Faculty of Information Technology

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av. Dmytra Yavornytskoho, 19
http://www.nmu.org.ua/en/

DNIPRO UNIVERSITY of TECHNOLOGY 1899

Department of System Analysis and Control

Research and development of complex objects and systems in the field of humanitarian, social, natural and technical sciences.

Dnipro University of Technology

Students	over 10 000
Teachers	771
Graduation specialties	53
Institutes	4
Faculties	9
Departments	52
Scientific councils	7
International partners	118

77 Undergraduate courses

30 Postgraduate courses

13 Doctoral courses

According to the national rating "Top 200 Ukraine 2019 in Ukraine-2019" Dniorotech takes:

- 4th place among technical universities.
- 8th place among higher educational institutes.

Entered the ratings QS EECA, "top 50 Ukrainian HEE according to employers" from magazine "Focus"

System analysis and control department

http://sau.nmu.org.ua/en/index.php

- was founded in 1971.
- carries out preparation of bachelors and masters of direction "System Analysis“ since 1999.
- The educational process is provided by
  - 4 professors, 3 doctors of sciences;
  - 8 associate professors (4 Phd in physics and mathematics, 4 Phd in technical sciences);
  - 4 experienced assistants.

Scientific Direction

- Applicating of artificial intelligence methods to solving industrial problems in metallurgy and mining;
- Optimal control of systems with distributed parameters. Approximation of Optimization Problems for Ill-Posed Nonlinear Elliptic Systems;
- Research of stability and stabilization of unsteady rotation of a rigid body with fluid, modeling of complex systems;
- Optimal two-stage allocation of material flows in a transport-logistic system with continuously distributed resource;
- Mathematical modeling and methods for solving problems of optimal multiplex partitioning of sets;
- Development of the adversarial attack algorithms.

Evolutionary methodology used to manage, optimize production processes and forecasting in metallurgy

Provided by Timur A. Zheldak, associated professor, Phd inTechnical sciences

Problems solved:

- Task scheduling of orders in a wide range of products
- The task of optimizing the charge in the BOF production
- The task of restoring the functions of mathematical models of steel deoxidation and certification of finished products
- Two-stage task of optimum cutting of billets of rolling production
- The problem of predicting the stability of the converter lining
- Ingot weight optimization problems due to the flow of the process in future cutting

Pages and Contacts:

https://orcid.org/0000-0002-4728-5889
http://www.researcherid.com/rid/E-9761-2019
https://scholar.google.com.ua/citations?hl=uk&user=mFvgN9UAAAAJ
zheldak.t.a@nmu.one

Evolutionary methodology used to manage, optimize production processes and forecasting in metallurgy

Main methods:

1) Group method of data handling (GMDH)
2) Ant colony optimization (ACO, ASC, MMAS)
3) Method of simulating artificial immune systems (HIMO, HISF, AiNET)
4) Real numerical coding genetic algorithm (RCGA)
5) Rules-based expert systems (ExSys)
6) Fuzzy-logic nets and decision making systems (ANFIS, Mamdani, Takagi-Sugeno)

The main publications for this study:

1) http://nbuv.gov.ua/UJRN/Nvngu_2016_5_24 .
2) http://nbuv.gov.ua/j-pdf/Nvngu_2013_1_16.pdf
3) https://www.academia.edu/10576535/Knowledge-Based_Intellectual_DSS_of_Steel_Deoxidation_in_BOF_Production_Process
4) https://www.academia.edu/10567334/Using_an_Evolutionary_Heuristics_for_Solving_the_Outdoor_Advertising_Optimization_Problem

Research of stability and stabilization of unsteady rotation of a rigid body with fluid, modeling of complex systems

Provided by Tatyana V. Khomyak, associated professor, Candidate of Physical and Mathematical Sciences

Object of Investigation is a Lagrange top with an axisymmetric cavity containing an ideal incompressible fluid.

Subject of Investigation is the problem of stability and passive stabilization of the unstable rotation of a Lagrange top with a fluid by means of rotating rigid bodies.

Research methods. Methods of analytical mechanics (Hamilton-Ostrogradsky principle) and modal analysis (equations of perturbed motion of a perfect rotating fluid) were used to obtain equations of motion of a system of elastically coupled rigid bodies with fluid. The conditions for the reality roots of the n degree equation are used, which are obtained by the innor method.

References

1. Khomyak T. V. Stabilization of the Unstable Spinning of a Lagrange Top Filled with a Fluid. International Applied Mechanics – 2015. – V.51, № 6, P. 702-709. (https://link.springer.com/article/10.1007/s10778-015-0728-0)
2. Khomyak T.V., Kononov Y.N. On the rotation stabilization of the unstable gyroscope containing fluid by rotating the rigid body. Facta Universitatis, Ser. Mech. Autom. Contr. Robotics, 4, No. 17, 195–201 (2005).
3. Khomyak T.V., Kononov Y.N. Stabilization by rotating rigid bodies for unstable rotation of a rigid body with cavities containing a fluid: Abstract and CD-ROM Proc. 21st Int. Congr. on Theoretical and Applied Mechanics (ICTAM-04), IPPT PAN, Warsaw, Poland (2004), p. 320.
4. Khomyak T.V., Kononov Y.N. Stabilization of the unstable spinning of a rigid body with a fluid by a rotating rigid body," Visn. Donetsk. Univ., Ser. A, No. 2, 180–185 (2003).
5. Khomyak T.V., Kononov Y.N. Stabilization of the unstable free motion of a rigid body with a fluid by rotating rigid bodies: Proc. 3rd Belarus. Congr. on Theoretical and Applied Mechanics, OIM, Minsk, October 16–18 (2007), pp. 332–337.

