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Hybrid Intelligence: theory and application scenarios

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About the author

Alexander P. Ryjov is a professor at Lomonosov Moscow State University, Faculty of Mechanics and Mathematics, Chair of Mathematical Foundations of Intelligent Systems, Russia. He is also the head of the Chair at the School of IT-management, Institute of Economics, Mathematics and Information Technology, Russian Presidential Academy of National Economy and Public Administration. Prof. Ryjov was elected Vice-president of the International Academy of CIO (https://iacio.org) in 2018. He is VP on AI Research at OneForce, Inc. (https://oneforce.co)

His areas of research are human-computer information intelligent systems, fuzzy set theory, bio-inspired computing. The theory is applied to information processing, a measure of uncertainty, hybrid intelligence, personalization of interaction with the digital world, evaluation and monitoring of complex business-, economical-, and socio-political problems and processes. He has 100+ scientific publications including 5 books and chapters in 12 books.

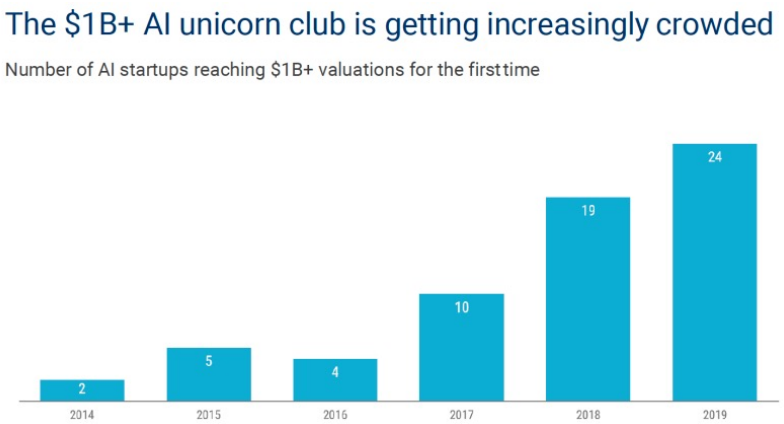
Alexander has extensive experience in large project management at national and international levels. He is passionately involved in activities in various professional bodies, expert of Russian Government Research and Consulting Center of Expertise, Ministry of Education and Science Russia/ Computer science group, Waseda University International e-Government Ranking Committee, Committee for grants Cluster Information Technologies Fund Skolkovo, Russian Academy of Sciences, Russian Foundation for Basic Research; he is member of advisory boards of Russian and international professional and scientific organizations; member of editorial boards of national and international scientific journals; member of organizing and program committees of national and international scientific conferences.

More detailed information available on http://www.intsys.msu.ru/en/staff/ryzhov/

AI: two pictures

😃

- $15.7tr - Potential contribution to the global economy by 2030 from AI; Up to 26% boost in GDP for local economies from AI by 2030:
  PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution - https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html
- McKinsey Global Institute predicts that the potential value of AI could reach US$13 trillion annually by 2030
  Notes from the AI frontier - https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-applications-and-value-of-deep-learning
- CB Insights:



- …

😠

- AI heading back to the trough. The expectations over artificial intelligence (AI) are becoming too inflated. AI will indeed change everything, but not any time soon.
  (https://www.networkworld.com/article/3206313/internet-of-things/ai-heading-back-to-the-trough.html)
- Inflated Expectations: Artificial Intelligence Still Depends on Humans (https://techonomy.com/2016/07/27222/)
- What AI mostly needs is expectation management (https://towardsdatascience.com/what-ai-mostly-needs-is-expectation-management-625c90ea147f)
- Here's Why AI Can't Solve Everything (https://www.sciencealert.com/ai-machine-learning-solve-all-humanity-problems-unrealistic)
- The Seven Deadly Sins of AI Predictions. Mistaken extrapolations, limited imagination, and other common mistakes that distract us from thinking more productively about the future. We are surrounded by hysteria about the future of artificial intelligence and robotics—hysteria about how powerful they will become, how quickly, and what they will do to jobs.
  (https://www.technologyreview.com/s/609048/the-seven-deadly-sins-of-ai-predictions/)
- …

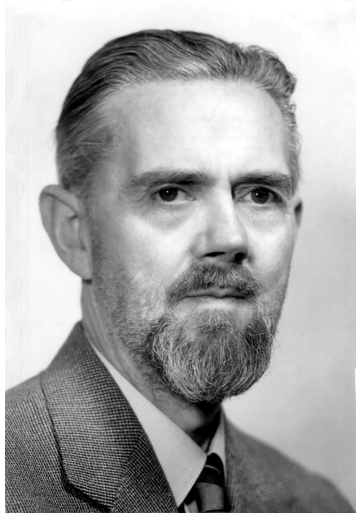
AI: wrong expectations and results

- **Facebook is shutting down M, its personal assistant service that combined humans and AI**
  'We learned a lot,' company says
  (https://www.theverge.com/2018/1/8/16856654/facebook-m-shutdown-bots-ai)
- **Cambridge Analytica and Scl Elections Commence Insolvency Proceedings and Release Results of Independent Investigation into Recent Allegations**
  (https://ca-commercial.com/news/cambridge-analytica-and-scl-elections-commence-insolvency-proceedings-and-release-results-3) (2 May 2018)
- **IBM's Watson Health wing left looking poorly after 'massive' layoffs** Up to 70% of staff shown the door this week, insiders claim
  (https://www.theregister.co.uk/AMP/2018/05/25/ibms_watson_layoffs/)
- Who next?
- What next? "AI winter" for 20 years?
- In this situation, the right step is backing to the starting point

AI winter
(https://en.wikipedia.org/wiki/AI_winter)

- The 1987 collapse of the LISP machine market
- Slowdown in deployment of expert systems
- The end of the Fifth Generation computers project
- Strategic Computing Initiative cutbacks
- …

Fathers-founders' vision: AI is not a self-sufficient, self-thinking, self-… box



William Ross Ashby: "***Intellectual power**, like physical power, **can be amplified**. Let no one say that it cannot be done, for the gene-patterns do it every time they form a brain that grows up to be something better than the gene-pattern could have specified in detail. What is new is that we can now do it synthetically, consciously, deliberately*"
(Ashby, W.R., (1956). *An Introduction to Cybernetics*. London, UK: Chapman and Hall, 1956 (p. 271). Retrieved from http://pespmc1.vub.ac.be/books/IntroCyb.pdf)

Joseph Carl Robnett Licklider : "***Man-computer symbiosis is an expected development in cooperative interaction between men and electronic computers**. It will involve very close coupling between the human and the electronic members of the partnership… Preliminary analyses indicate that the symbiotic partnership will perform intellectual operations much more effectively than man alone can perform them "*
(Licklider, J.C.R., (1960). Man-Computer Symbiosis. *IRE Transactions on Human Factors in Electronics, vol. HFE-1*, 4-11 (p. 4) Retrieved from http://groups.csail.mit.edu/medg/people/psz/Licklider.html)

