Biological and Semiotic Artificial Intelligence, and Machine Learning Methods in Solving Complex Cognitive Problems

Funded by Swedish Institute

KNEU Science Park

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Kyiv National Economic University named after Vadym Hetman, Ukraine

- Doctor of Science, Professor
- 25+ years in Data Science, AI
- Leadership of KNEU Science Park
- Editor-in-Chief of the scientific-analytical journal

"Neuro-fuzzy modeling technologies in economics"

Data Mining

Econometrics

- ✓ Regressions (linear, logistic, etc)
- ✓ ARIMA
- ✓ Principal components analysis
- ✓ Support Vector Machine
- ✓ Naive Bayesian Classifier
- ✓ Discriminant models
- ✓ K-Nearest Neighbors
- ✓ Decision Trees

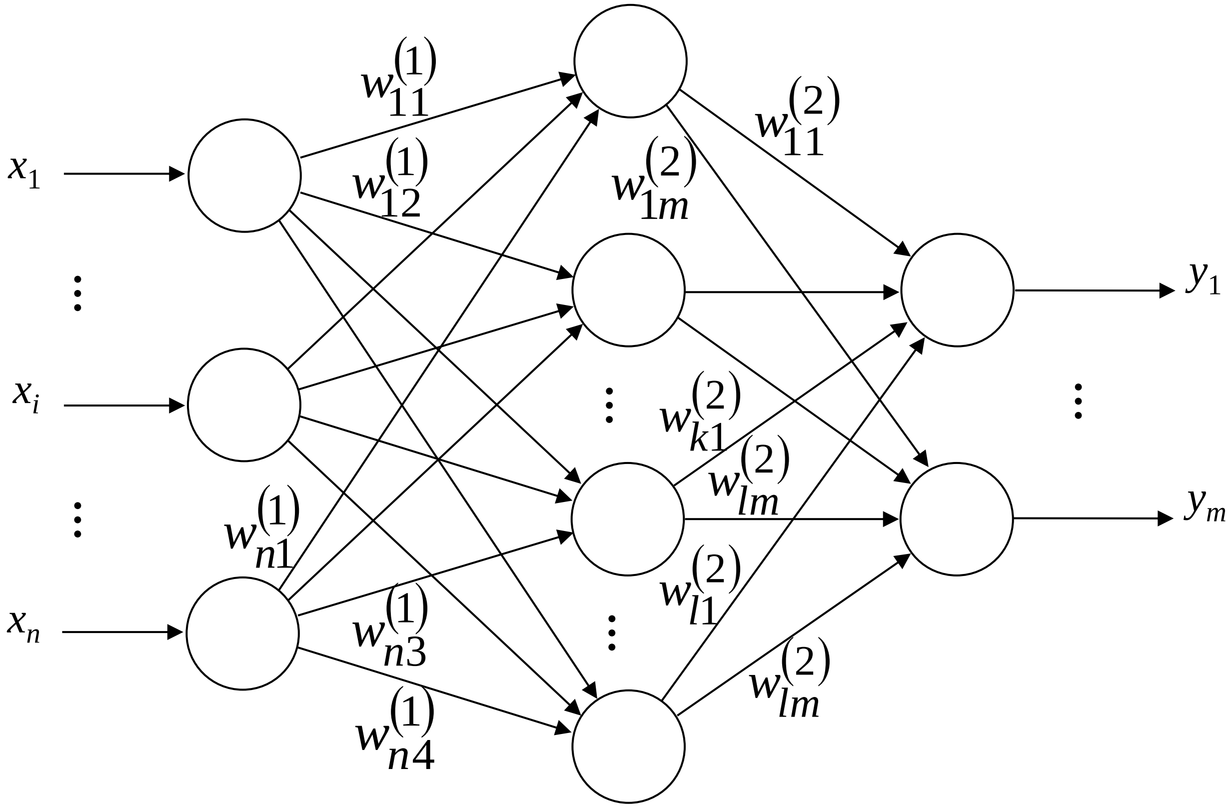
Machine Learning

- ✓ Decision Trees
- ✓ Ensemble Technologies
  - Random Forest
  - Boosting
  - Bootstrap
  - Begging
- ✓ Cluster Methods
  - Agglomerative
  - Density-Based
  - Spectral
  - Soft
- ✓ Neural Networks

Artificial Intelligence

- ✓ Neural Networks
  - Perceptrons
  - Recurrent networks
  - Self-organizing maps
  - Convolutional networks
  - Cognitrons
  - Transformers
- ✓ Fuzzy Logic
  - Mamdani algorithm
  - Sugeno algorithm