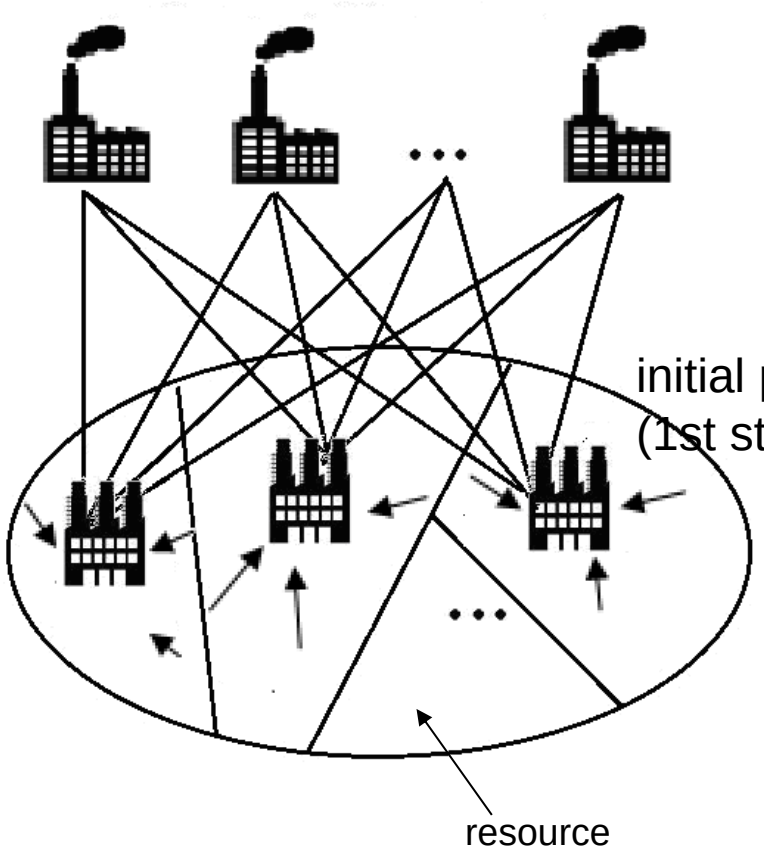
Optimal two-stage allocation of material flows in a transport-logistic system with continuously distributed resource

Provided by Svitlana A. Us, PhD in Physics and Mathematics, Professor;
Olha D. Stanina, Phd inTechnical sciences

The object of the research is a two-stage process of material flows allocation in the transport-logistic system, the structural elements of which are enterprises that collect a resource, is been distributed in a certain territory (centers of the first stage), and the enterprises that consume or process this resource.

Objective. The goal of the work is to ensure the reduction of transport costs in the organization of multi-stage production, the raw material resource of which is distributed in some territory, through the development of appropriate mathematical apparatus and software.

Two-stage transport problem with continuously distributed resource



Problem. It is necessary to find the location coordinates of the first-stage centers in a given territory, determine the service areas of these centers for the collection of raw materials and distribute the preliminary sorted raw materials between the centers of the second stage minimizing total transport costs.

Application areas

- rational collection of agricultural crops and their delivery first to the granaries, and then to the end user;
- forming a network of modern waste transfer stations and waste sorting stations to reduce the specific total costs for the export of waste;
- planning of logging operations and subsequent removal of timber with the organization of intermediate warehouses, taking into account not only the specific plots being developed, but also the possibility of using pile sites for delivering timber to them from neighboring felling areas;
- distribution of materials flows between customers, points of receipt and processing of raw materials, ensuring minimum transportation costs;
- formation of a regional warehouse network, net of a postal delivery services.

Spesific features of the task

- the resource, that is collected and transported, is continuously distributed throughout the specified area;
- the location of the first stage enterprises may be known in advance or not;
- capacities of the the first stage enterprises can be set in advance or they will have been determined by the amount of raw materials collected in their corresponding zones

Methods. The theory of continuous linear problems of optimal set partitioning, duality theory, and methods for solving linear programming problems of transport type.

Two-stage transport problem with continuously distributed resource

Problem A. To find such partition of set Ω into disjoint subsets $\bar{\omega} = \{\Omega_1, \Omega_2, \ldots, \Omega_N\}$ (some of which can be empty), to determine coordinates of its centers $\tau_1^I, \ldots, \tau_N^I$ and supply volumes $v_{11}, \ldots, v_{NM}$, under which the functional

$$F(\bar{\omega}, \tau^I, v) = \sum_{i=1}^{N} \int_{\Omega_i} c_i^I(x, \tau_i^I)\, \rho(x) dx + \sum_{i=1}^{N} \sum_{j=1}^{M} \left(c_{ij}^{II}(\tau_i^I, \tau_j^{II}) + a_i \right) v_{ij} \quad (1)$$

would have reached a minimum value, and the following conditions were satisfied:

$$\int_{\Omega_i} \rho(x) dx = \sum_{j=1}^{M} v_{ij},\ i = \overline{1, N}, \quad (2)$$