Fuzzy logic – mathematics for Hybrid Intelligence

In a paper published in 1961 entitled “From Circuit Theory to System Theory” … I wrote:

> ”There is a fairly wide gap between what might be regarded as ‘animate’ system theorists and ‘inanimate’ system theorists at the present time, and it is not at all certain that this gap will be narrowed, much less closed, in the near future. There are some who feel that this gap reflects the fundamental inadequacy of conventional mathematics—the mathematics of precisely-defined points, functions, sets, probability measures, etc.—for coping with the analysis of biological systems, and that to deal effectively with such systems, which are generally orders of magnitude more complex than man-made systems, **we need a radically different kind of mathematics**, the mathematics of fuzzy or cloudy quantities which are not describable in terms of probability distributions. Indeed, the need for such mathematics is becoming increasingly apparent even in the realm of inanimate systems, for in most practical cases the a priori data as well as the criteria by which the performance of a man-made system are judged are far from being precisely specified or having accurately- known probability distributions.”

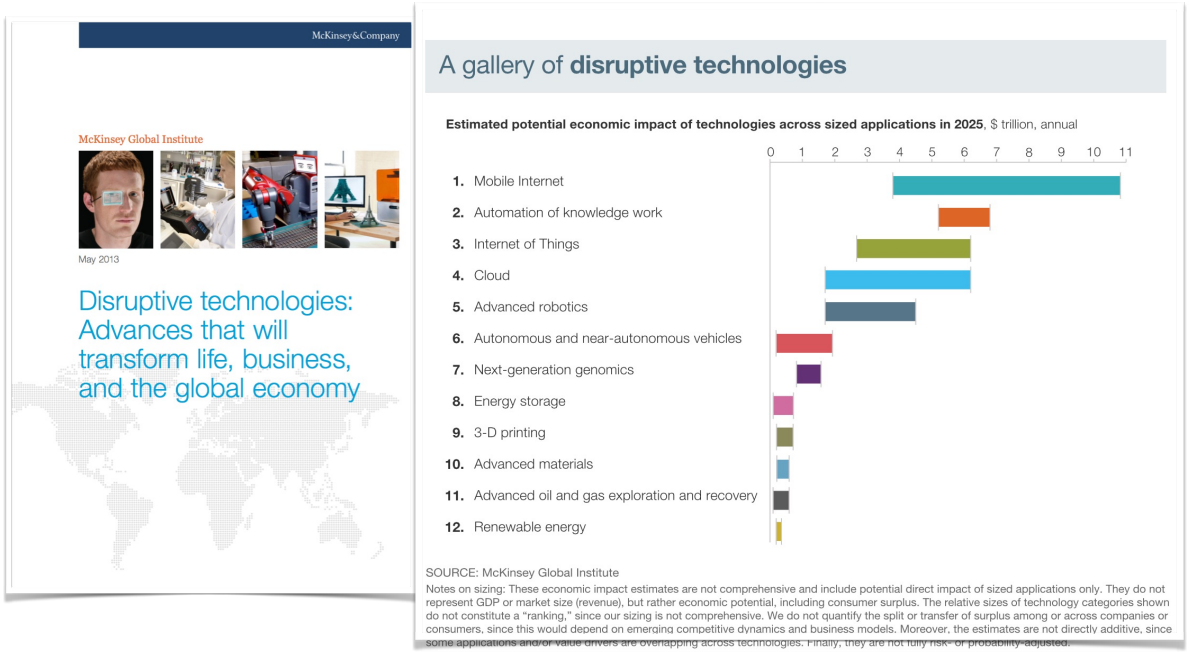
It was this observation that motivated my development of the theory of fuzzy sets, starting with the 1965 paper “Fuzzy Sets”, which was published in Information and Control.

From Computing with Numbers to Computing with Words. From Manipulation of Measurements to Manipulation of Perceptions. - IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS—I: FUNDAMENTAL THEORY AND APPLICATIONS, VOL. 45, NO. 1, JANUARY 1999 (https://ieeexplore.ieee.org/document/739259)

”The advent of the Computer age has stimulated a rapid expansion in the use of quantitative techniques for the analysis of economic, urban, social, biological and other types of systems in which it is the animate rather than inanimate behavior of system constituents that plays a dominant role. At present, most of the techniques employed for the analysis of *humanistic*, i. e., human-centred systems are adaptations of the methods that have been developed over a long period of time for dealing with *mechanistic* systems, i. e., physical systems governed in the main by the laws of mechanics, electromagnetism, and thermodynamics. The remarkable successes of these methods in unraveling the secrets of nature and enabling us to build better and better machines have inspired a widely held belief that the same or similar techniques can be applied with comparable effectiveness to the analysis of humanistic systems…. It is in this sense that **precise quantitative analyses of the behavior of humanistic systems are not likely to have much relevance** to the real-world societal, political, economic, and other types of problems which involve humans either as individuals or groups.”

Outline of a New Approach to the Analysis of Complex Systems and Decision Processes (IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS, VOL. SMC-3, NO. 1, JANUARY 1973 - https://pdfs.semanticscholar.org/1c08/0ebc575e1524f09cc1cb250cd087551b0989.pdf)