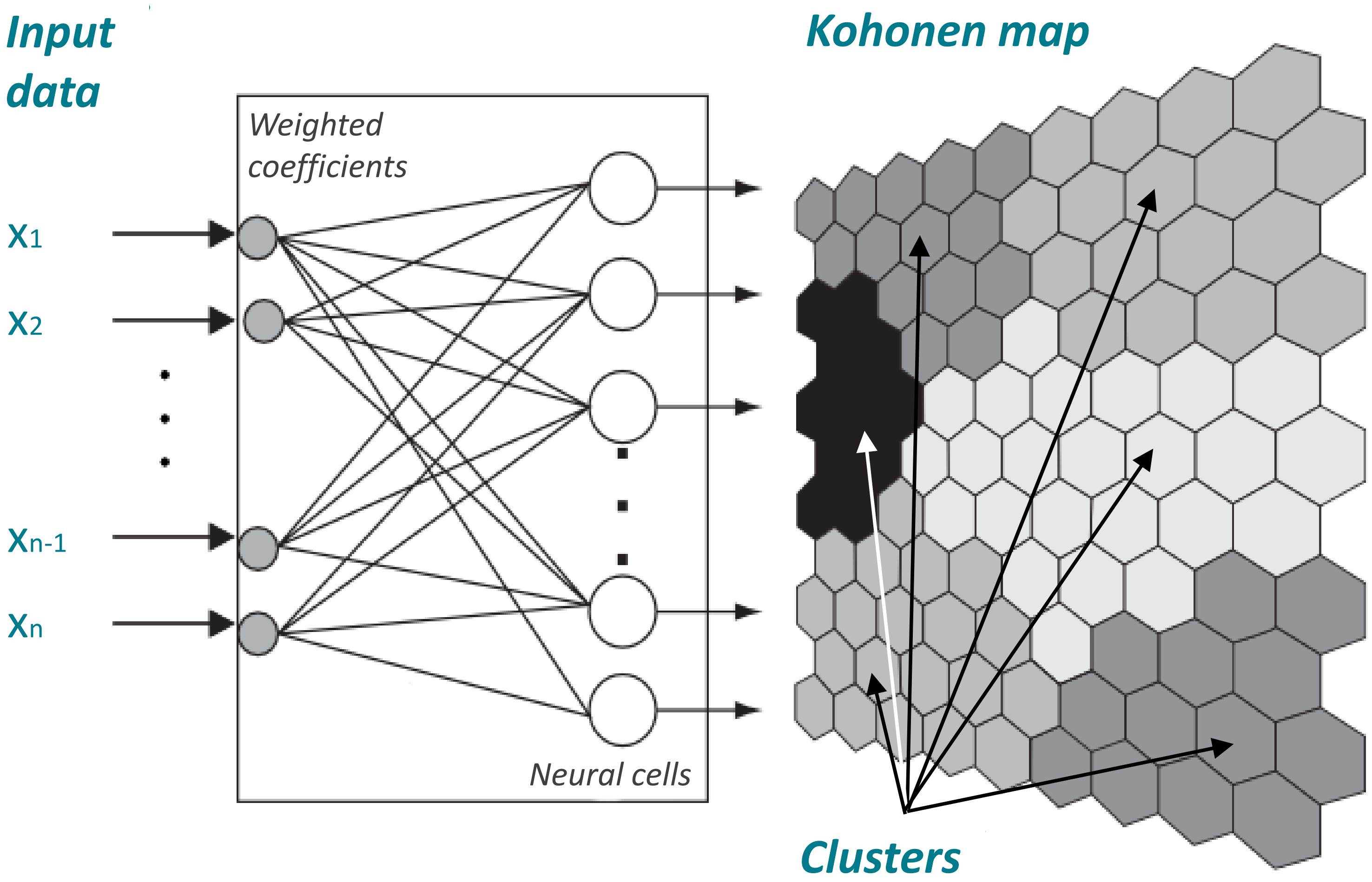
Perceptron

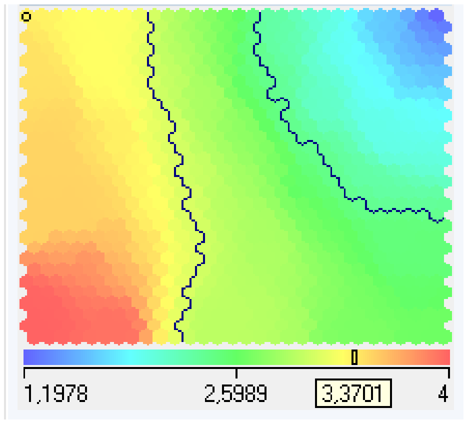


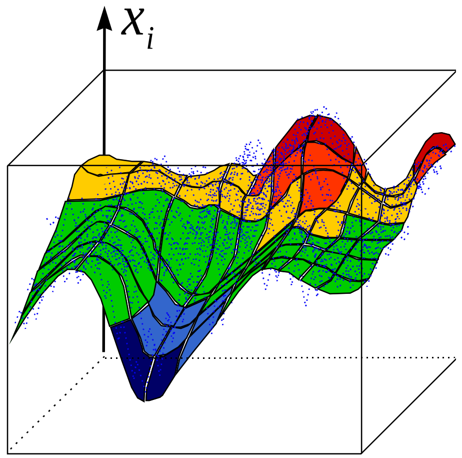
x_1
x_i
x_n
$w_{11}^{(1)}$
$w_{12}^{(1)}$
$w_{n1}^{(1)}$
$w_{n3}^{(1)}$
$w_{n4}^{(1)}$
$w_{11}^{(2)}$
$w_{1m}^{(2)}$
$w_{k1}^{(2)}$
$w_{lm}^{(2)}$
$w_{l1}^{(2)}$
$w_{lm}^{(2)}$
y_1
y_m

AI methods for automated clustering

Self-organizing map

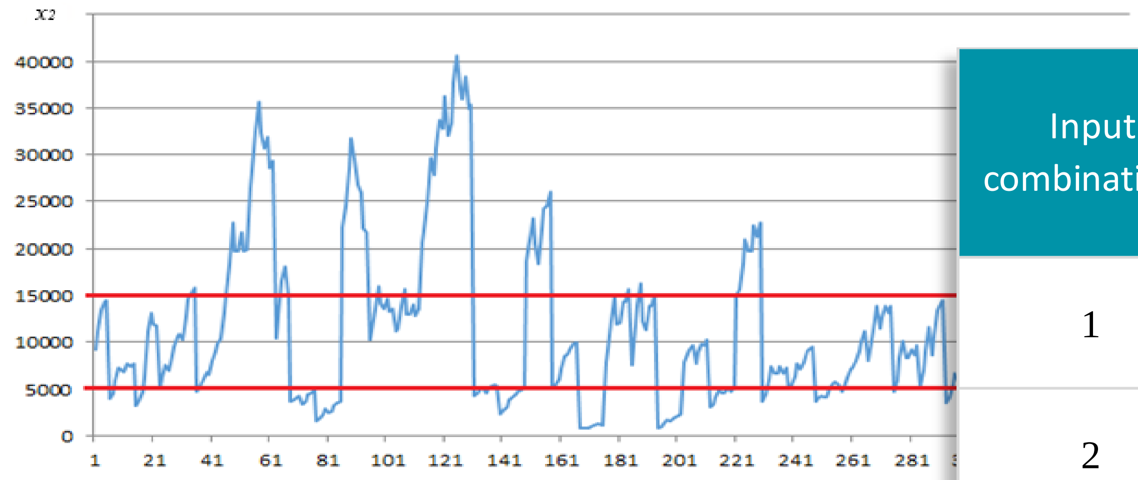


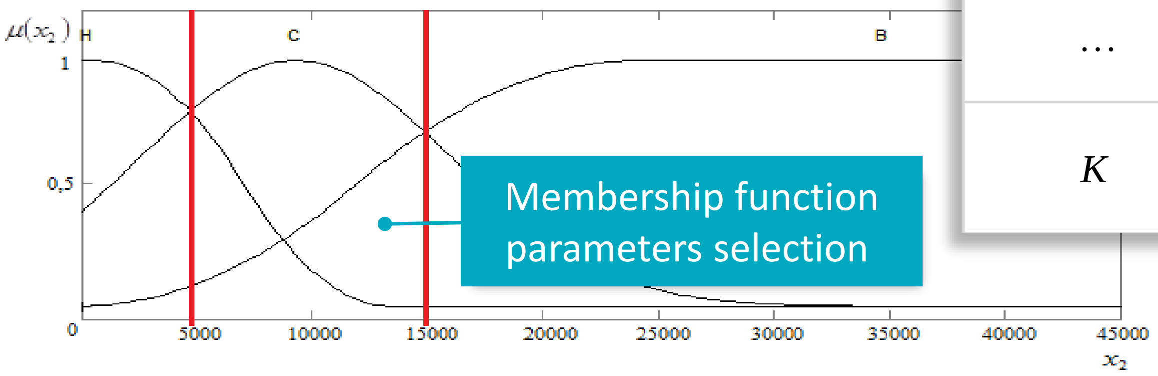




Applying fuzzy logic

Automatic formation on the basis of decision making rules taking into account the results of clustering