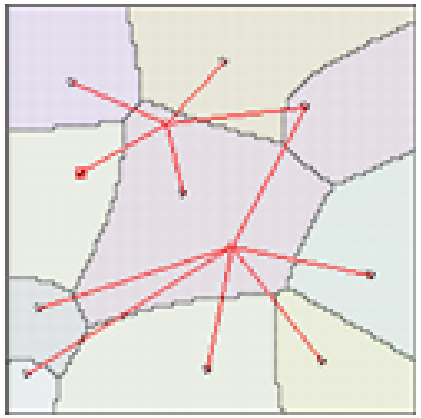
$$\sum_{i=1}^{N} v_{ij} = b_j^{II},\ j = \overline{1, M}, \quad (3)$$

$$\bar{\omega} \in \Sigma_\Omega^N,\ v \in R_{NM}^+,\ \tau^I \in \Omega^N, \quad (4)$$

$$\Sigma_\Omega^N = \left\{ \bar{\omega} = \{\Omega_1, \ldots, \Omega_N\}:\ \bigcup_{i=1}^{N} \Omega_i = \Omega,\ \text{mes}\left(\Omega_i \cap \Omega_j\right) = 0,\ i \neq j,\ i,\ j = \overline{1, L} \right\}. \quad (5)$$

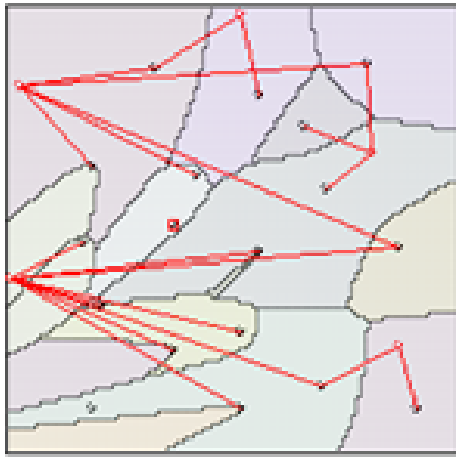
Optimal partition of set and communication scheme

M=2

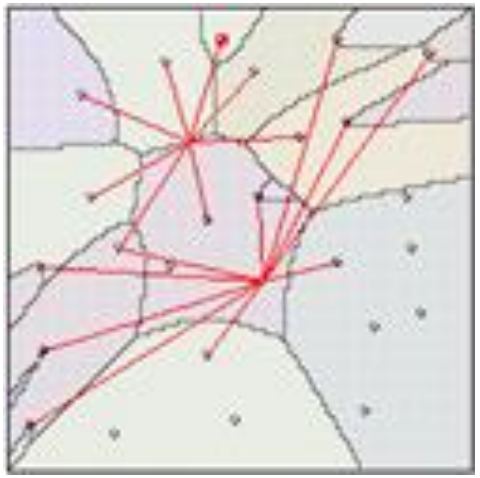


N=10

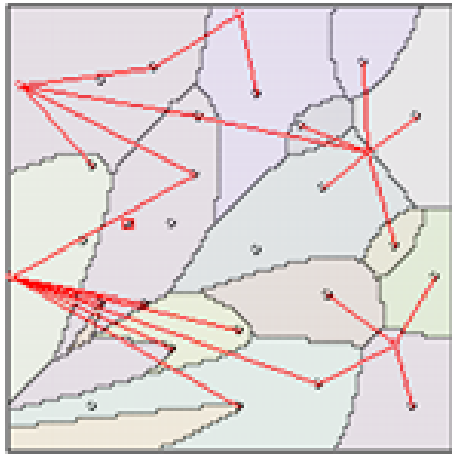
M=5



N=18



N=25



N=25

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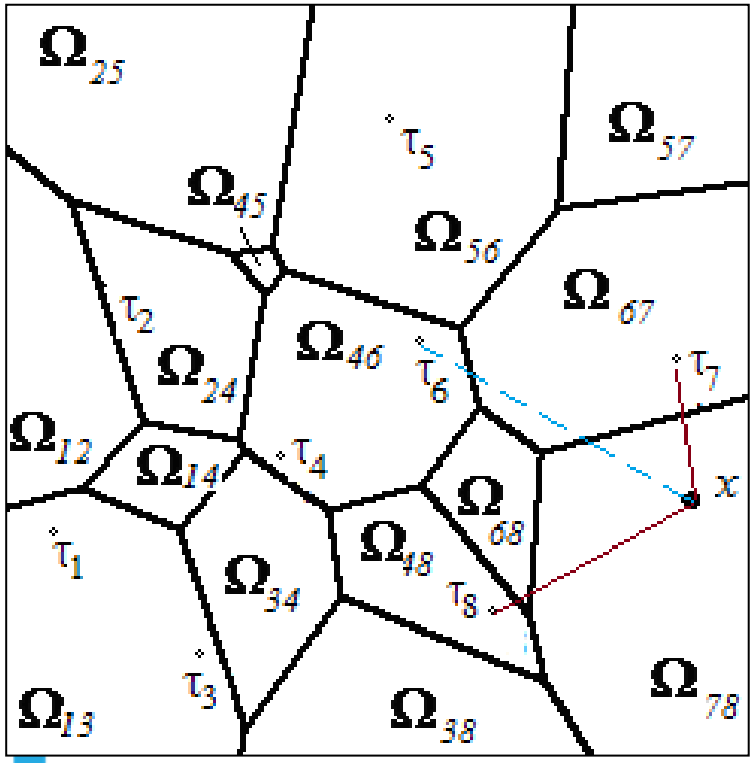
1. An optimal two-stage distribution of material flow at the fuel and energy complex enterprises / B Blyuss, L Koriashkina, S Us, S Minieiev, S Dziuba - E3S Web of Conferences, 2019 / DOI https://doi.org/10.1051/e3sconf/201910900008
2. Zelentsov D., Us S., Koryashkina L., Stanina O. , Solving Continual Two-Stage Problems of Optimal Partition of Sets // International Journal of Research Studies in Computer Science and Engineering (IJRSCSE) / Volume 4, Issue 4, 2017, PP 72-80
3. Us S.A, Stanina O.D, The methods and algorithms for solving multi-stage location-allocation problem, Power Engineering and Information Technologies in Technical Objects Control, Balkema 2016, pp 163-172.
4. Us S.A, Stanina O.D, On some mathematical models of facility location problems of mining and concentration industry, Theoretical and Practical Solutions of Mineral Resources Mining, Balkema 2015, pp 419-424.