Business see perspectives of Hybrid Intelligence



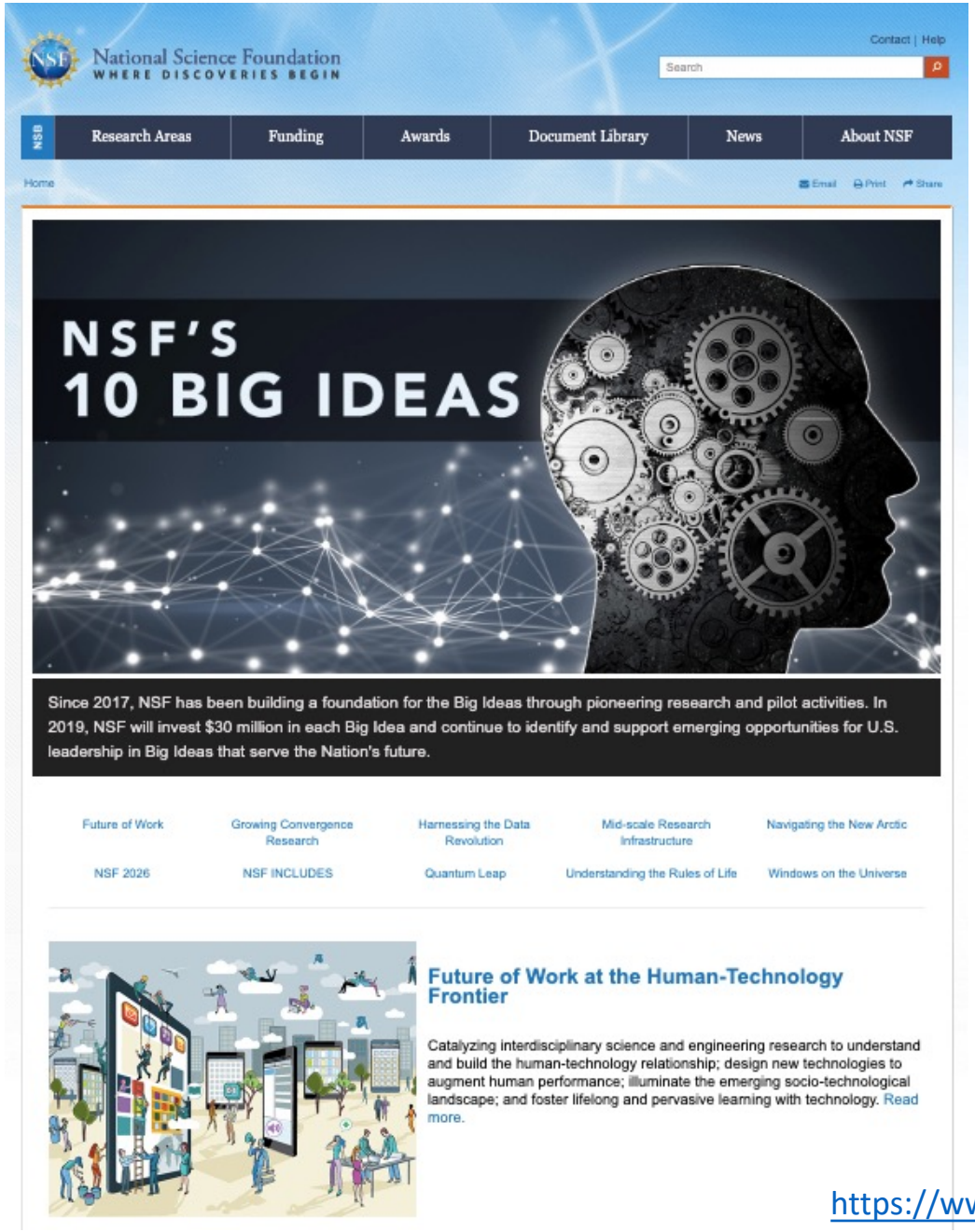
McKinsey. Automation of knowledge work - *"These capabilities not only extend computing into new realms …, but also create new relationships between knowledge workers and machines. It is increasingly possible to interact with a machine the way one would with a **coworker**"*

(McKinsey Global Institute (May 2013). *Disruptive technologies: Advances that will transform life, business, and the global economy*. (p.41) Retrieved from http://www.mckinsey.com/insights/business_technology/disruptive_technologies)

IBM. *"At IBM, we are guided by the term "augmented intelligence" rather than "artificial intelligence". It is the critical difference between systems that **enhance and scale human expertise** rather than those that attempt to replicate all of human intelligence. We focus on **building practical AI applications that assist people** with well-defined tasks, and in the process, expose a range of generalized AI services on a platform to support a wide range of new applications"*

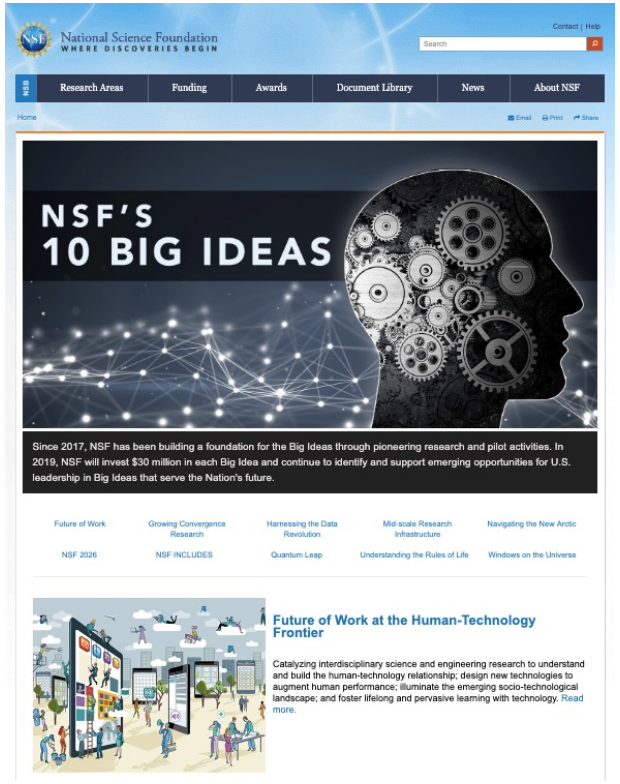
IBM, (2018). Cognitive computing. Preparing for the Future of Artificial Intelligence. Retrieved from http://research.ibm.com/cognitive-computing/ostp/rfi-response.shtml

Now: NSF



https://www.nsf.gov/news/special_reports/big_ideas/index.jsp

Now: NSF



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NSF 2026	NSF INCLUDES	Quantum Leap	Understanding the Rules of Life	Windows on the Universe

Future of Work at the Human-Technology Frontier

Understanding how constantly evolving technologies are actively shaping the lives of workers and how people in turn can shape those technologies, especially in the world of work.

The future of work at the human-technology frontier will bring together NSF research communities to conduct basic scientific research on the interaction of humans, society, and technology that will help shape the future of work to increase opportunities for workers and productivity for the American economy.

Four research themes:

- Building the human-technology partnership
- Augmenting human performance
- Illuminating the socio-technological landscape
- Fostering lifelong learning.

RELATED NEWS

Future of Work at the Human-Technology Frontier
(Feb. 2019)