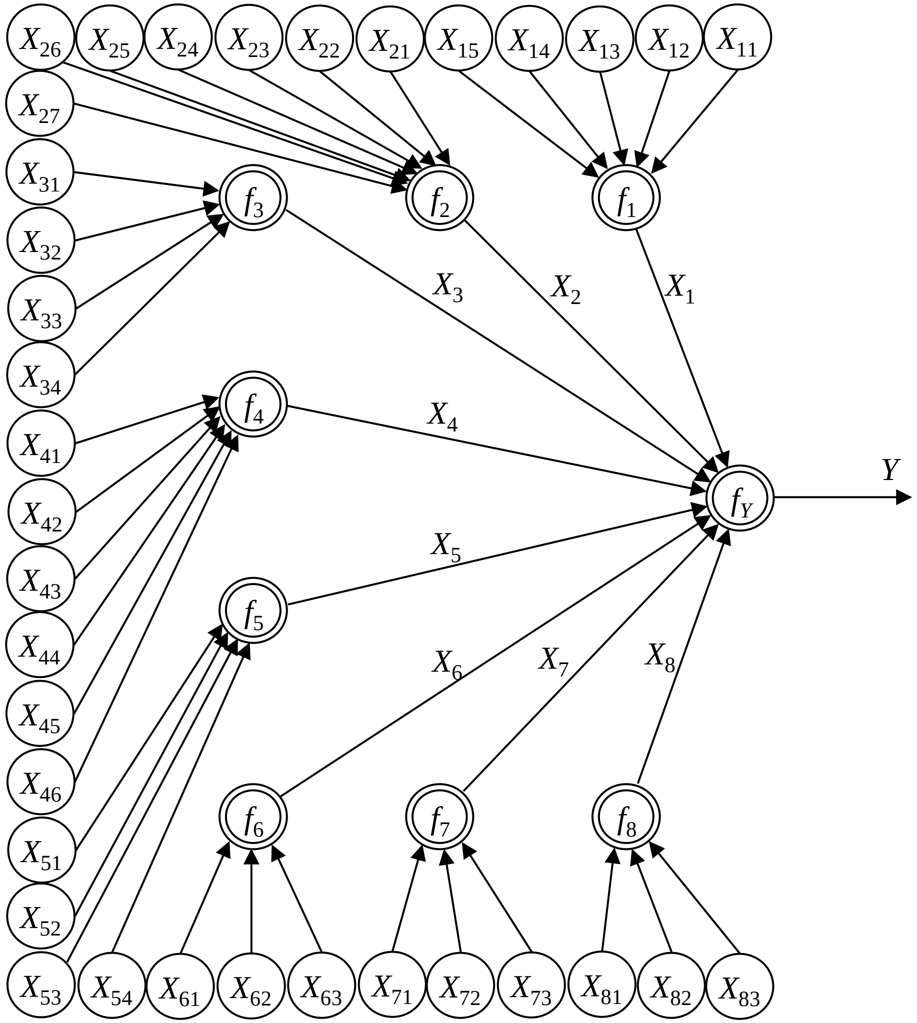


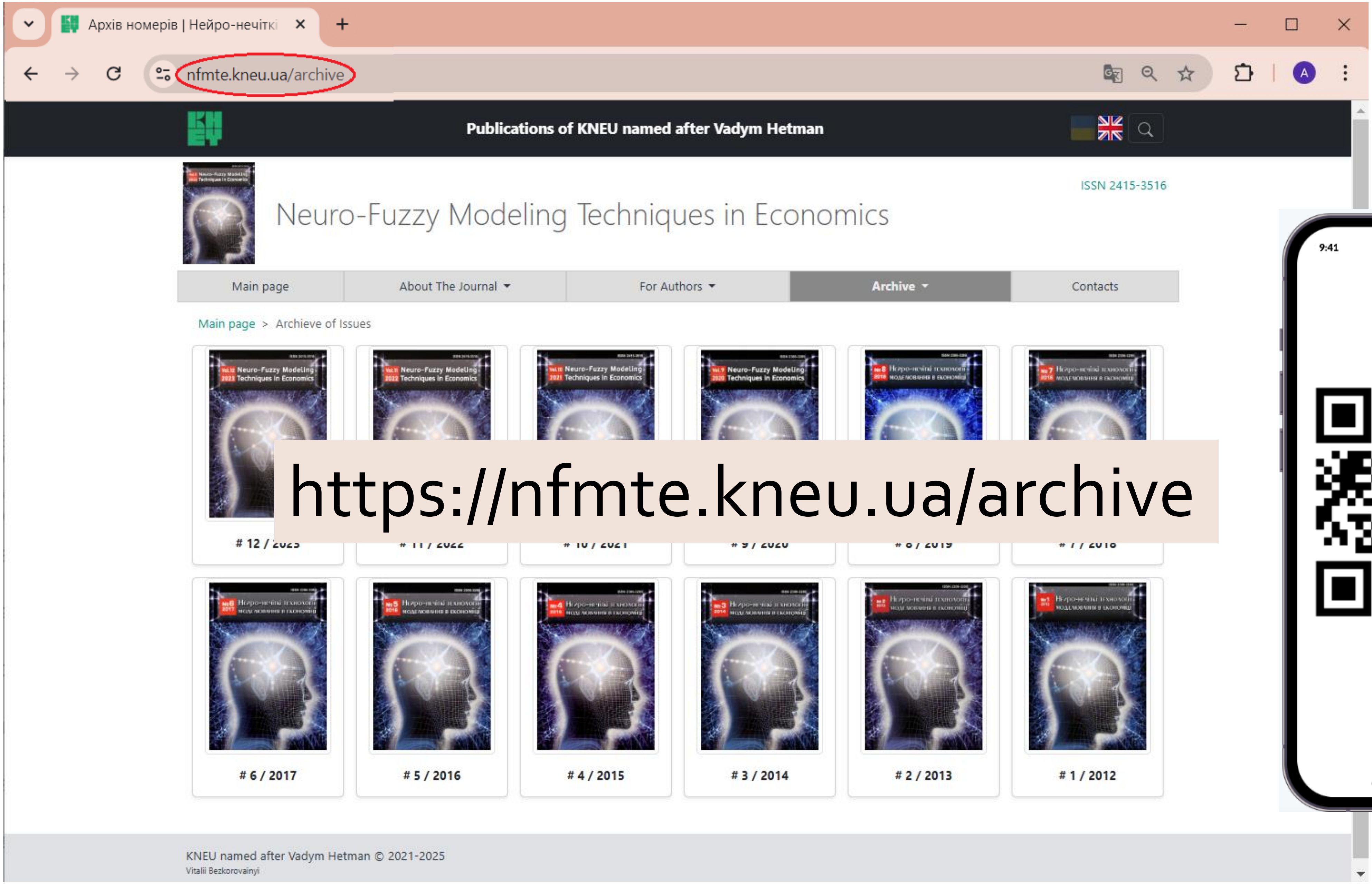


Input combinations	Input variables				Output variable
	X_1	X_2	…	X_n	y
1	*Low*	*Low*	…	*Low*	$f_1(X_1, X_2, \dots, X_n)$
2	*Mid*	*Mid*	…	*Mid*	$f_2(X_1, X_2, \dots, X_n)$
…	…	…	…	…	…
K	*High*	*Mid*	…	*High*	$f_K(X_1, X_2, \dots, X_n)$

AI methods for prediction and clussification

Hierarchical Neuro-Fuzzy System





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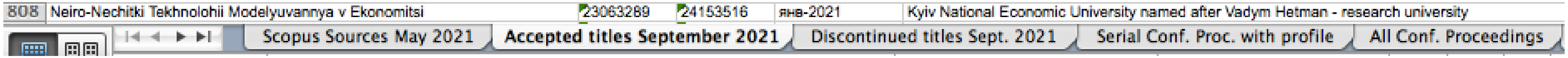


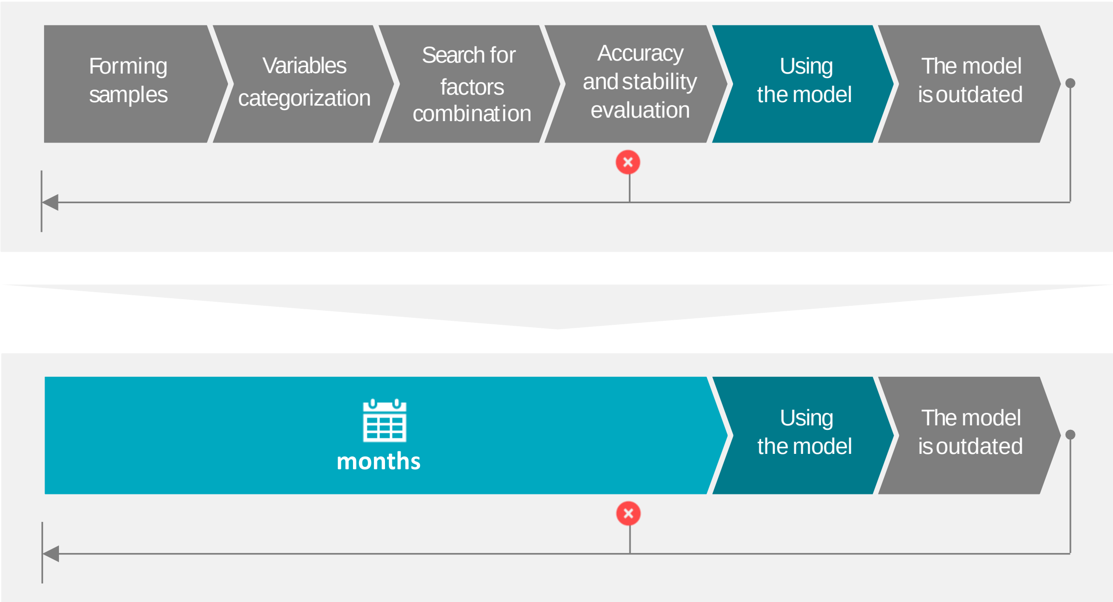
Scopus

Decision-making months vs. minutes

Businesses pay for maintaining highly-skilled expensive professionals that use advanced and costly tools to go through a number of routine stages with many iterations until they finally come up with a model to, for example, assess credit risks.