Mathematical modeling and methods for solving problems of optimal multiplex partitioning of sets

Provided by **Larysa S. Koriashkina** P. , PhD in Physics and Mathematics, associated professor and **Antonina P. Cherevatenko**, PhD in Technical Science, teaching assistant



Problem statement: It is required to find a partition of the limited set into subsets of points, each of which would correspond (in accordance with certain criteria) to the same set of *k* points from *N*, which are called centers (sites) (*k*<*N*).

- Coordinates of centers can be either known or have to be determined along with partition.
- The restrictions on power of subsets, possible places of centers' location and other can be considered.

Examples of project results

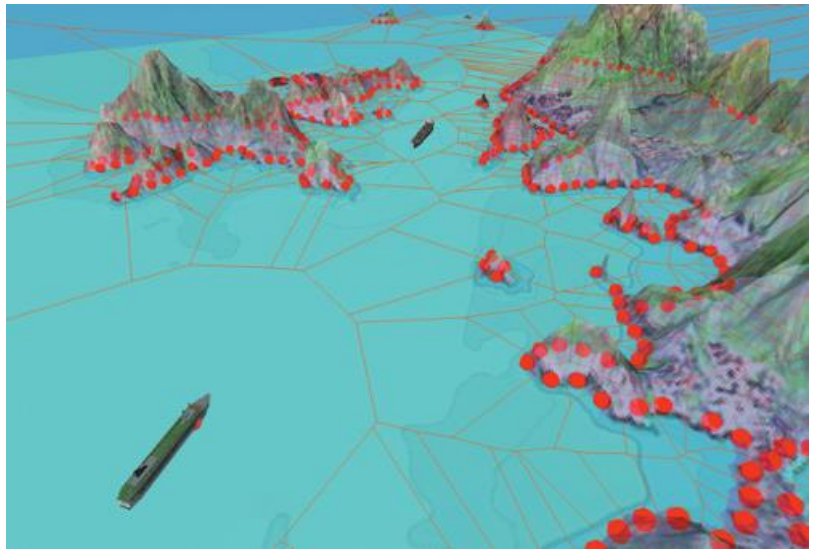
a *b*

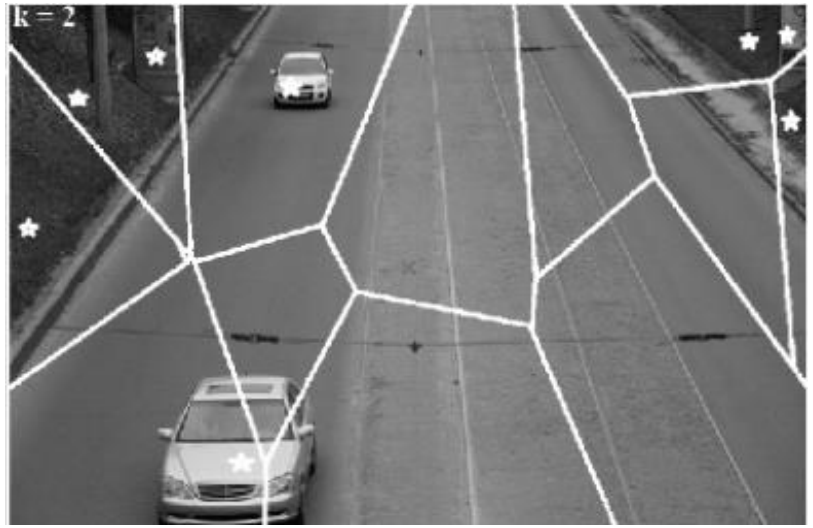
Fig. 1. Optimal partitions of the second order of a disjoint set for nine centers in Minkowski metric with parameter $p = 2$ (*a*) and $p = 1$ (*b*)

Fig. 2. Optimal partition of the second order of a disjoint set for nine using data from GIS

Practical applications

- computer graphics,
- geometric modeling,
- pattern recognition and forms analysis,
- maps segmentation,
- geospatial data mining,
- modeling of retail trade areas,
- analysis of video frames content,
- etc.





- Koriashkina L.S. Continuous problems of optimal multiplex-partitioning of sets without constraints and solving methods / L.S. Koriashkina, A.P. Cherevatenko // Journal of Computational & Applied Mathematics. — 2015. — N 2 (119). — P. 15–32.

- Koriashkina L. The continuous problems of the optimal multiplex partitioning an application of sets / L. Koriashkina, A. Cherevatenko, O. Mykhalova // Power Engineering and Information Technologies in Technical Objects Control – Pivnyak, Beshta & Alekseyev (eds). — Taylor & Francis Group, London. — 2016. — P. 233–239.

Development of the adversarial attack algorithms

Provided by **Larysa S. Koriashkina** P. , PhD in Physics and Mathematics,
associated professor and **Kostiantyn Khabarlak**, postgraduate student

The ongoing research in a direction of neural network inference understanding has led to a discovery coined as **Adversarial Attack**.