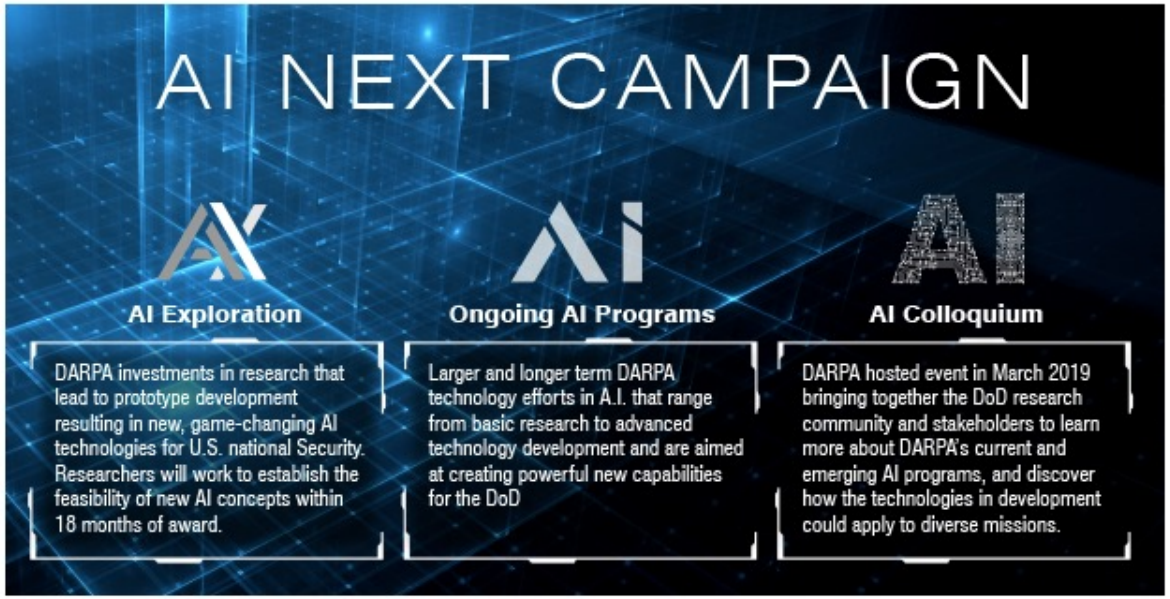
Future of Work at the Human-Technology Frontier: Core Research (FW-HTF)
(Program Announcement, Dec. 6, 2018)

Now: DARPA

DARPA DEFENSE ADVANCED RESEARCH PROJECTS AGENCY ABOUT US / OUR RESEARCH /

Defense Advanced Research Projects Agency > Work With Us

AI Next Campaign



For more than five decades, DARPA has been a leader in generating groundbreaking research and development (R&D) that facilitated the advancement and application of rule-based and statistical-learning based AI technologies. Today, DARPA continues to lead innovation in AI research as it funds a broad portfolio of R&D programs, ranging from basic research to advanced technology development. DARPA believes this future, where systems are capable of acquiring new knowledge through generative contextual and explanatory models, will be realized upon the development and application of "Third Wave" AI technologies.

https://www.darpa.mil/work-with-us/ai-next-campaign

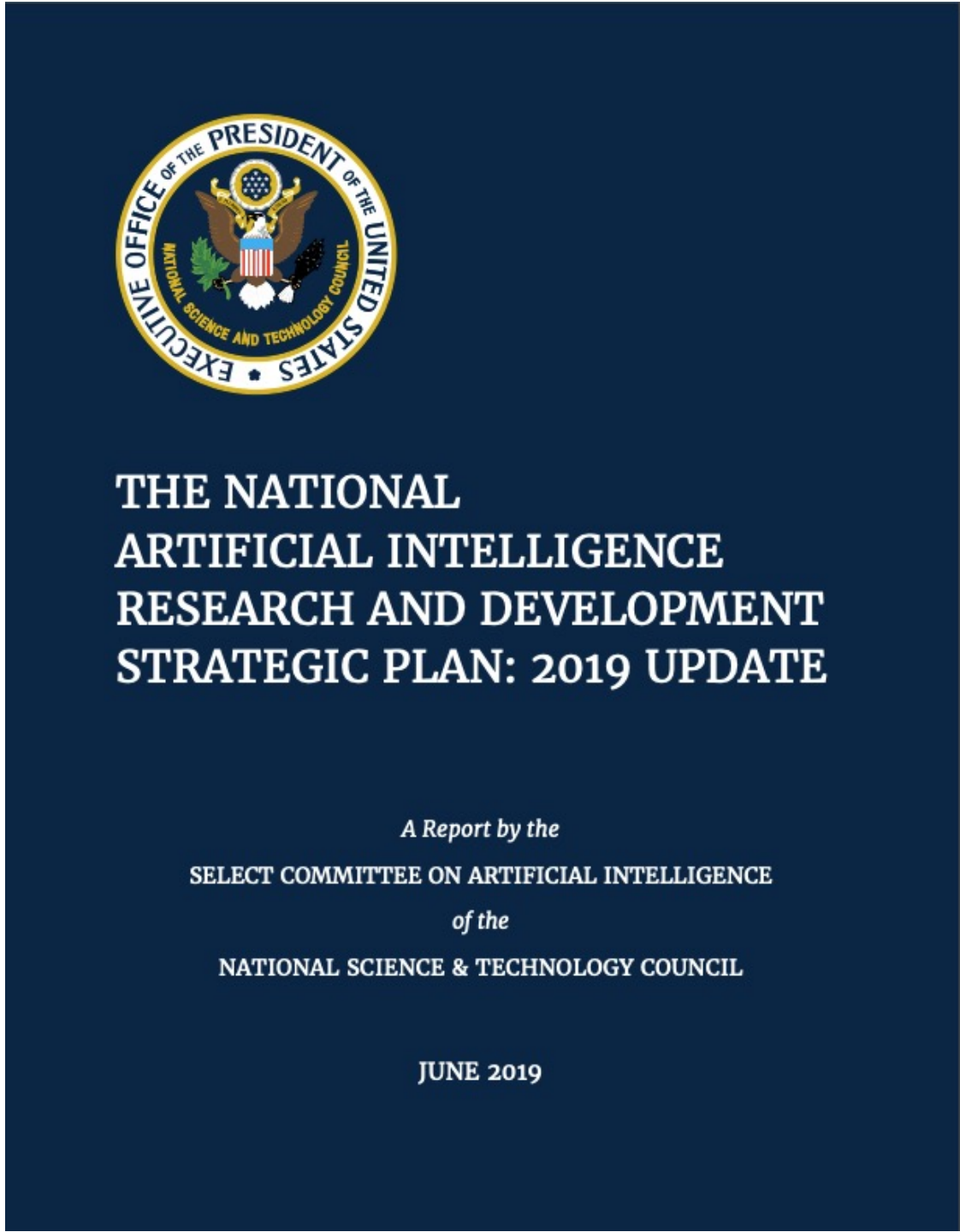
Now: DARPA

DARPA envisions a future in which machines are more than just tools that execute human-programmed rules or generalize from human-curated data sets. Rather, the machines DARPA envisions will function more as colleagues than as tools. Towards this end, DARPA research and development in **human-machine symbiosis** sets a **goal to partner with machines**.
...
DARPA is focusing its investments on a third wave of AI that brings forth machines that understand and reason in context.

