. Earlier rules in the knowledge base that belong to the modified provision of the legal regulation – traditional programme parts – are automatically shown and can be modified if necessary (*Figure 12*).

The documents in the document store behind the system and the versions of the related models can be updated at the same time.

Applications are easier to maintain. The ability to provide explanations may be used in testing, too, to detect modelling errors.

AI TOOLS THAT CAN BE USED IN THE IT SYSTEMS OF THE PUBLIC SECTOR

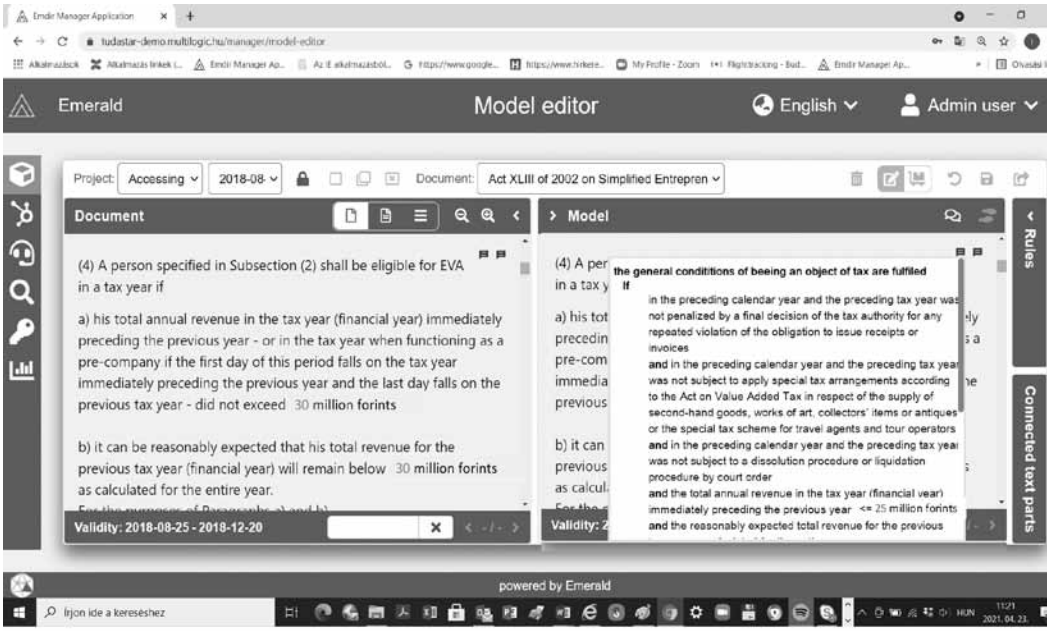
Now we are going to review the AI solutions that can be applied with the IT systems of the public sector, discussing four areas of use.

Support to customer service activities (front-office)

In the case of telephone customer service, it may be a good solution to introduce expert systems integrated with professional systems. On the basis of the original question asked,

Figure 12

MODEL ('PROGRAMME') RULE BELONGING TO THE DOCUMENT SECTION THAT CONTAINS THE MODIFIED VALUE



Source: own edited

the administrator goes through the dialogue offered by the expert system, has a dialogue with the client, answers the questions of the expert system, and gets to the final answer. During the process, using the explanatory services of the system, he/she can explain his/her answers if necessary, citing the required legal background. With a correctly implemented legal regulation based expert system, a complete and lawful decision can be made, even an expert of the area could not decide in any other way.

The training time of administrators will be reduced, in an extreme case, it will only be the time required for learning the management of the expert system.[8] This requires the system to possess all the 'knowledge' of the given professional area. It is necessary to have a correct and complete legal background, if we want to record only the contents of legal regulations in the expert system. Naturally, the consensus based knowledge of the experts of the given area can also be entered into the system, if the area is not subject to normative regulations.

On-line and direct service to clients

This is different from the customer service implementation as the ability to give explanations is not necessarily provided, and the dialogue is not necessarily performed with the human operator, but with the expert system.

However if the application gives an explanation, too, it is advantageous to give it

in an easy-to-understand every-day language, and not in the complicated legal language of regulations.

The advantage of this solution is that we answer the questions at a uniform level, operators themselves and their knowledge are immaterial, as they are not present.

It should be ensured that the client could switch to communication with a natural person any time, and the operators should see how the person got to that given point (assistance service). It is a precondition of on-line administrative decisions that the expert system communicating with the client is connected to the background and professional systems.

The use of expert systems improves user experience, and they ask relevant questions only, so consultation or administration takes less time.