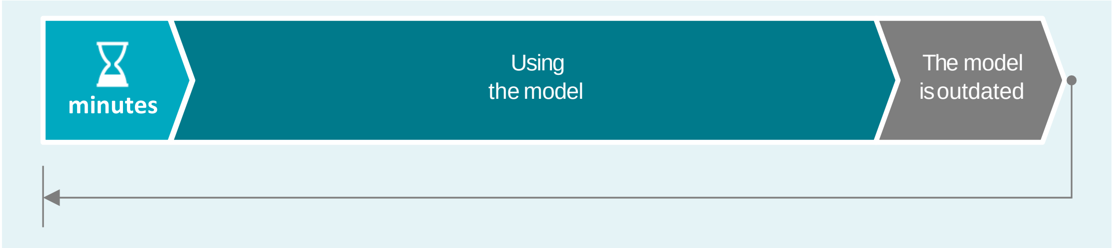
As the model won't be valid for a long time, they start from scratch each time a new effort to maintain the current efficiency is required. Thus, this does look like a rocket science and takes up to months.

The routine cycle



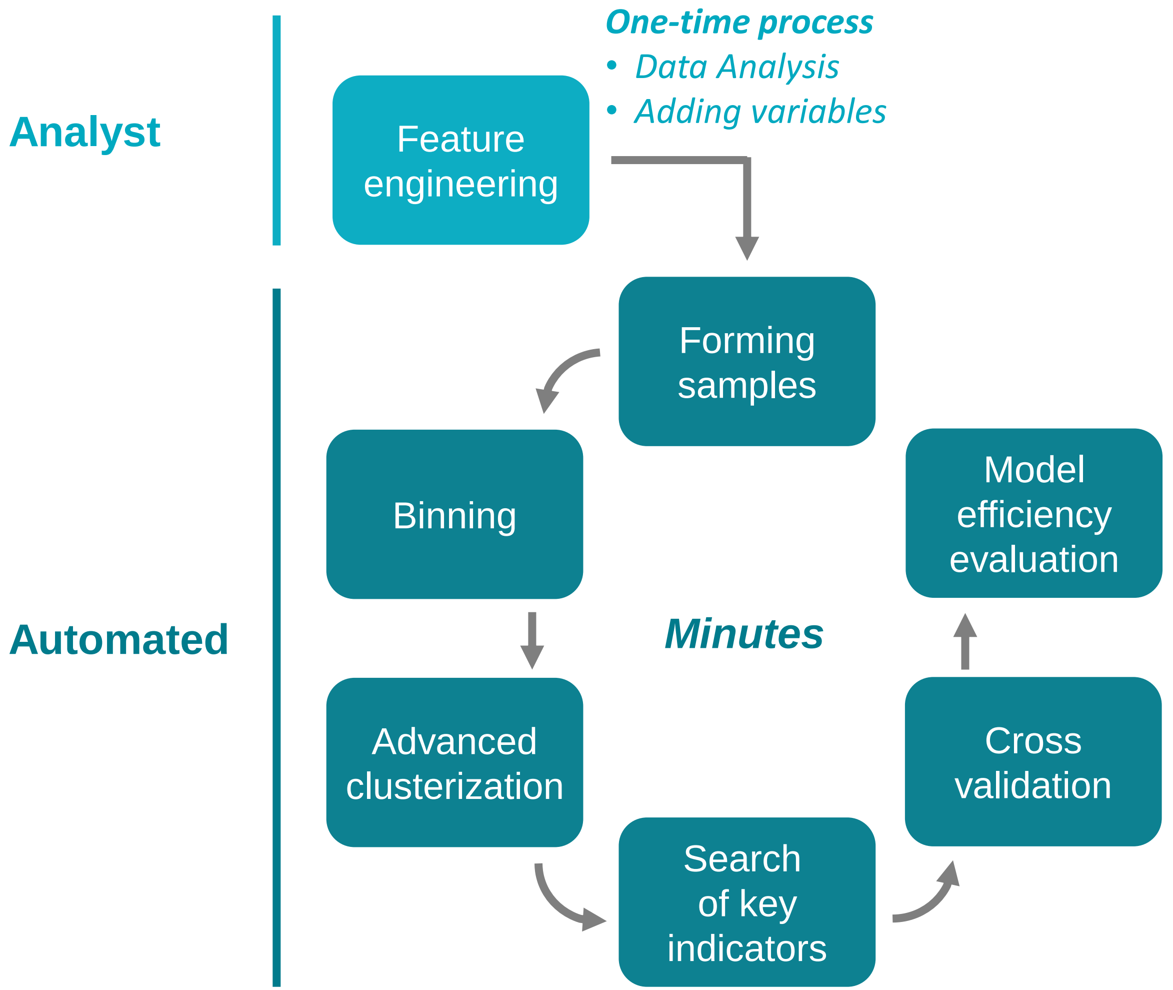
With our approach, all the routine comes down to a matter or literally minutes. As a result, significant incremental time for data-driven decision-making.

Automated process



Customizing business cases for data-driven decision making

Modeling | *Implementing results*

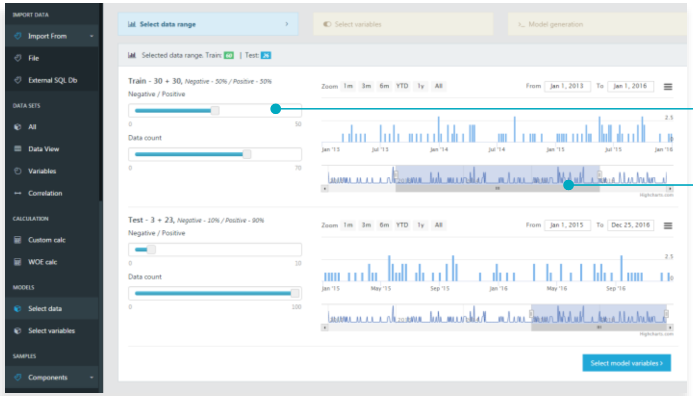


1 **Fully automated process**
No need to interact with the system. Simply approve the new model once it's built within the required cycle on updatable data

2 **Semi-automated solution**
Embrace advanced modeling with customized features and UI to build models for your tasks or prove and implement your own concepts

Interfaces for managing the process of semi-automated model building

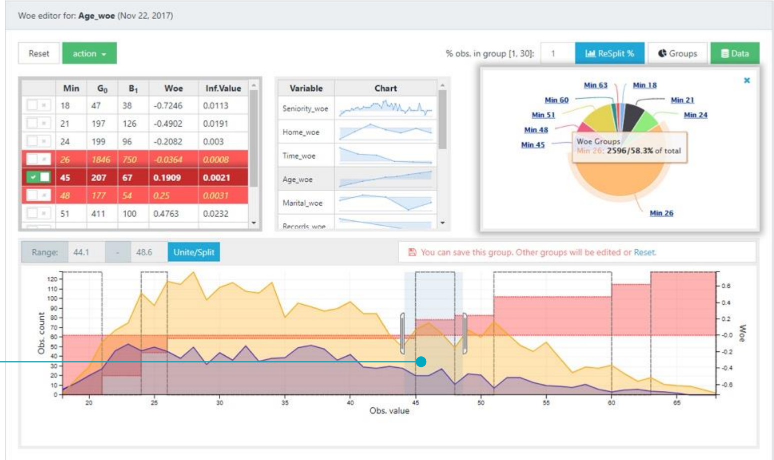
1 *Forming samples for model building and testing*



Setting the proportion of positive and negative samples in the training and test datasets

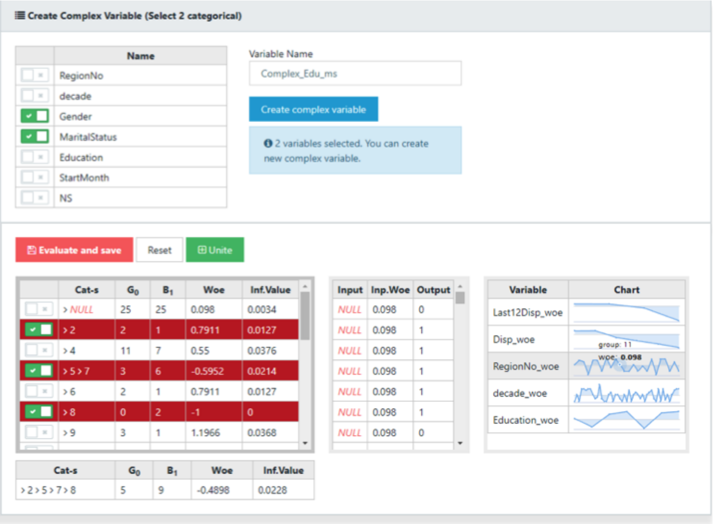
Choice of time ranges for the formation of training and test samples