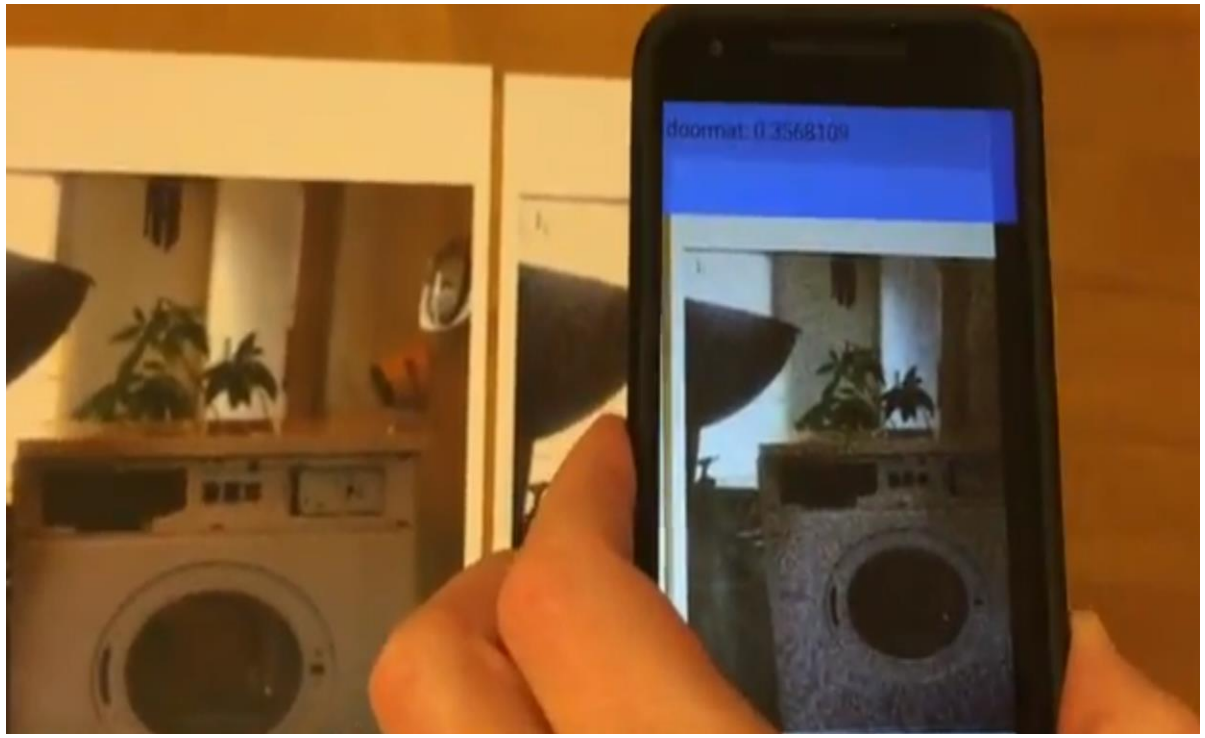
By adding a slight human-imperceptible perturbation to an input image, it has been made possible to fool the network and force it to misclassify the image as an instance of another class.

Such an attack has been further divided into **2 subgroups**:

1) **the non-targeted attack**, when the new inference class is of no importance unless it's different from the source;
2) **the targeted attack**, when we specify the target class we want the network to predict after the attack for a given image.

Problem statement: It is required to develop simplified adversarial attack algorithms based on a scoping idea, which

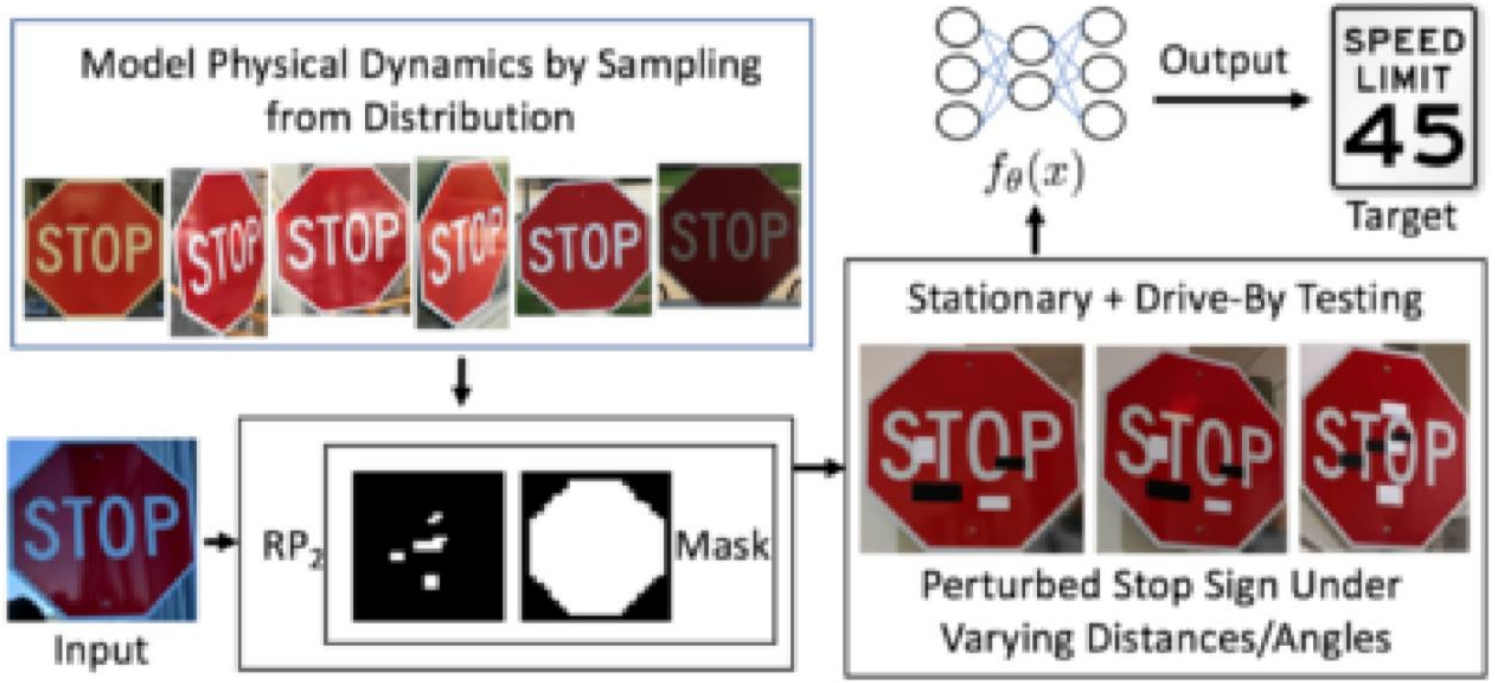
- enables execution of fast adversarial attacks that minimize structural image quality (SSIM) loss,
- allows performing efficient transfer attacks with low target inference network call count
- opens a possibility of an attack using pen-only drawings on a paper for the MNIST handwritten digit dataset.