Pre-processing applications (robotic process automation – RPA)

In most cases, the RPA is used for IT support tasks. It is mainly used for activities that are not in contact with clients, where they can be used efficiently. RPA accelerates the processes and improves the quality and the efficiency of the service. Another advantage is that there is basically no need to modify the existing IT systems because of the RPA, and there is no need to carry out huge system integration tasks. Similarly to expert systems, RPA solutions sit on the 'top' of the professional systems, or they are before them in the sequence of processing, so they can communicate with the professional systems through interfaces. A working solution might be introduced even in weeks for individual processes. When a process changes, the RPA solution can be adjusted to the new process within a short time, there is no need to start change management projects of several years (Boulton, 2018; Wikipédia, 2019).

In our case, they can do the pre-processing of incoming information for both customer service and background systems (e.g. reading e-mails or forms, opening attachments, inserting data from the attachment to a target application, checking whether a form has been fully filled in, sending reply messages, performing calculations etc.).

Implementation of background processing systems (back-office)

Expert systems may be advantageous for back-office systems, too.

The applications implemented with the present expert shells already require relatively low memory and processing capacity. Used for the implementation of back-office or professional systems, statements said in Administration, mapping of legal regulations remain true.

Because of the large sizes, it is especially important to automatically show changes in legal regulations after their recording in the document store, and to automatically show earlier rules belonging to the modified legal regulations – traditionally programme parts – and to be able to modify them if necessary (Figure 12).

As far as back-office processing is concerned, the introduction and the spread of more AI solutions (possibly in integration with RPA or expert systems) can be expected with the development of new technologies. In the interpretation and processing of rules (legal regulations, other rules) that form the basis of expert systems, and in their preparation for the expert systems, the introduction of machine learning and software robots may increase the scope of application for professional systems, too.

ABOUT A FEW AI BASED SYSTEMS IMPLEMENTED/UNDER IMPLEMENTATION ABROAD AND IN HUNGARY

Based on the above points, in the area of the public sector it is mainly the performance of various transactions where the use of expert systems offers great potentials. Apart from transactions, they can play important roles in audits, self-revisions and various evaluation processes (assessment of tenders, loan assessment etc.). The earlier cited part in the Hungarian AI strategy refers to that.

A large number of AI based solutions operate in a number of countries around the world. Administrative solutions using machine learning are for instance (OPSI, 2017; BIT, 2017; Machony, Albrecht, Sensoy, 2019). Applications produced with the expert shell operate for instance in England (ESI, 2020), in Australia (IVAG, 2020), in Netherlands (EDO, 2018), in New-Zealand (CSCL, 2020), in the USA (e-HASP2, 2006; Alimony, 2018).

In fact, large suppliers like 'be informed', Exsys, ORACLE report on their websites various applications produced with expert shells. However, the majority of these use high-level modelling – rule-based programming – only.

Presently, we are aware of two such applications in Hungary: the Treasury's Téba (eGOV, 2013) and the National Customs and Tax Administration's (NCTA) Eskort (Lethan, Jacobsen, 1987) systems. Téba is an OPA (ORACLE, 2017) based solution, in which the option to provide explanations is not used (KIFÜ, 2012). The Eskort, an expert system purchased in 1999 to support VAT audits, is able to make one-step deductions only, but with explanation.

In Hungary, an example for AI based administration support initiated ex officio is the NCTA's Flexible Tax Audit Decision Support and Data Mining System (RADAR) (Vikárius, 2009). The RADAR system was implemented with the purpose of increasing the efficiency of audits – to assist risk analysis and more efficient selections. Based on the audit results of cases examined before, the system looks for those features of the cases that are very likely to have led to high tax deficits, and makes deductions for the future. The system contains a wide range of data, and they are connected in the RADAR with taxpayer focus. Analysis uses logistic regression – machine learning – too, for the evaluation. The implementation of predictive analysis in the organisation significantly contributed to the improvement of the efficiency of audits.

The implementation of the Prime Minister's Office Knowledge Base project is currently in progress (Prime Minister's Office, 2017), in which the 16 expert systems produced in the Emerald *(Figure 13)* would be able to support 30 per cent of the annual 12 000 000 transactions. With another 12 expert systems, 70 per cent of the transactions could be supported. It is a question of decision and integration whether they would be used for the provision of information or decision-making.

However, it is an interesting question why are there no expert systems in the Hungarian public administration?