3 *Automatic binning with manual category editing*



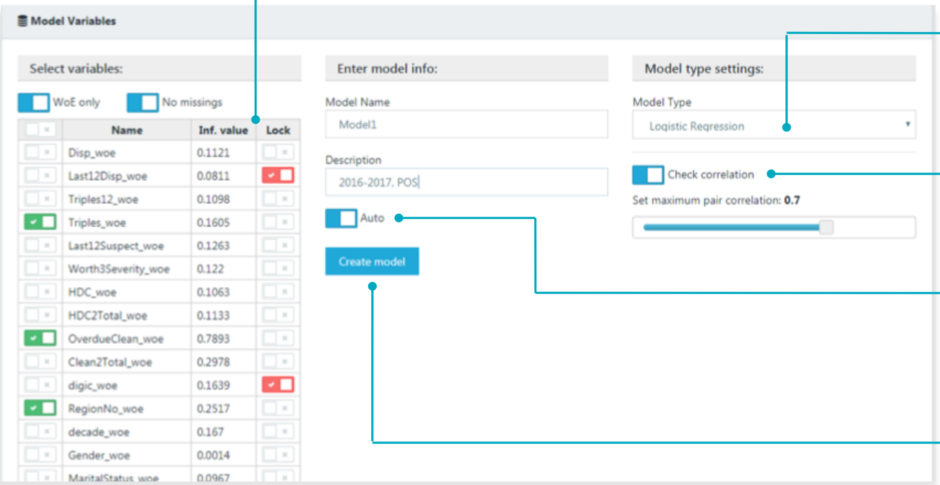
Possibility of repeated binning with refined parameters or manual adjustment of category boundaries

2 *Forming combined predictors*



4 *Setting the model*

Select variables if you build a model manually



Choose model type

Set limit for pair correlation between input variables (if needed)

Enable automated selection of the most significant factors

Build a model according to the selected settings

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Target customer

Focus industries

- Banking
- Insurance
- Public sector
- Manufacturing
- Retail & distribution

Business lines in focus

Risk Management
- Credit risks assessment
- Loan terms personalization
- Collector scoring
- Transactional risks
- Fraud detection
- Pledged property management

Finance
- Macroeconomic forecasting
- Forecasting stock, currency and commodity markets
- Budgeting process automation
- Stress-testing the business

Marketing & Distribution
- Demand/sales forecasting
- Marketing spend optimization
- Customer churn prevention
- Customer segmentation
- Cross-selling optimization

Manufacturing
- Processes optimization
- Quality forecasting
- Predictive maintenance

HR
- Jobseeker’s match
- Employee churn prediction

Case studies

Case study 1: Banking (*Assessing risks of corporate clients across industries*)

Higher **efficiency** + Significantly improved **speed** = **Cost cuts** and **improved P&L**

Developing a set of scoring models for corporate borrowers risk assessment

	Qualification needed	Time spent	Efficiency
National Bank of Ukraine	Professional team, including two PhDs	4 months	
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Case study 2: Banking (*Risk-based loan amount personalization*)

Applying risk-based personalization approach to SME overdraft loans unlocked significant incremental value potential for a large EU bank

Step 1: Risk assessment

Predicting SME clients default.

Step 2: Loans personalization

Identifying optimal loan amount to maximize portfolio size, same time reducing the cost of risk. This way, the bank was able to identify client that:

- should be denied a loan;
- can be provided with a loan, but with a decreased limit;
- can be provided with a loan, but with a significantly increased amount without increasing the risk.

SME overdraft loans **portfolio value**

SME overdraft loans **portfolio profit**

+30% top-line growth

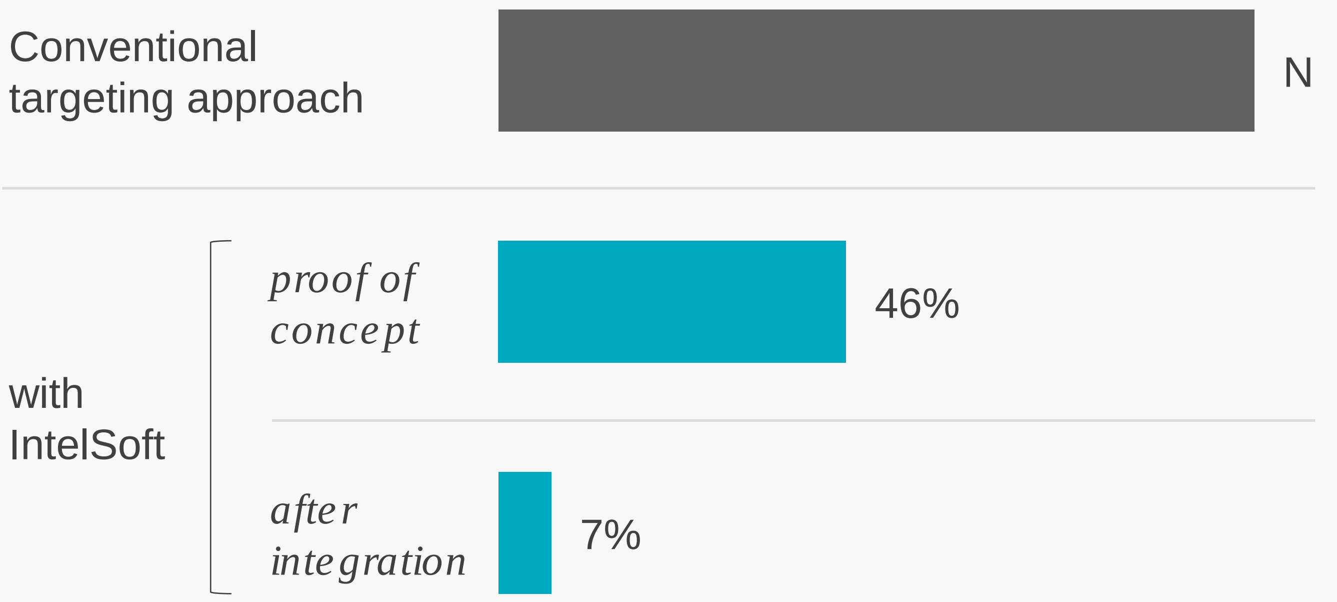
+90% bottom-line improvement

Case study 3: Marketing spend optimization

Predicting customers' behavior after mass text massaging campaign

Efficiency

Budget needed to achieve the same marketing campaign results (increased cashless payments by bank customers)



Impact

up to

93%

cost cutting

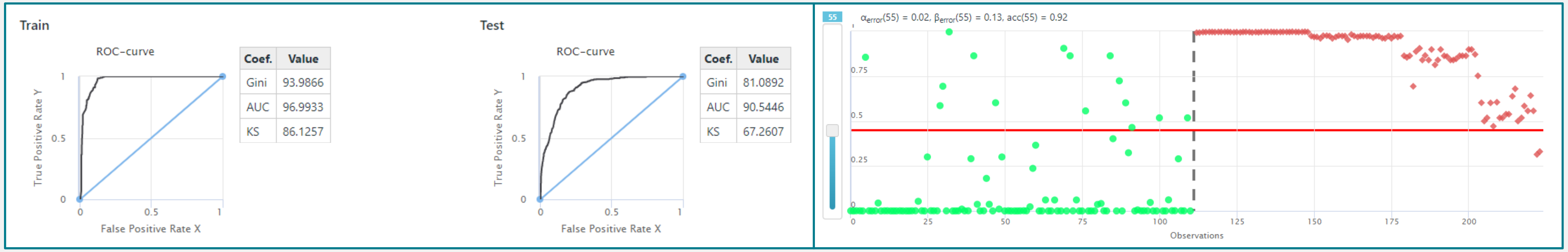
Case study 4: Cross-sell activities optimization (*cash loans for retail customers*)

1

Assessing credit risk

Conducting risk assessment as a first step allows to avoid rejecting customers who respond to the offer but fail to meet established risk criteria.