Floor mat

Adversarial examples in the physical world / A. Kurakin, I. Goodfellow, and S. Bengio. – 2016.

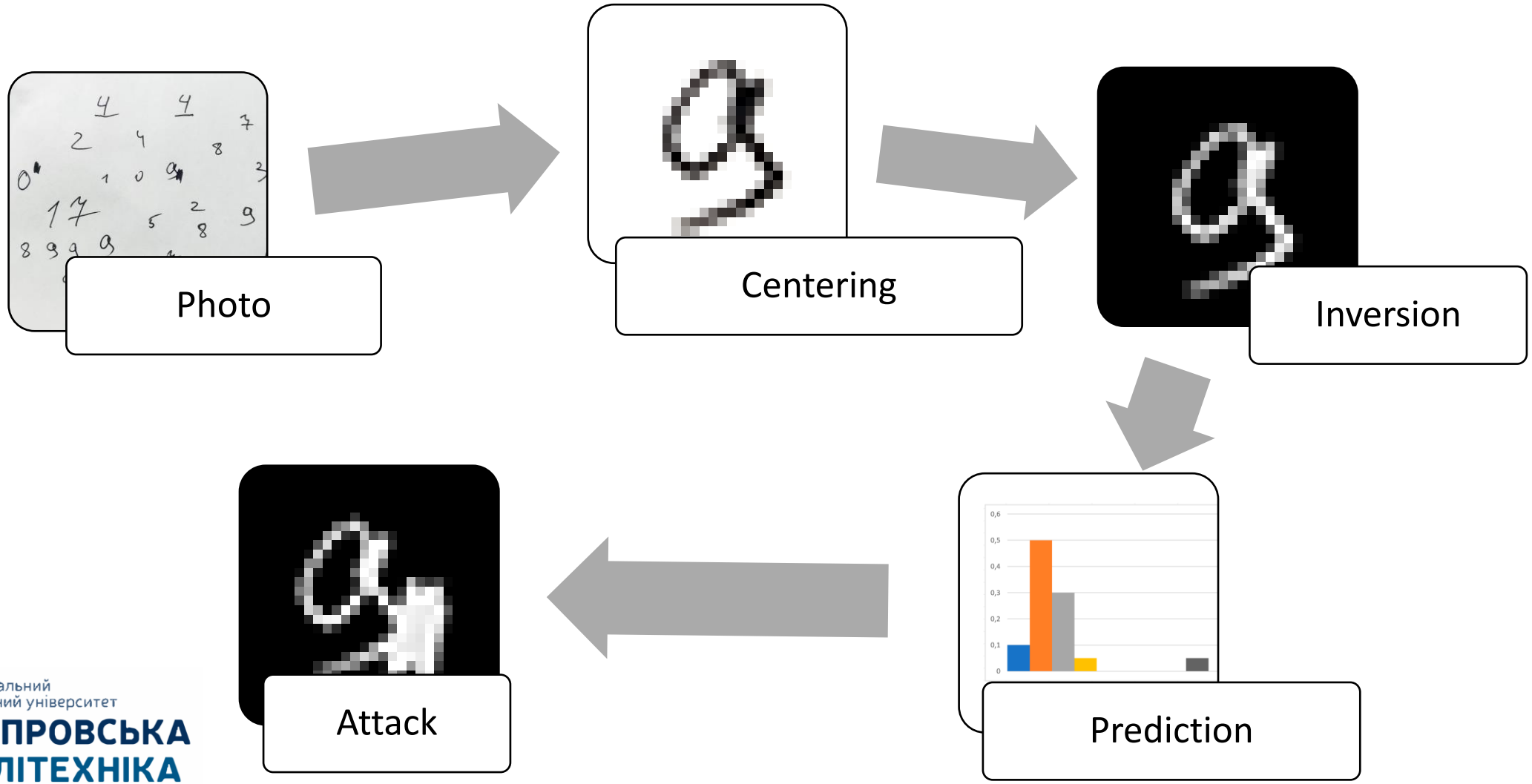
Adversarial attacks can be conducted in real-world



«Stop» – «Speed Limit 45»

Robust Physical-World Attacks on Deep Learning Models. / Kevin Eykholt, Ivan Evtimov, Earlence Fernandes, Bo Li, Amir Rahmati, Chaowei Xiao, Atul Prakash, Tadayoshi Kohno, Dawn Song. – 2018.