One of the reasons is 'historical'. Following the change in the political system, large state institutions and state-owned companies that pursued significant AI R&D activities of international level were mainly closed or privatised – with the exception of the MTA SZTAKI (Institute for Computer Science and Control), owned by the Hungarian Acadamy of Science.

Researchers found jobs as employees, and were mainly involved in the sale of the products of foreign companies, so AI – expert system development – virtually disappeared.

Figure 13

EXPERT SYSTEMS OF KNOWLEDGE BASE

Life situation	Type of transaction	Number of transactions completed
Documents, operation of vehicle (OG)	Request for issue or replacement of private passport in normal, extraordinary, urgent and prompt proceeding	399 114
	Request for issue of beginner driving licence	199 635
	Request for replacement of driving licence	984 619
	Request for re-issue of driving licence	87 547
	Request to issue permanent identity card	687 937
	Request to replace or re-issue permanent identity card	1 005 409
Retirement (NYU)	Request to determine old-age pension	35,126
	Request to determine women's preferential old-age pension	12 241
	Request to determine widow's pension	11 071
	Initiation of pension insurance data reconciliation procedure ex officio or on request	7 052
	Special request to increase old-age pension	6 927
Family (CSA)	Request to determine eligibility for family allowance (child raising support, education support)	95 262
	GYES - Request to determine eligibility for child care allowance	41 334
	GYET - Request to determine eligibility for child raising support	12 452
	GYED - Request for childcare benefit	12 069
	Request for infant care benefit	8 004

Source: Prime Minister's Office Knowledge Base

We would like to highlight two other obstacles to the introduction of such systems (Futó, 2019, pp. 61-62). There were no authentic 'champions'. The first initiative to implement a knowledge-based application usually comes from a supplier. If the bidder is a large multinational company, it had a long list of references in the given area. But the real question is who needs to be convinced about the usefulness of the future application? The potential supplier has to find a 'champion' within the institution, who understands – perhaps already knows – the key elements of the operation of the proposed solution, and who is an authentic person willing to support the project, even 'campaign' for it.

If the application of knowledge-based technology – expert systems – is still in its initial phases in the country, local suppliers have no proper experience in the implementation of such systems. Internationally known suppliers have not enough competent partners locally, such experts are only one step ahead of the professionals of the customer. The use of foreign experts may be too expensive for the given institution. In addition, marketing specialists over-simplify the task, do not inform enough about the inputs and maintenance costs.

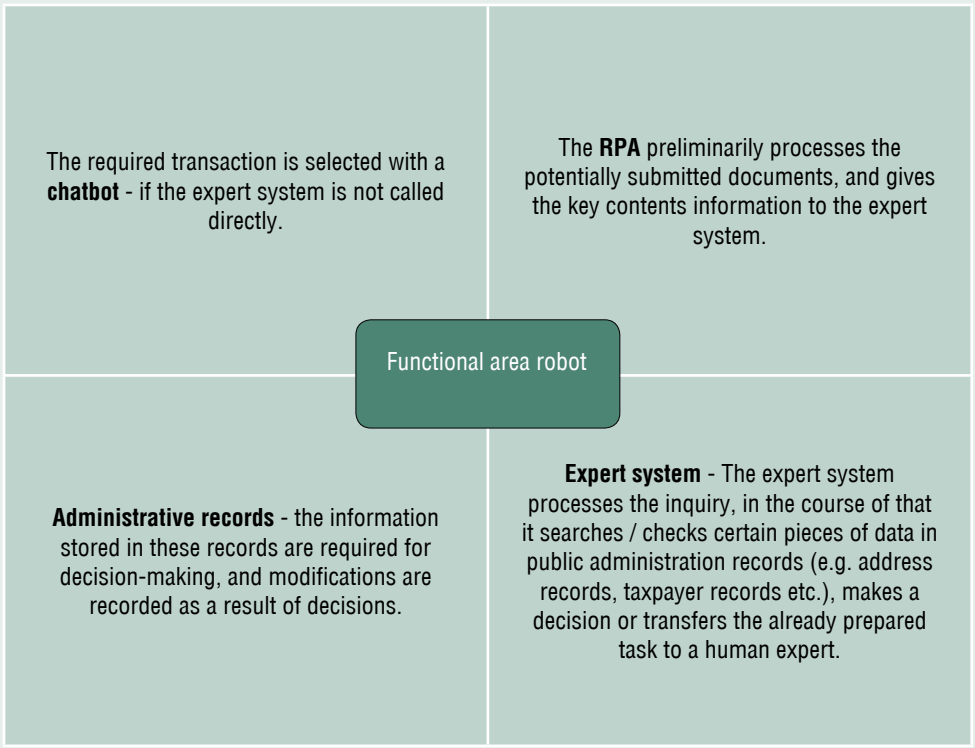
This is why the 16 expert system prototypes implemented in the Prime Minister's Office is an interesting initiative (Figure 13).