***Customers' default prediction** model accuracy:*



2

Predicting product offer acceptance

As a second step, probability of accepting cash loan by each customer is calculated which allows to:

- offer a cash loan only to the customers who most likely will **perceive the offer as relevant**; and
- **optimize marketing spend** by skipping those who will perceive the offer as irrelevant.

Cash loan acceptance prediction** model accuracy: **GINI = 76.38

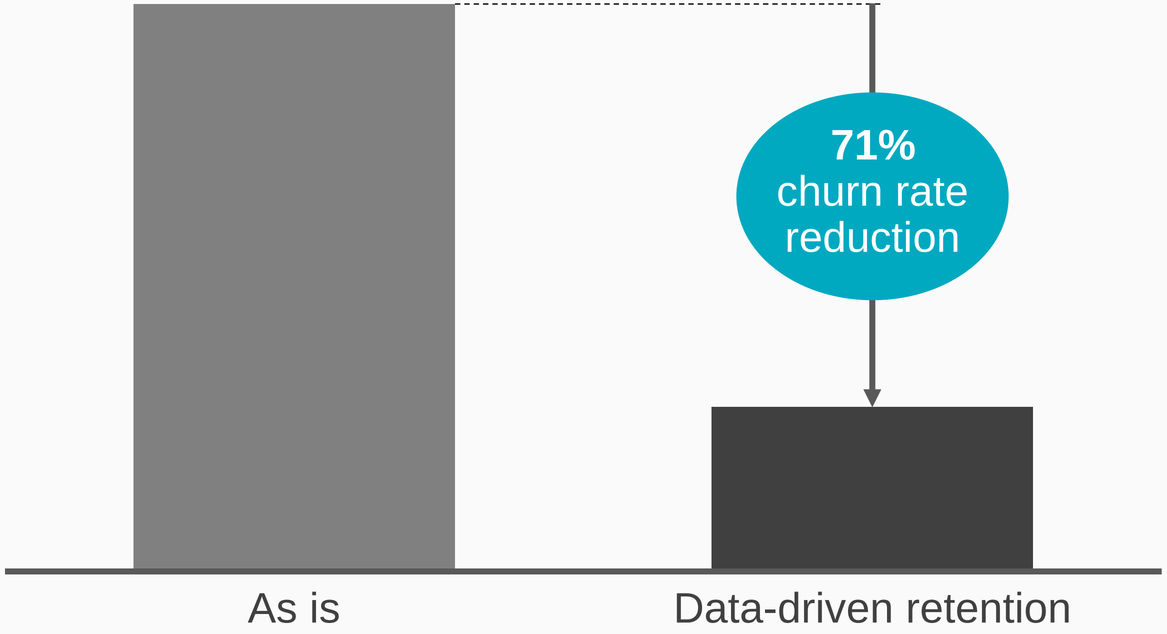
Case study 5: Data-driven customer retention

Conducting customer retention campaign based on churn prediction

Efficiency

Retention campaign results based on 3-month churn prediction

Churn rate, %



Impact

1,500%+

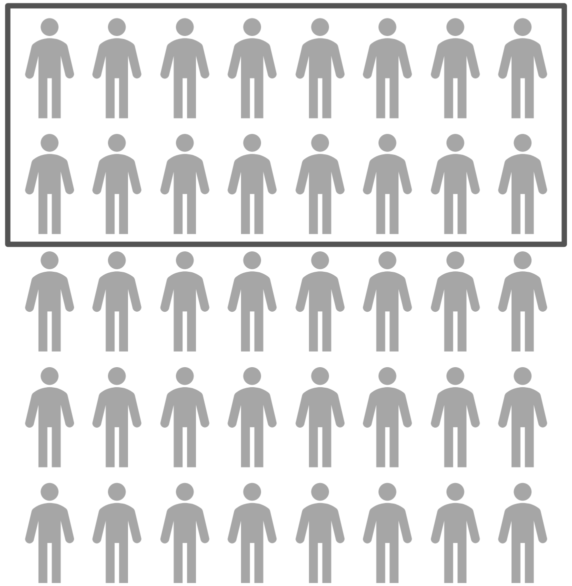
Project ROI

Case study 6: Public sector (*Fraud detection*)

Identifying fraud when granting social welfare to citizens

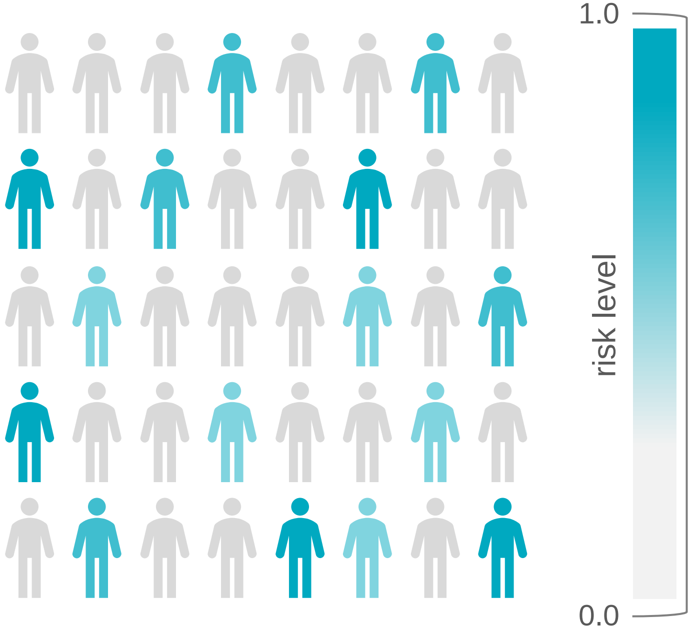
Conventional approach

randomly checking citizens with the available human resources



with IntelSoft

allocating resources to check the most risky citizens first



>90%

fraud detection accuracy

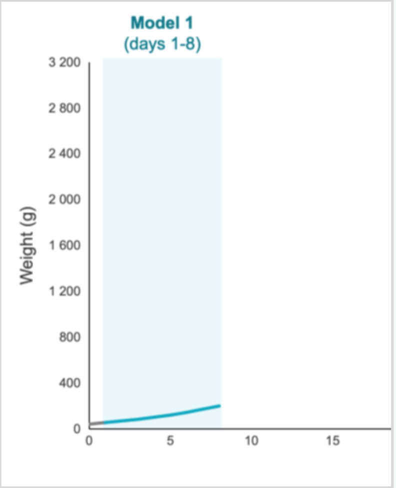
Case study 7: Manufacturing (*Chicken incubation process optimization*)

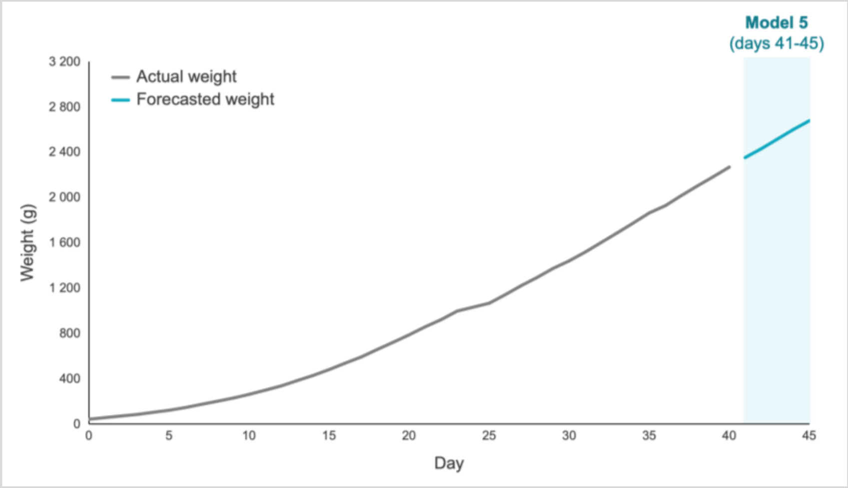
1

Permanent chicken weight forecasting

✓ Based on historical and real-time data about incubation parameters and internal/external environment, weight is forecasted for periods:
- days 1-8 (Model 1)
- days 9-17 (Model 2)
- days 18-25 (Model 3)
- days 26-40 (Model 4)
- days 41-45 (Model 5)

