Methods of large investment unit modelling

The traditional notion of investment activities is that of sacrificing some of today's positive value in favour of the future precarious one. As far as investment decisions are concerned, three fundamental criteria, usually characterised by contradictory trends, are taken into consideration. As improving one of the parameters implies worsening of another one, the practice is one of solving an optimisation problem. The three parameters we will be concerned with are the following:

- **profitability** – most often expressed in the form of interest rate, profit rate, or pay-back period;
- **risk** – the degree of uncertainty associated with the return on investments expected; to be expressed by means of probability theory and statistic methods;
- **liquidity** – the speed of converting the investment back to hard money.

When making a decision concerning making an irrecoverable investment, such as e.g. building a hydroelectric power station, liquidity naturally becomes secondary, leaving us with just parameters characterising **the profitability and the safety (i.e. risk) of the investment**. Investment models can be based on deterministic models, but the effect of change of the individual parameters on output parameters has to be monitored to check the stability (robustness) of the solution. Using a concrete example of the decision-taking process concerning a relatively large investment (building a hydroelectric power station in Middle Asia within the framework of a B.O.T. project), we want to show two possible approaches to modelling these complex investment projects, namely deterministic models and generic algorithms. The paper also presents the fundamental possibilities of neural nets which can be fully used in the process.

Selected parameters for investment assessment

The (often irreversible) decision-taking process concerning the development of an investment (and its environment) within the span of years or even decades is the cause for **the increasing risk of a deviation of the prognosis from the future real monetary income and capital investments.** The investment is, within the span of several years, composed of a system of financial flows (investment receipts and expenditures at various points of the investment activity; i.e. cash flows) spread over time – remember the gradual investments into building or renovating your house or apartment, renovating your shop or building new production capacities of your firm. Before the investment assessment proper that is part of the decision-taking process concerning the adequacy or inadequacy of the investment, all cash flows are recommended to be projected into a suitable point in time by means of **interest bearing** (with respect to a particular date ahead of time) or **discounting** (with respect to a particular date in the past).

Investment assessment (evaluation) is based on simple criteria (relations) to make the decision whether to invest at all or not easier for us. The most frequently used parameters are the following:

- **Net Present Value (NPV);**
- **Internal Rate of Return (IRR);**
- **Pay-Back Period (PBP).**

Basic principles of generic algorithms

There are problems solved by the nature surprisingly easily where the algorithms proposed by humankind fail. Problems of this kind can be found in complicated and changing environments, which can be the case of investment decisions, too. Based on the analogy found in nature, two approaches have been formulated, namely **artificial neural nets** and **genetic algorithms**. Genetic algorithms are used where the search for accurate solutions based on systematic exploration would take an almost infinite period of time.

Genetic algorithms are a way how to cope with a problem by means of a computer, the solving process basically imitating population development of an animal species. Each next solution generation consists of selected individuals who have survived plus the offspring of the parents of other selected individuals while the old generation perishes. The process repeats for hundreds and thousands of generations until most individuals within a generation have interbred to such a point that they are not substantially different and there is no point going on. The undesirable state when there are no differences between individuals within a generation is prevented by means of mutations. Mutations are also an opportunity to adapt the population to changing environment, e.g. change in natural conditions has to be responded to.

3. Practical application of genetic algorithms in investment decision-taking

Practical application of genetic algorithms in modelling processes will be demonstrated on the example of reducing the risks in the process of investment decision-taking concerning a large (irrecoverable) investment. The potential use of these algorithms in modelling processes is, however, much broader.
There are various problem solving software products based on genetic algorithms available at present. One of them, which communicates with the much used spreadsheet programme EXCEL, is GeneHunter by WARD Systems Group, Inc., Maryland, USA.

The programme is designed for work with a spreadsheet made in Excel: after feeding in loan values for the particular years and formulas for computing the interest and the profit (since the values will be optimised, even random-generated loans can be used) and setting the optimisation parameters, the optimisation process can be run.
Table 1 lists the year, the loan, the credit, the interest, the payment and the profit for the various years for all three alternatives. The numbers are in million CZK. The NPV1 alternative is an alternative where the credit plus the interest are paid back by 2023; in the NPV2 alternative the credit plus the interest are paid back by 2021. The NPV3 alternative involves pay-back by 2014 and maximum profit possible till 2024. The profit (including negative values) is represented in the graphs.

Figure 1 shows the optimisation of costs so that the credit and the interest are paid back in 2023 and 2021 for NPV1 (left columns) and NPV2 (right columns) respectively. The graph shows the values stated in the NPV1 and NPV2 Profit columns of Table 1.

Figure 2 shows the optimisation set in such a way that the credit and interest are paid back by 2013 and the profit till 2024 is as high as possible. The graph corresponds to the values stated in the NPV3 Profit column of Table 1.