Practical application



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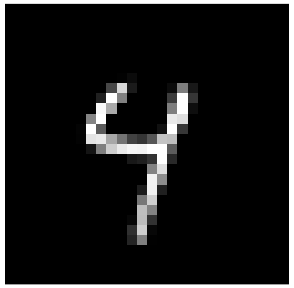
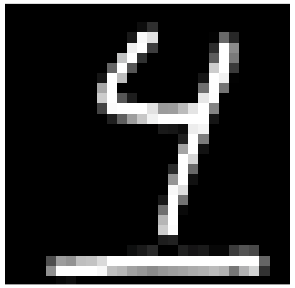
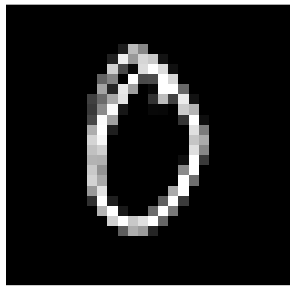
Attacks performed with the help of the designed importance map are successful



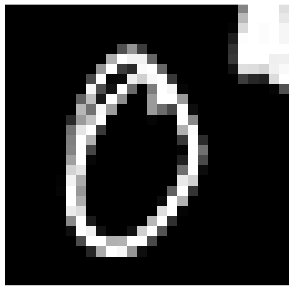
4 (80%)



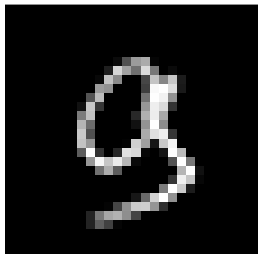
9 (42%)



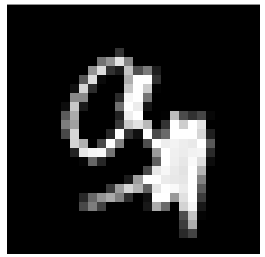
0 (81%)



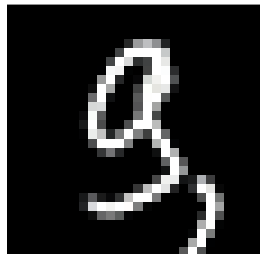
5 (100%)



9 (53%)



6 (56%)



5 (62%)

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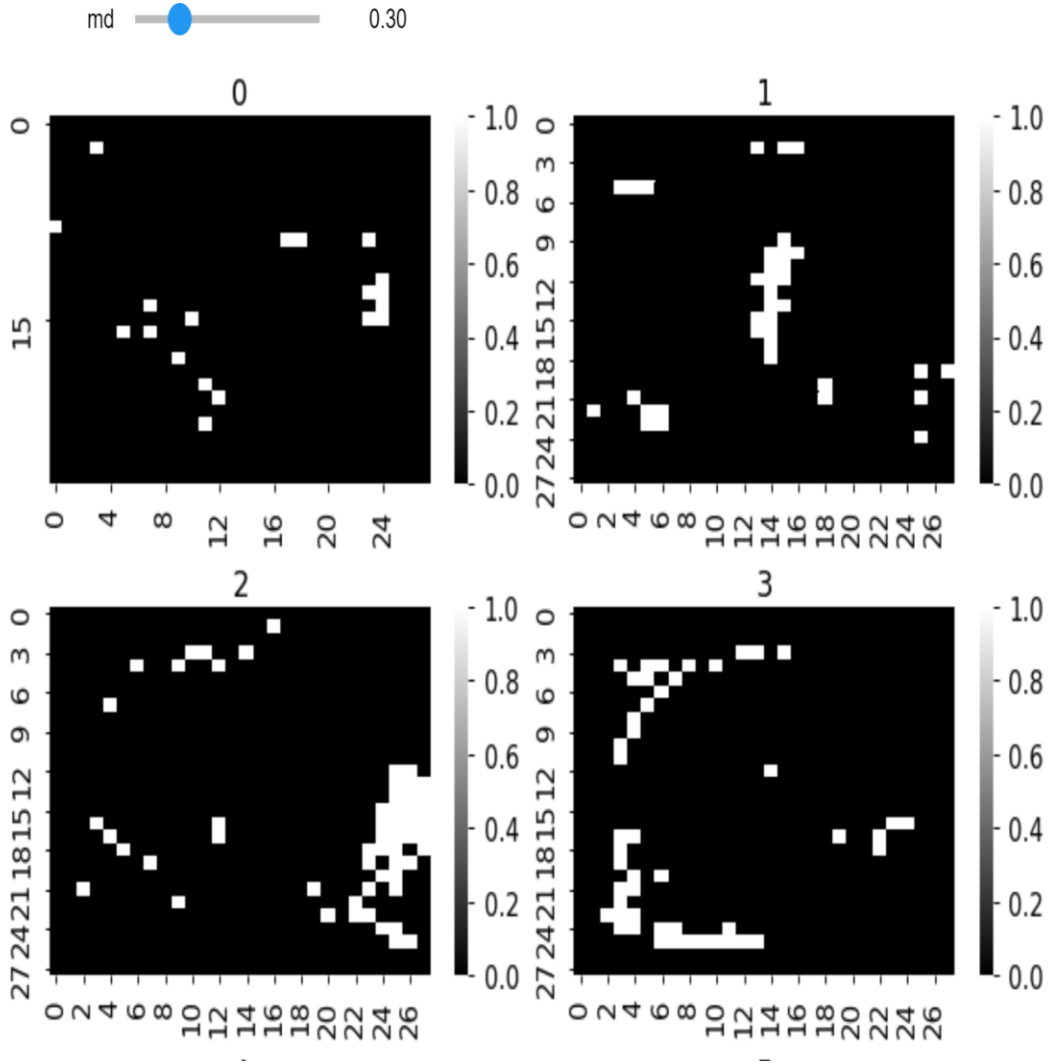
What was be used?