✓ Calculating 'best performance curve' for each incubation parameters combination



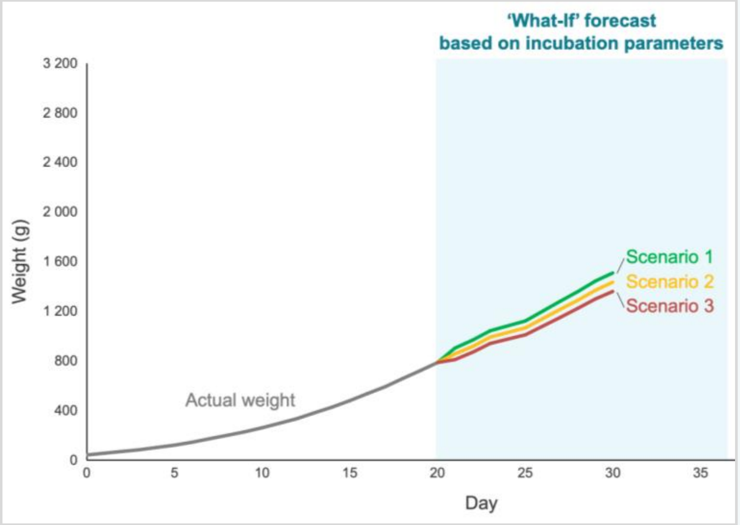


2

Goal-driven incubation parameters optimization

✓ Zootechnician is now able to input the initial chicken characteristics for the run and receive the optimal environment parameters plan for the run

✓ At each incubation time point (with or without deviation from 'best performance curve'), optimal environment parameters can be set to achieve the planned weight:
- feed and water
- heating
- humidity
- lights
- ventilation
- other controlled parameters



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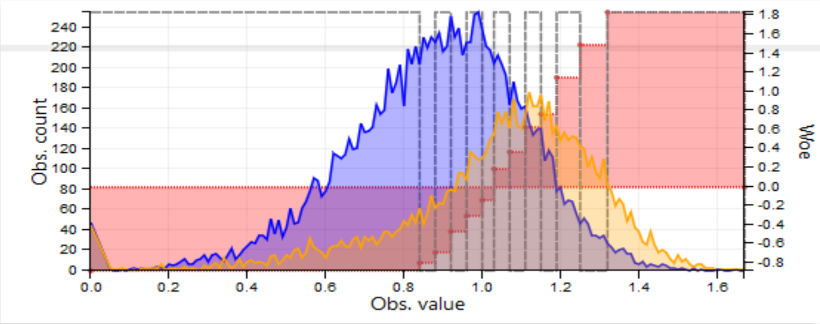
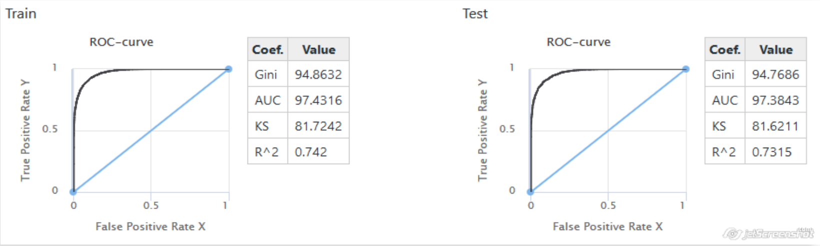
Case study 8: Predictive medicine

Identifying risk of cardiovascular diseases

Modeling

- 20K+ people
- 350+ input factors on regional and personal levels:
  - demographic
  - socioeconomic
  - ecologic
  - medical
- Identified
  75 key factors

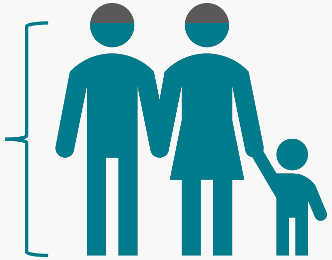




Results

95%

of cases diagnosed without focused study



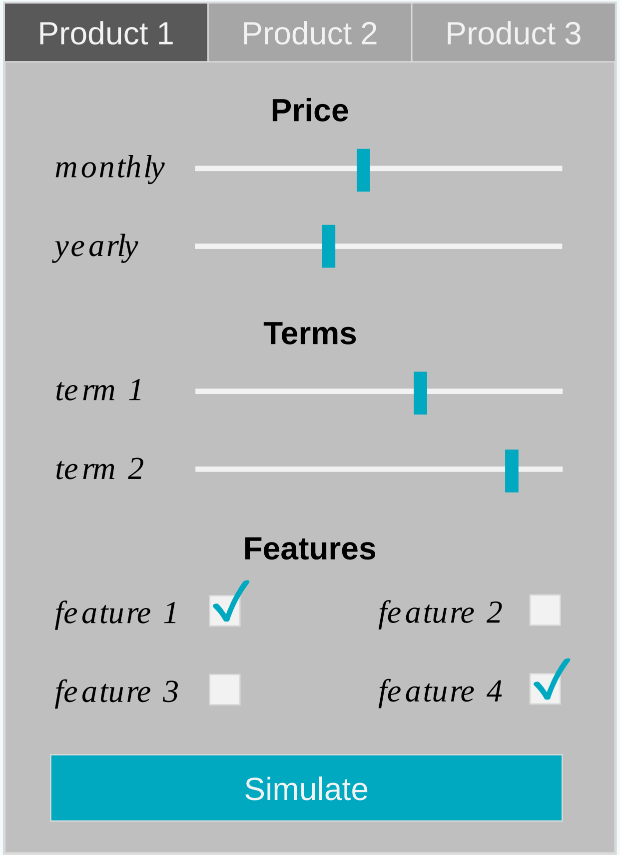
Impact

- ✓ Improve treatment efficiency
- ✓ Acquire new clients by offering predictive medicine
- ✓ Boost revenue by targeting client base with personalized check suggestions

Case study 9: Product constructor

Smooth user experience

Fine-tune product prices and terms



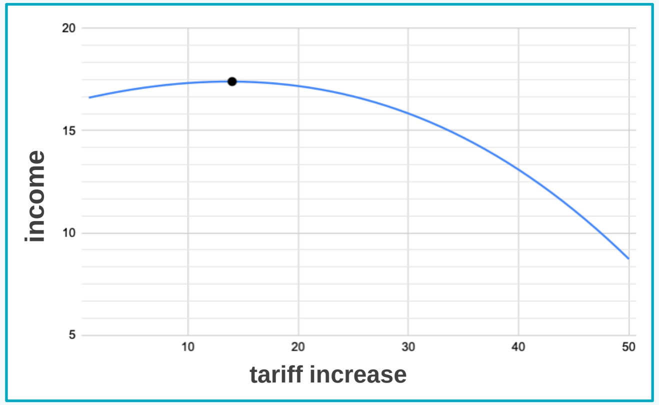
Automated advanced analytics

Get forecasts and reports on-the-fly

- ✓ Up-to-date behavioral segmentation
- ✓ Client churn/migration prediction
- ✓ Sales forecast by product
- ✓ Products profitability

Product price optimization

Determining the optimal price of the package / product taking into account the clients churn