		NPV1				NPV2				NPV3			
Year	Loan	Credit	Interest	Payment	Profit	Credit	Interest	Payment	Profit	Credit	Interest	Payment	Profit
2001	20	20	1	0	-20	20	1		-20	20	1		-20
2002	40	61	4	0	-61	61	4		-61	61	4		-61
2003	50	116	9	0	-116	116	9		-116	116	9		-116
2004	60	185	14	0	-185	185	14		-185	185	14		-185
2005	70	270	21	12	-258	270	21	15	-255	270	21	19	-250
2006	20	300	24	66	-233	296	23	39	-257	292	23	19	-272
2007	0	257	20	1	-255	280	22	1	-279	296	23	22	-273
2008	0	276	22	9	-266	302	24	18	-284	297	23	23	-273
2009	0	288	23	46	-242	308	24	47	-260	297	23	52	-245
2010	0	265	21	84	-180	285	22	31	-253	268	21	60	-208
2011	0	202	16	9	-192	276	22	56	-219	229	18	42	-187
2012	0	208	16	0	-208	241	19	11	-230	205	16	63	-142
2013	0	224	17	2	-222	249	19	55	-193	159	12	83	-75
2014	0	240	19	28	-212	213	17	2	-211	88	7	99	11
2015	0	231	18	3	-228	228	18	73	-154	0	0	120	120
2016	0	246	19	81	-165	172	13	11	-161	0	0	130	130
2017	0	184	14	11	-173	175	14	6	-168	0	0	138	138
2018	0	188	15	18	-169	182	14	20	-162	0	0	145	145
2019	0	184	14	43	-140	176	14	60	-116	0	0	196	196
2020	0	155	12	30	-125	130	10	54	-76	0	0	216	216
2021	0	137	11	34	-103	86	6	28	-58	0	0	243	243
2022	0	114	9	77	-37	65	5	67	0	0	0	270	270
2023	0	46	3	43	-3	2	0	0	0	0	0	338	338
2024	0	7	0	7	0	-34	-2	0	0	0	0	402	402

Table 1. NPV1, NPV2 and NPV3 input values and result alternatives.

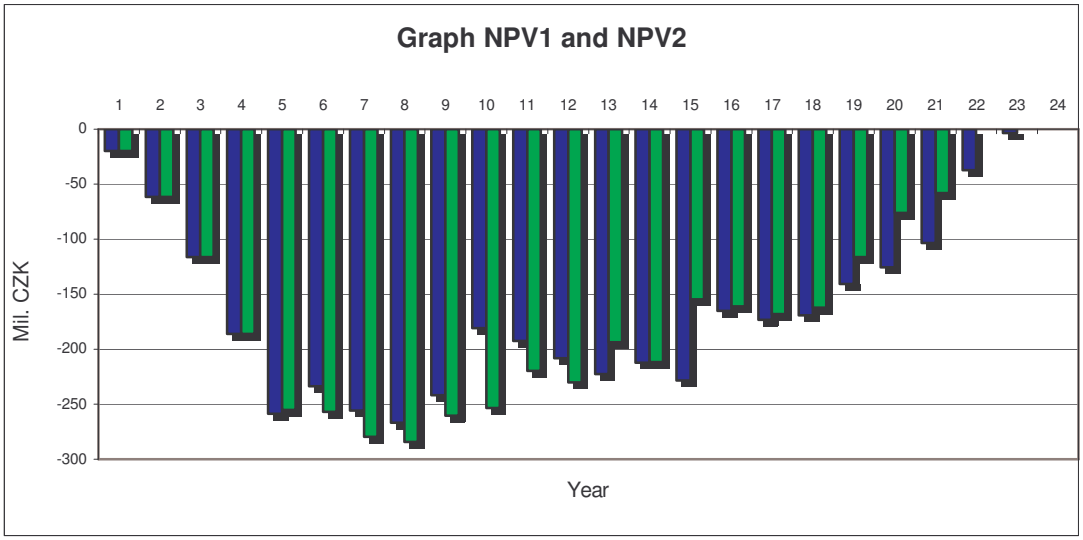

Figure 1. Temporal development of NPV1 and NPV2.

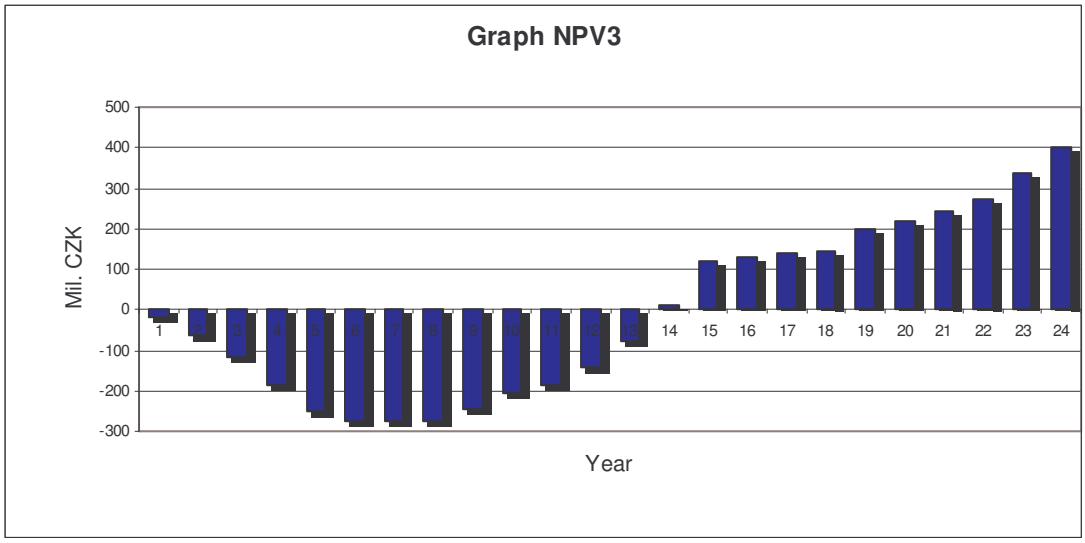

Figure 2. Temporal development of NPV3.

Conclusion

It can be said that the use of generic algorithms in the process of modelling large investment units is a replacement of at least the same value as investment pay-back modelling based on classical spreadsheet programmes.

Models – whether deterministic or based on artificial intelligence – cannot, however, be but supporting tools for company management decisions; only careful preparation of investment strategy regarding large investment units helps to minimise the risks, losses and costs.