- binary map of importance
- Ability to write in only one color
- Regularization of the algorithm’s parameter *min_diffrence*



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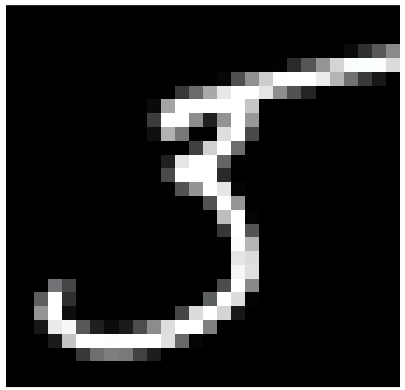
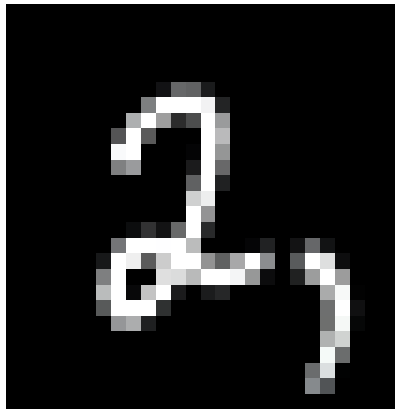
Random perturbations without knowing vulnerable regions have no effect



3 (74%),
5(26%)



2 (98%)

- **Khabarlak. K, Koriashkina L.** Minimizing Perceived Image Quality Loss Through Adversarial Attack Scoping – arXiv preprint arXiv:1904.10390

- **Khabarlak. K, Koriashkina L.** Scoping Adversarial Attack for Improving its Quality – Radio Electronics, Computer Science, Control, 108-118 – 2019

Directions of student scientific work

- Development of distributed client-server applications;
- Development of expert systems;
- Analysis and optimization of business processes of enterprises;
- Conducting system analysis and development of DSS for making managerial decisions in the conditions of production enterprises;
- The use of adaptive smoothing methods for predicting the performance of enterprises.

Dual degree programm

Problems

- Differences in the schedule of the educational process;
- Annual changes to the list of available courses

  We need it by September or earlier to coordinate a curriculum before educational process will be start

Module Equivalents at the University of Koblenz-Landau and at the National Mining University

Modules and Study Units at the Uni KO-LD "Mathematical Modeling of Complex Systems"	Modules and Study Units at the National Mining University "System analyses and control"
Project seminar Project seminar	Industrial Practical Training Pre-Diploma Practical Training
Master thesis final oral exam	Master thesis final oral exam
Special topics of Applied Mathematics	Game Theory in the Conflict Situation Studies Special topics of Applied Mathematics
Numerics for Partial Differential Equations	Mathematic Modelling and Analysis Dynamic System
Integer Optimization	Methods of discreet optimization
Pattern Recognition	Machine Learning of Complex Systems
Machine Learning & Data Mining	Intellectual Data Analysis
Robotics and Computer Vision	Robotics and Computer Vision
Enterprise Architecture Modeling I	Enterprise Architecture Modeling

Comparative characteristic of the program modules

Course name	Numbers of credits	Course name	Numbers of credits
Obligatory modules 2017		**Obligatory modules 2019**	
Higher School Pedagogy	**3**		
Intellectual Property	**3**		
Philosophical Issues of Scientific Research	**3**		
		English/German/French for Professional Purposes	**6**
Labor Safety in the Branch	**3**	Security Management, Autonomy and Responsibility in Professional Activities	**3**
Methodology of Scientific Research	**3**	Methodology of Scientific Research	**3**
Game Theory in the Conflict Situation Studies	**5**	**Game Theory in Conflict Situation Studies**	**6**
Intellectual Data Analysis	**6**	**Intellectual Data Analysis**	**6**
Basics of Logistics	**6.5**	Basics of Logistics	**6**
Industrial Practical Training	**6**	**Industrial Practical Training**	**8**
Pre-Diploma Practical Training	**3**	**Pre-Diploma Practical Training**	**4**
Master Thesis	**21**	**Master Qualification Thesis**	**18**
Optional Compulsory Section		**Optional Compulsory Section**	
Enterprise Economic Activity Analysis	**4**		
Integrated Management Systems	**7.5**		
Project Management	**5**		
Discrete Optimization Methods		**Discrete Optimization Methods**	**6**
Mathematic Modelling and Analysis Dynamic System	**5**	**Mathematic Modelling and Analysis Dynamic System**	**6**
Machine Learning of Complex Systems	**6**	**Machine Learning of Complex Systems**	**6**
Enterprise Architecture Modeling	**6**	**Enterprise Architecture Modeling**	**6**
Robotics and Computer Vision	**6**	**Robotics and Computer Vision**	**6**

Students academic mobility

Proposels

- Academic mobility for bachelor student, who know German
- Dual supervisers of graduation projects (master and bachelor)
- holding summer schools
  - topics
  - organization of classes and excursions,
  - group work.
- the opportunity to attract students from other specialties for academic mobility

Thank you for your attention

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