AUTOMATIC PUBLIC ADMINISTRATION DECISION-MAKING SYSTEM – WITH AI SUPPORT

The Government is planning to establish a new Regulated eAdministration Service (SZEÜSZ) named Automatic Public Administration Decision-Making System (AKD) (Hungarian Official Gazette, 2020; p. 5820).[9] One possible AI-based implementation of that would be the introduction of *functional area robots*. Functional area robots could support the handling of transactions in individual functional areas – life situations. The functional area robot – depending on the task

Figure 14

FUNCTIONAL AREA ROBOT



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– may consist of the dynamic configuration of the four elements presented in *Figure 14*.

CONCLUSION

In this article we examined how the two large families of artificial intelligence tools – expert systems and machine learning – can be used in public administration, with special regard to administrative decisions, as administrative processes always end with a decision.

As the decision has to be justified and documented in public administration pursuant to Article 81 (1) of the act on public administration, machine learning systems, which operate as black boxes, are unable to directly satisfy this requirement.

In the case of normative regulations, expert systems may make substantive decisions, and if equity needs to be practised, they may be used to support decisions. Apart from administrative decisions, it is exactly their 'regulation-based' nature that could make expert systems efficient tools in the area of audits or even self-tests.

Expert systems are able to operate in a proper and efficient way if connections are built to and among professional systems, and if we are able to follow the normative regulations accurately and in an up-to-date manner. In the area of transaction and client identification, AI solutions applying machine learning may play special roles (video, audio, text processing, visual identification of persons etc.). This is how various AI technologies can be connected, supporting the digitalisation of our public services.

In the case of solutions using artificial intelligence, the quality of data that are the basis of processing (authenticity, reliability, up-to-date nature) and having proper knowledge about them are basic conditions.

There are major developments going on in the area of e-administration, and more and more AI-based solutions are introduced. This trend is further strengthened by the implementation of the accepted AI strategy. 'The objective is to facilitate the electronic access and digitalisation of public services, in which AI is one the technologies we can apply', says the HAIS. With this article, we wished to draw attention to the possibility of using one of the elements of AI, that is expert systems in public administration.

There may be general solutions that we can insert into our specific solutions (e.g. image recognition, language interpretation, voice recognition, identification), but there are. AI solutions where it is more the method that can be applied in a different domain. Both are important, the general solution and the method, and knowing them is important to achieve rapid results in the digitisation of public services.

The Covid–19 outbreak had a bombshell effect on digital transition, as contacts were indeed switched to digital methods, but it is necessary to support internal procedures, too, with technology. AI, including expert systems and related methods, can help to increase the efficiency of electronic public services. Not to mention that the introduction of expert systems (also known as symbolic AI) has a strong standardisation effect already at the design stage. It is not possible to move forward without defining the rules, so there are benefits to be gained from planning the implementation. The aim of this article was to draw attention to the usefulness of expert systems in the modernisation of public services.

Notes

[1] https://ec.europa.eu/digital-single-market/en/european-egovernment-action-plan-2016-2020

[2] Informatikai Vállalkozások Szövetsége (ICT Association of Hungary)

[3] https://ai-hungary.com/files/e8/dd/e8dd79bd380a40c9890dd2fb01dd771b.pdf

[4] The Artificial Intelligence Coalition was formed in 2018 on the initiative of the Ministry of Technology and Innovation, and it was joined by domestic players that are interested in and affected by the development and the use of technology in various areas.

[5] General Data Protection Regulation

[6] The RPA (Robotic Process Automation) is the implementation of standardised processes with software robots.

[7] It has to be noted that rules can be interpreted as process definitions, where the consequence means the head of the procedure, while preconditions mean the body of the procedure.

[8] Present legal regulations do not allow for it yet, government decrees stipulate the skills required for the staff to do the transactions.

[9] The tender invitation related to the Automatic Public Administration Decision-Making (AKD) system was closed on 30 November 2020. [Establishment of Regulated eAdministration Service related to the Automatic Public Administration Decision-Making (AKD) system] https://www.palyazat.gov.hu/kfop-227-vekop-20-automatikus-kzigazgatsi-dntshozatali-akd-rendszer-szeszkialaktsa-1#)

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