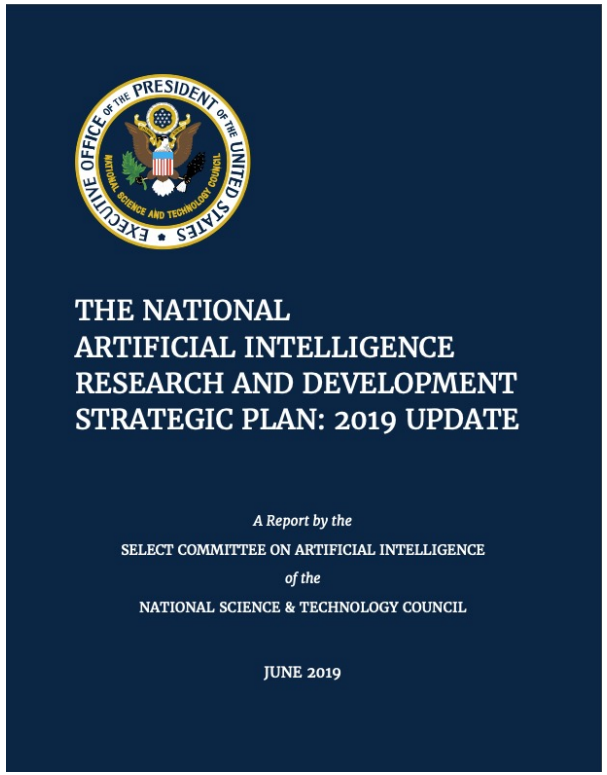
https://www.darpa.mil/news-events/2018-09-07

Now: Whitehouse

https://www.whitehouse.gov/wp-content/uploads/2019/06/National-AI-Research-and-Development-Strategic-Plan-2019-Update-June-2019.pdf?fbclid=IwAR3qk0nDr8-sGAqaJnch2m8-asO1JS1D9DjvapEEBth2CA9y5M6-thfhKlY



Now: Whitehouse



Strategy 2: Develop effective methods for human-AI collaboration. Increase understanding of how to create AI systems that **effectively complement and augment human capabilities**.

Table of Contents

https://www.whitehouse.gov/wp-content/uploads/2019/06/National-AI-Research-and-Development-Strategic-Plan-2019-Update-June-2019.pdf?fbclid=IwAR3qk0nDr8-sGAqaJnch2m8-asO1JS1D9DjvapEEBth2CA9y5M6-thfhKlY

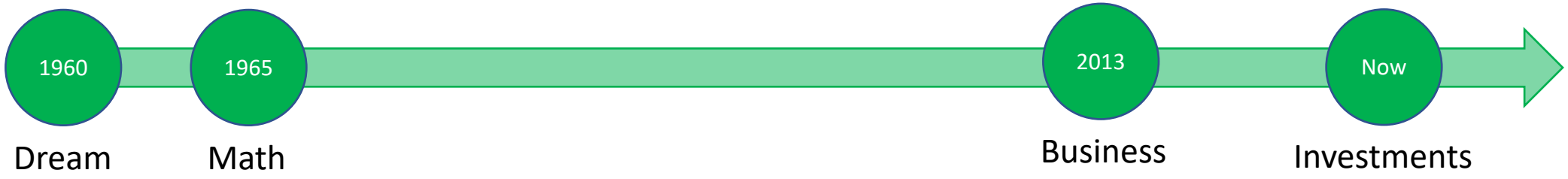
Hybrid Intelligence: from dream to investments

McKinsey & Company

Lotfi Zadeh (1965)

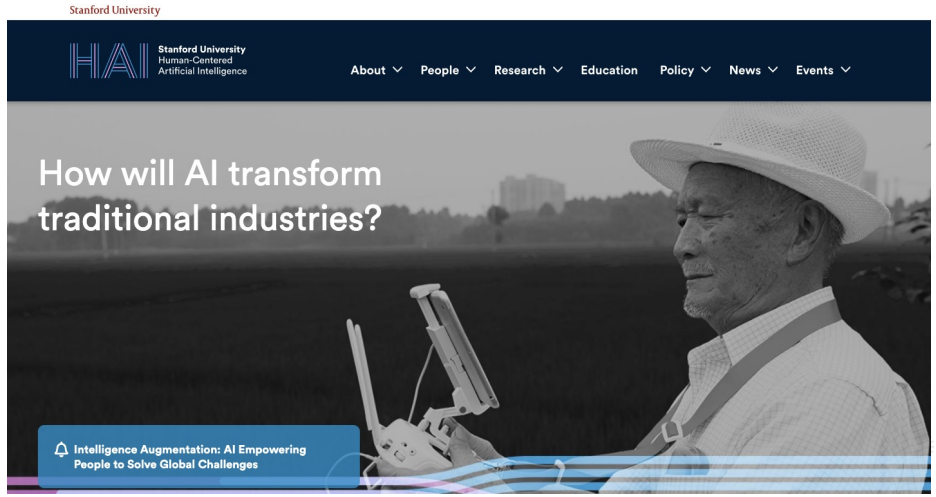
Joseph Carl Robnett Licklider (1960)

William Ross Ashby (1956)



Hybrid Intelligence: from investments to academia and business

- Stanford founded the Institute for Human-Centered AI (HAI) in 2019: to guide and build the future of AI (https://hai.stanford.edu/)
- Google's $5 Mn Funded AI Institute Will Explore Human-AI Interactions, 03/09/2020 (https://analyticsindiamag.com/googles-5-mn-funded-ai-institute-will-explore-human-ai-interactions/)
- Startups: OneForce, Inc. and others



ONEFORCE

Intelligent Software

Built to empower knowledge workers

Case study: muscular power amplifiers evolution

- Spade → Excavator
- Horse → Rocket
- Lever → Crane
- …

For different tasks we have different amplifiers

We have cases for an amplifiers of some Intelligence features

- Memory




- Computing Capabilities


AI as a dream

- Prometheus molded a man from clay
- Pygmalion carved a statue (Galatea) from ivory and fell in love with her, and Aphrodite revived the statue, and she became his wife
- Hephaestus created Pandora, the first woman on earth

- Iron man Albertus Magnus
- Mechanical knight da Vinci
- The mechanical children of Pierre Jacques-Droz
- The homunculus of Paracelsus