Direct impact on the bottom line

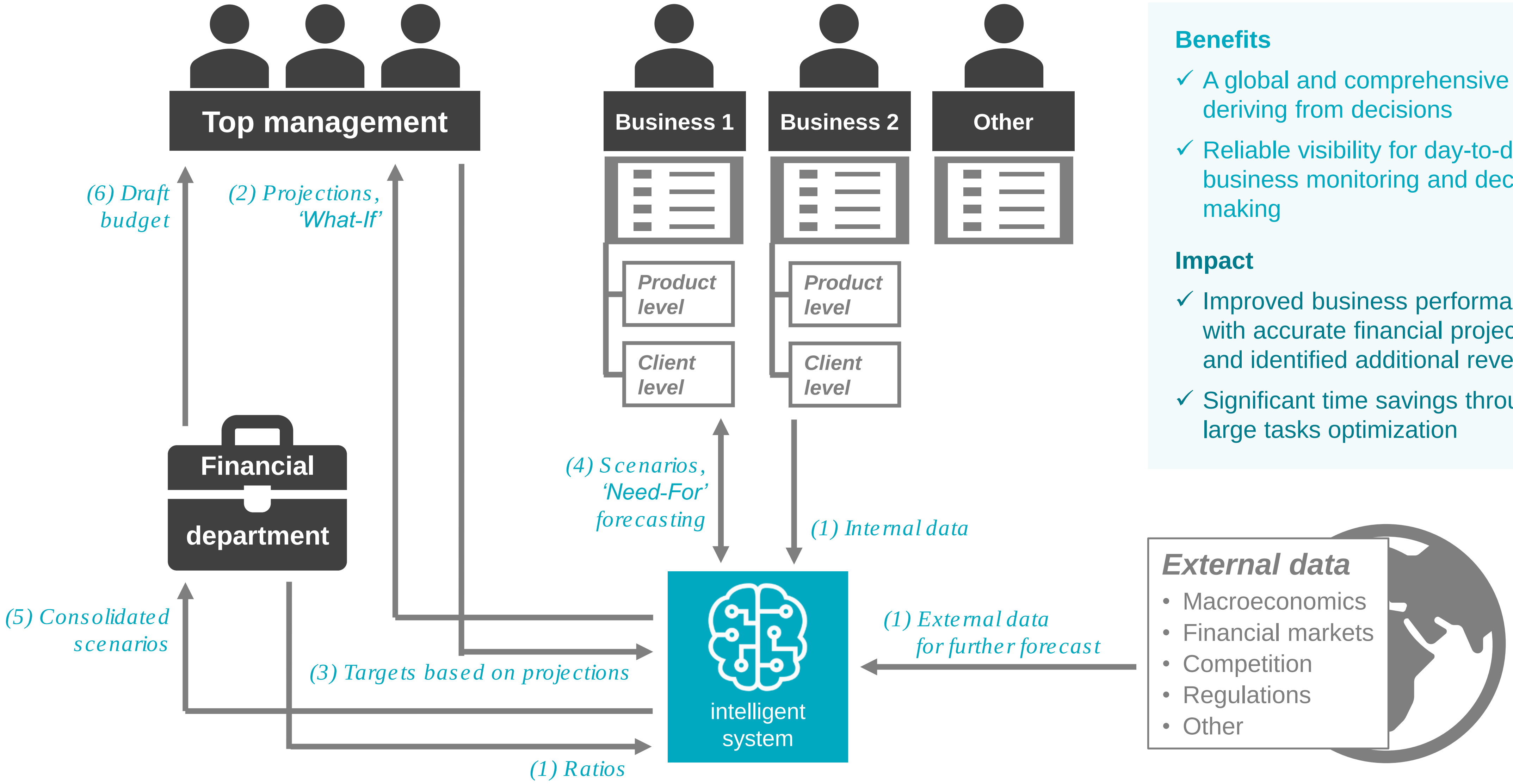
Bottom-line impact

- ✓ Boost sales by applying the most effective product design
- ✓ Manage profitability with accurate forecasts by product/service

Operational impact

- ✓ Optimize large tasks by automating the routine
- ✓ Aim released hours to more valuable and strategic tasks

Case study 10: Finance (*Intelligent budgeting*)



Benefits

- ✓ A global and comprehensive view deriving from decisions
- ✓ Reliable visibility for day-to-day business monitoring and decision making

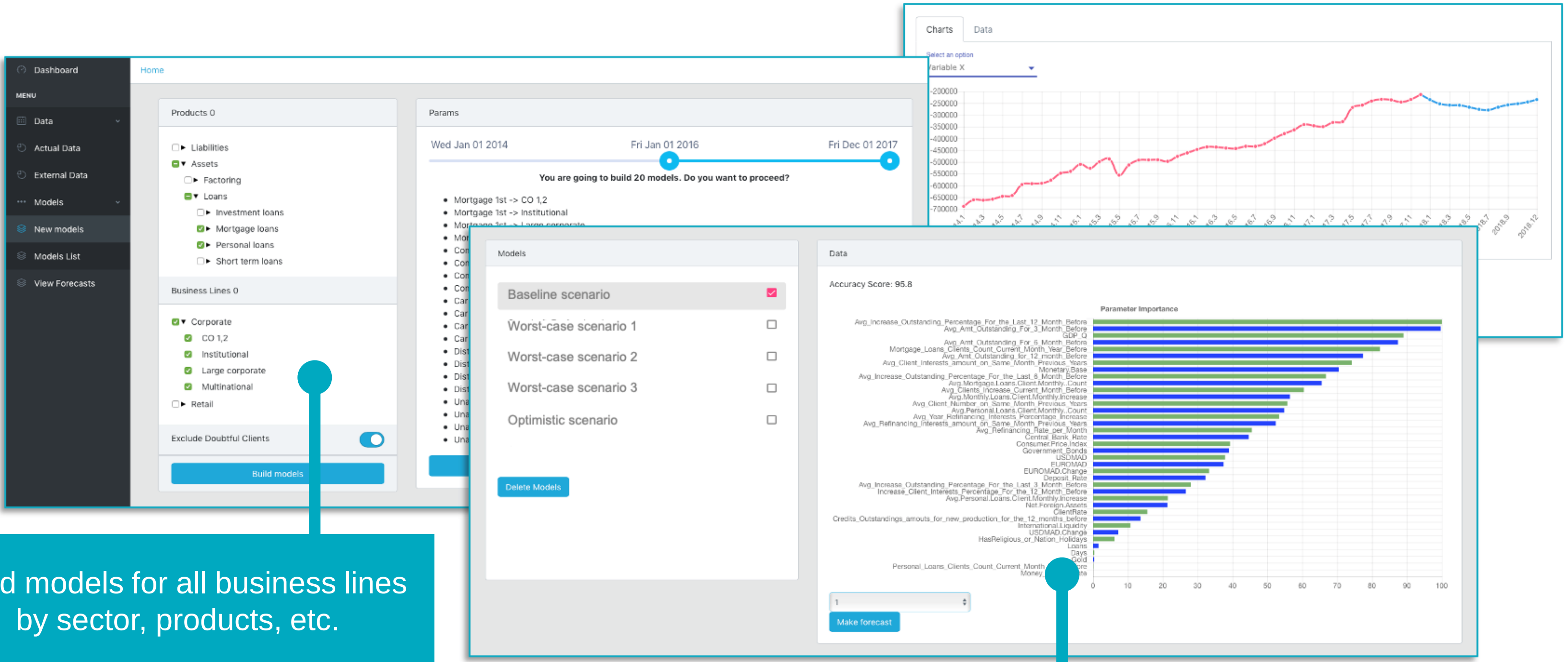
Impact

- ✓ Improved business performance with accurate financial projections and identified additional revenues
- ✓ Significant time savings through large tasks optimization

Case study 10: Finance (*Intelligent budgeting*)

Easy-to-use intelligent solution that allows companies to build budget on-the-fly with automated advanced analytics:

- ✓ Macroeconomics forecasts based on external data (ARIMA)
- ✓ 'What-If' products' sales and budget forecast (70+ neural network models)
- ✓ Targets based on projections
- ✓ 'Need-For' prescriptive analytics based on targets
- ✓ Scenario analysis for stress-testing



Build models for all business lines by sector, products, etc.

Analyze factors importance for each model to better understand budget components relation

Benefits

- A global and comprehensive view deriving from decisions
- Reliable visibility for day-to-day monitoring and decision making

Impact

- Improved business performance with accurate KPIs projections and identified additional revenues
- Significant time savings through large tasks optimization

Project milestones:

- ✓ Developed and successfully tested MVP with BNP Paribas Group
- ✓ Production version in progress..
- Scale the solution across the group

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Thank you!

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