The proposal of cadastral value determination based on artificial intelligence

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Political and economical environment

- Changes of political system started the complex reconstruction of polish state
- Substantial tax reforms including PIT and CIT were carried out
- New pension system was implemented, too
- Since the year 1989, the real estates market in Poland has been strongly developing
- These factors enable carrying out profound real estates tax reforms

Real estates tax

- Nowadays, real estates tax is based on estates size, but it is planned to introduce tax based on estates value
- However, the mass appraisal is a very complicated enterprise
- It demands carrying out tremendous data collection, concerning not only real estates but tax payers as well

Mass appraisal

- Estates value (called in polish law cadastral value) determination, that is basis for tax calculation, should be accompanied with new computer methods
- Data obligatory for real estates valuation can be divided into two groups:
  - Estates identification data
  - Data that have influence on estates value
- Most of these data are stored in Ground an Building Cadastre and Land Register

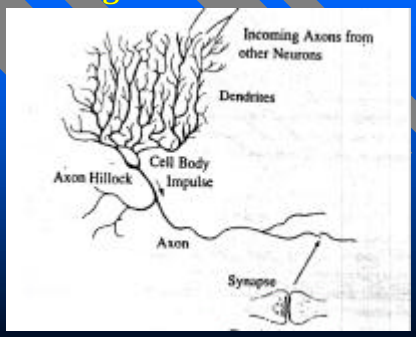
Real estates valuation method

- The valuation based on comparative approach is one of the most popular market value estimation methods
- When using this method, we presume that estates market value is found by comparison with similar estates with known transaction prices
- We also have to know differences between these estates, that have influence on their value
- The prices of estates representative for the market are supposed to be references during the mass appraisal

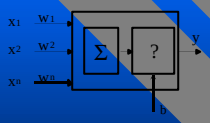
Real estates valuation method

- The real estates value determination purpose is to assign cadastral values to all estates in elaborated market
- The main difficulty here is lack of information on real estates, similar to those being subject of trade
- The number of these estates depends on presumed valuation method

The biological model of neuron



The mathematical model of neuron



- Like in biological neuron model input data activate or do not activate neuron
- In the first case the signal shows on output

The neural network learning algorithms

The neural network learning algorithms may be divided into two main groups:

- Learning with a teacher
- Learning without a teacher

Data dimension reduction

In the case of neural network dimension reduction, because of the small number of data, the application of the one of two methods (listed below) is suggested :

- The feature representatives choice
- Main components analysis

The selection of neural network construction

- The next important problem is the selection of proper neural network construction
- Such factors like proper learning process, learning method and its time consumption, layers structure and neuron internal functions should be taken under consideration here
- Multilayer perceptrons, that have one or more hidden layers have been examined during real estates valuation in Cracow Different learning algorithms were tested

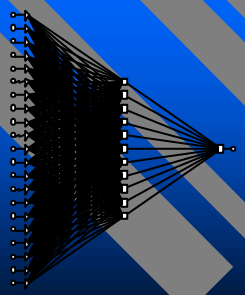
The selection of neural network construction

- Radial Base Function (RBF) networks, Generalized Regression Neural Networks (GNRR) and Linear Regression Networks were verified there
- After comparing results obtained for these networks of different types and taking into account input data base size and network learning parameters (including time consumption factor), the three layer perceptron was chosen for our purpose

The selection of neural network construction

- Radial Base Function networks were also found possible for application and others were rejected as not suitable for this task
- Output values for chosen network structure (obtained estates values) for all analyzed real estates set and all used attributes were calculated
- Obtained values have been found satisfactory
- Such a procedure corresponds to mass appraisal requirements
- Real estate valuation outcome may be obtained for any analyzed estate

Three layer perceptron



Three layer perceptron application

- Network constructions analysis shows that three-layer perceptron may be the appropriate tool for mass appraisal
- The neuron number in input layer is equal to attribute number. Radial Base Function networks may also be used for real estates valuation, but its much more difficult to find learning parameters for them
- It is not recommended to extrapolate descriptive parameters, because it is not possible to find function generated by this network structure

Three layer perceptron application

- The proposed network structure enables carrying out not only detailed estate valuation for a single estate, but mass appraisal as well
- Properly chosen knowledge base, based on representative estates, with necessary restrictions made during attributes defining, enables us to build the neural network, that can carry out the mass appraisal

Thank you