Fairy tales

Ancient Greece

Middle Ages

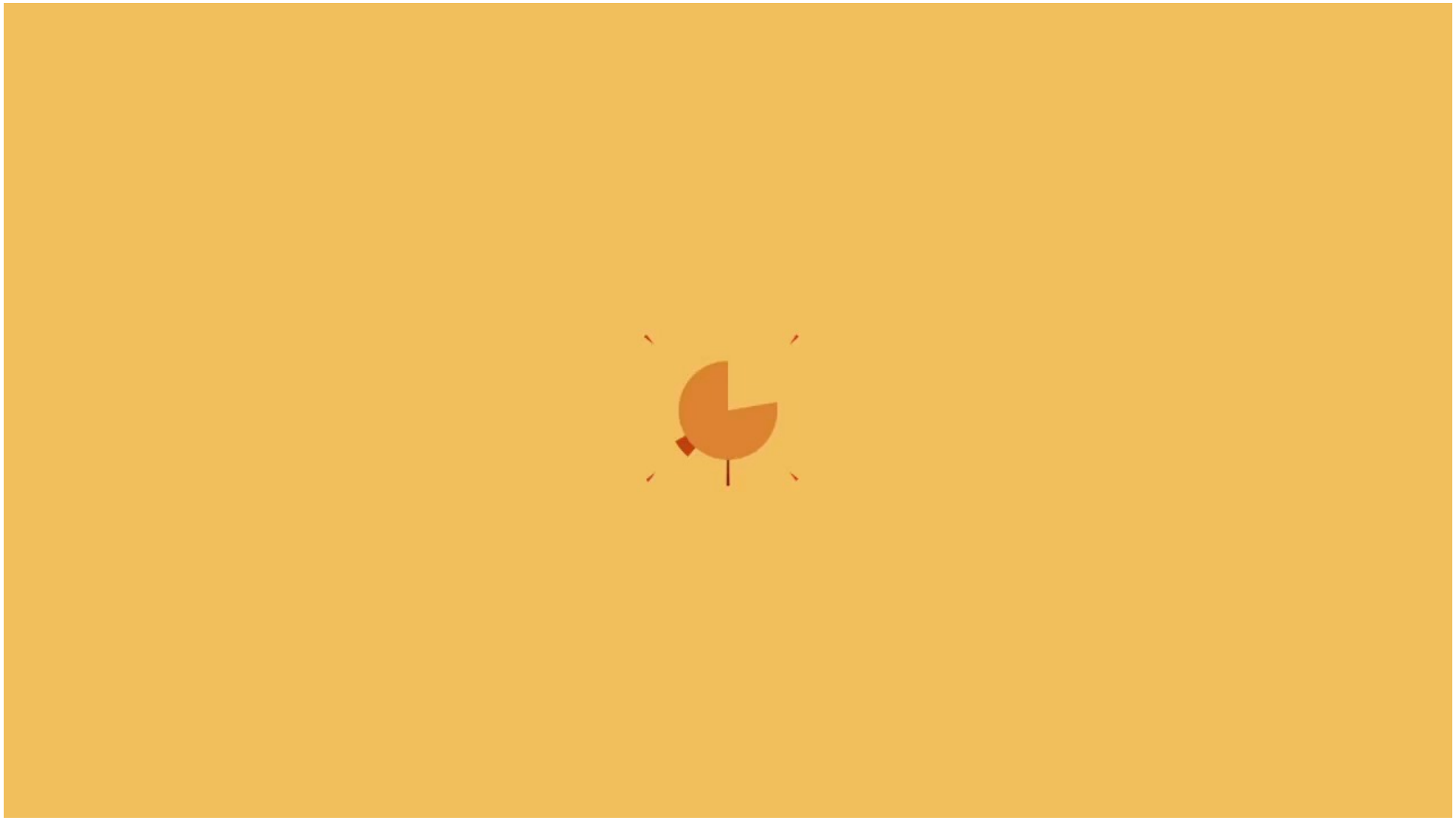
Case study: a dream to fly

Ancient Greece

Beginning of XX century

Now

But people are flying (Wingsuit)



The lesson is …

- Very expensive
- Very risky
- No practical sense

- Cheaply
- Safely
- Pragmatically

The lesson is …

- Very expensive
- Very risky
- No practical sense

- Cheaply
- Safely
- Pragmatically

AI as s dream → Artificial Intelligence

AI as s dream → Hybrid Intelligence

Hybrid Intelligence: main problems

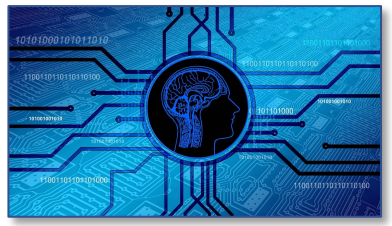
Two poles:

People doing all

Not scalable
Not reliable
…

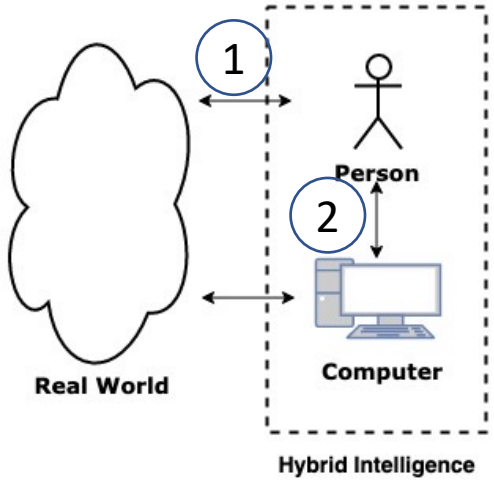
Scalable
Reliable
Realistic

AI doing all

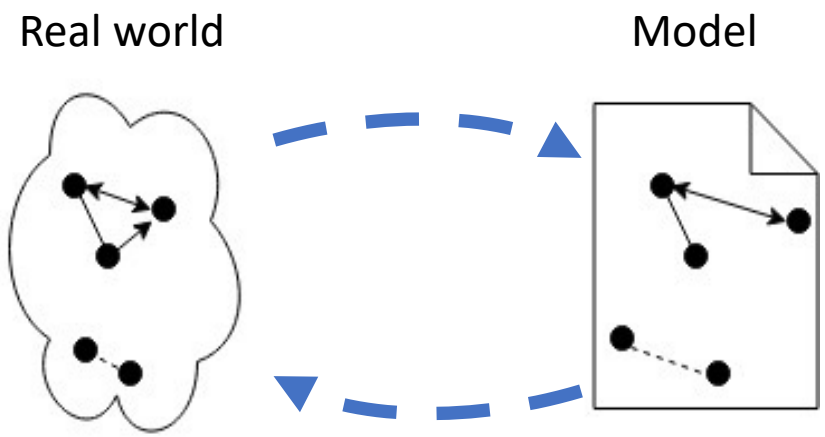


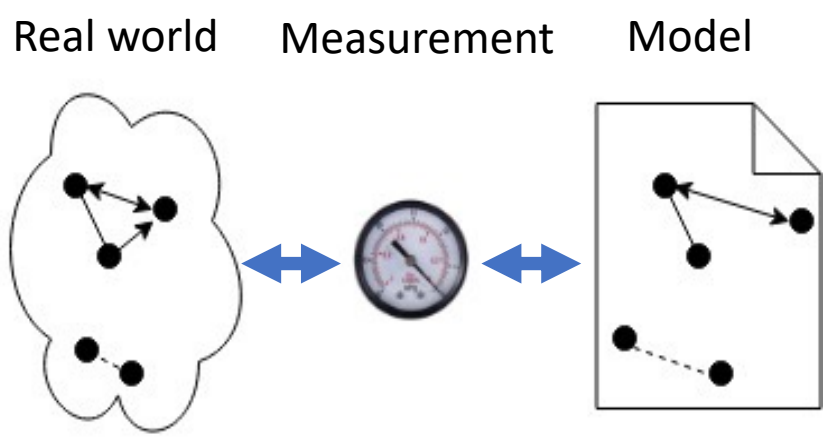
Not realistic for now

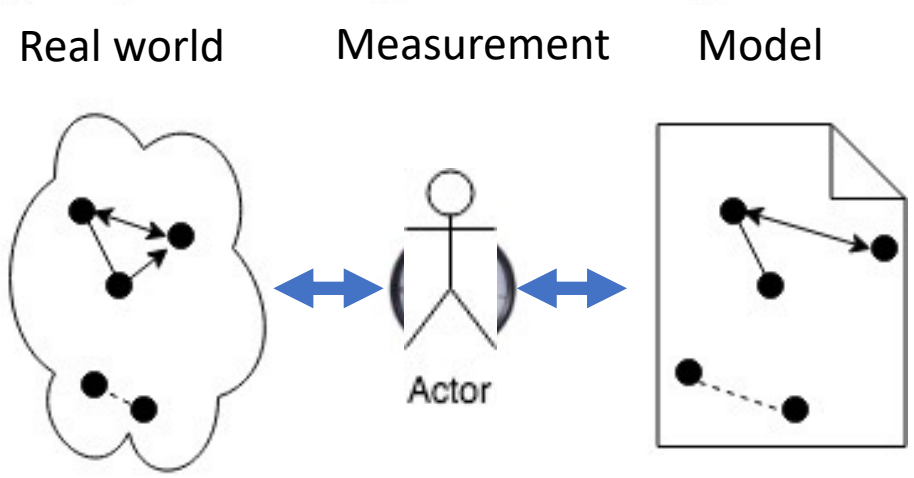
- Problem 1 (Perception modelling):
  How we describe objects from the real world? Can we describe the objects by the most reliable and the most effective for further computing way?
- Problem 2 (Perception-base computing):
  How we can manipulate with perception-based information (for example, search or generalize)? Can we optimize these calculations?



Problems' discussion







Problem 1 (Perception modelling)

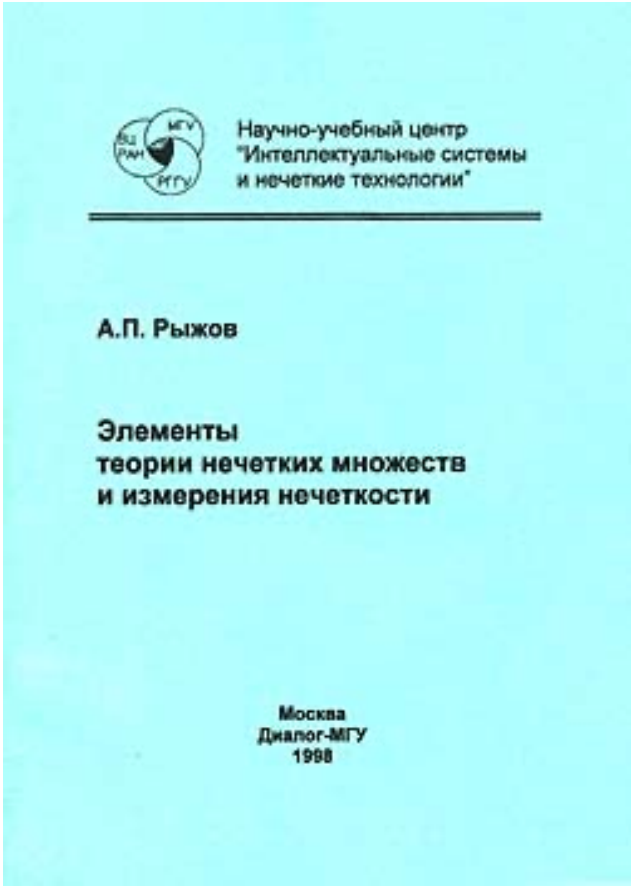
Problem 1. Is it possible, taking into account certain features of the man's perception of objects of the real world and their description, to formulate a rule for selection of the optimum set of values of characteristics on the basis of which these objects may be described? Two optimality criteria are possible:

> Criterion 1. We regard as optimum those sets of values through whose use man experiences the minimum uncertainty in describing objects.
>
> Criterion 2. If the object is described by a certain number of experts, then we regard as optimum those sets of values which provide the minimum degree of divergence of the descriptions.

It is shown [Ryjov, 1985] that we can formulate a method of selecting the optimum set of values of qualitative indications (collection of granules).

Moreover, it is shown [Ryjov, 1991] that such a method is robust, i.e. the natural small errors that may occur in constructing the membership functions do not have a significant influence on the selection of the optimum set of values. The sets which are optimal according to criteria 1 and 2 coincide.

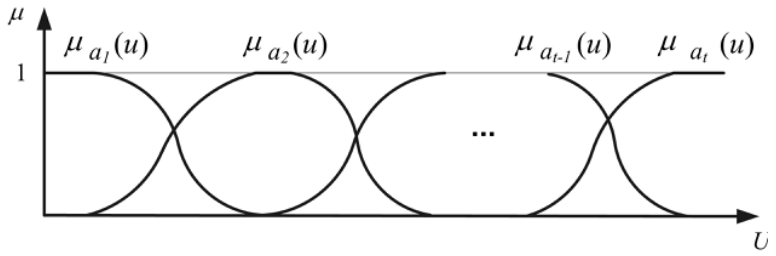
Following this method, we may describe objects with *minimum possible uncertainty*, i.e. *guarantee optimum* operation of the *hybrid intelligence systems* from this point of view.



http://intsys.msu.ru/staff/ryzhov/FuzzySetsTheoryApplications.htm

Problem 1: main insides

Model:

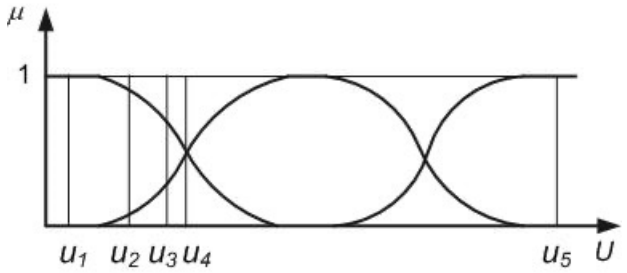


Simplest degree of fuzziness:

$$\xi(s_t) = \frac{1}{|U|}\int_U \left(1 - \left(\mu_{i_1^*}(u) - \mu_{i_2^*}(u)\right)\right) du$$

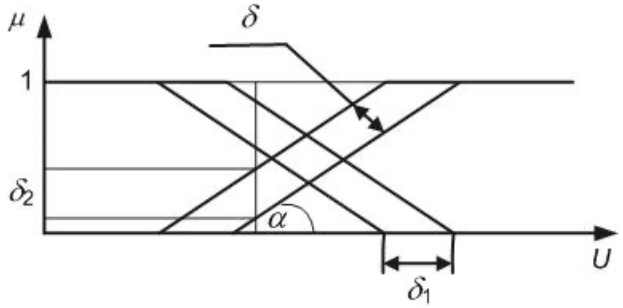
$$\mu_{i_1^*}(u) = \max_{1\le j\le t} \mu_j(u), \mu_{i_2^*}(u) = \max_{1\le j\le t, j\ne i_1^*} \mu_j(u)$$

Interpretation:



$$0 = \eta(s_3, u_1) = \eta(s_3, u_5) < \eta(s_3, u_2) < \eta(s_3, u_3) < \eta(s_3, u_4) = 1$$

Robustness:



$$\underline{\xi}(s_t) = (1-\delta_2)^2\xi(s_t), \overline{\xi}(s_t) = (1+2\delta_2)\xi(s_t)$$

Method for selection of the optimum set of values :

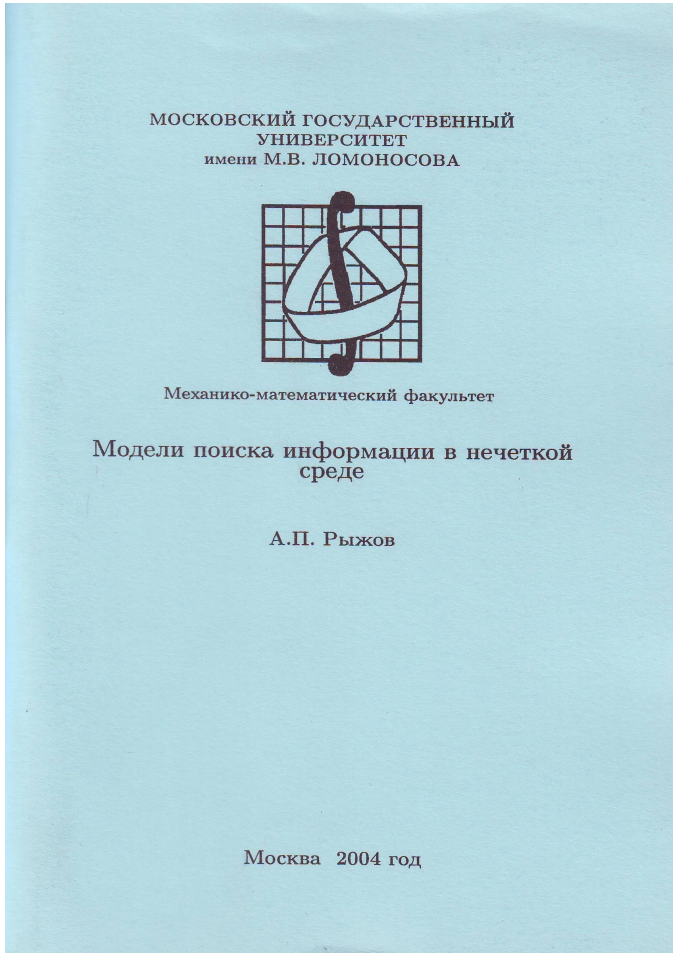
1. All the "reasonable" sets of linguistic values are formulated;
2. Each of such sets is represented in the form of $G(L)$;
3. For each set the measure of uncertainty $\xi(s_t)$ is calculated;

As the optimum set minimizing both the uncertainty in the description of objects and the degree of divergence of opinions of users we select the one that has minimal uncertainty: $s_t^*: \xi(s_t^*) = \min_{s_t \in G(L)} \xi(s_t)$.

Problem 2 (Perception-base computing)

Hybrid intelligence assumes, at least, the storage of information material (or references to it) and their linguistic evaluations in the system database. In this connection the following problem arises.

Problem 2. Is it possible to define the indices of quality of information retrieval in fuzzy (linguistic) databases and to formulate a rule for the selection of such a set of linguistic values, use of which would provide the maximum indices of quality of information retrieval?



It is shown [Ryjov, 1992] that it is possible to introduce indices of the quality of information retrieval in fuzzy (linguistic) databases and to formalize them.

It is shown [Ryjov, 1992] that it is possible to formulate a method of selecting the optimum set of values of qualitative indications (collection of granules) which provides the maximum quality indices of information retrieval.

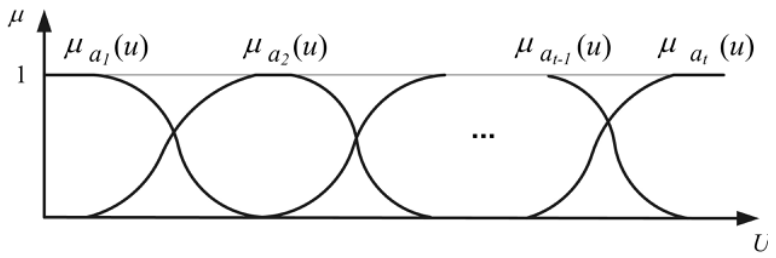
Moreover, it is shown [Ryjov, 1993] that such a method is robust, i.e. the natural small errors in the construction of the membership functions do not have a significant effect on the selection of the optimum set of values.

It allows to approve that the offered methods can be used in *practical tasks* and *to guarantee optimum work of hybrid intelligence systems*.

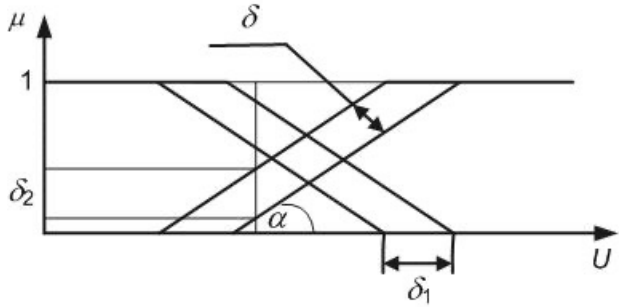
http://www.intsys.msu.ru/staff/ryzhov/FuzzyRetrieval2010.htm

Problem 2: main insides

Model:



Robustness:



Information loss ($IL_X(U)$) and of information noise ($IN_X(U)$):

$$IL_X(U) = IN_X(U) = \frac{1}{|U|}\sum_{j=1}^{t-1}(p_j + p_{j+1})\int_U \mu_j(u)\mu_{j+1}(u)N(u)du,$$

where $X = \{a_1, \cdots, a_t\}$, $p_i (i = 1,2, \cdots, t)$ - the probability of request offering in i- meaning of the characteristic X, $N(u)$ is the number of objects, the descriptions of which are stored in the database, that possess a real (physical, not linguistic) value equal to u.

Theorem. Let $s_t \in G(L)$, $N(u) = N = Const$, $p_i = {}^1/_t$ $(i = 1,2, \cdots, t)$. Then $IL_X(U) = IN_X(U) = \frac{c}{t}\xi(s_t)$, where c is a constant with depends on N only.

Theorem. Let $s_t \in G^{\delta}(L)$, $N(u) = N = Const$, $p_i = {}^1/_t$ $(i = 1,2, \cdots, t)$.

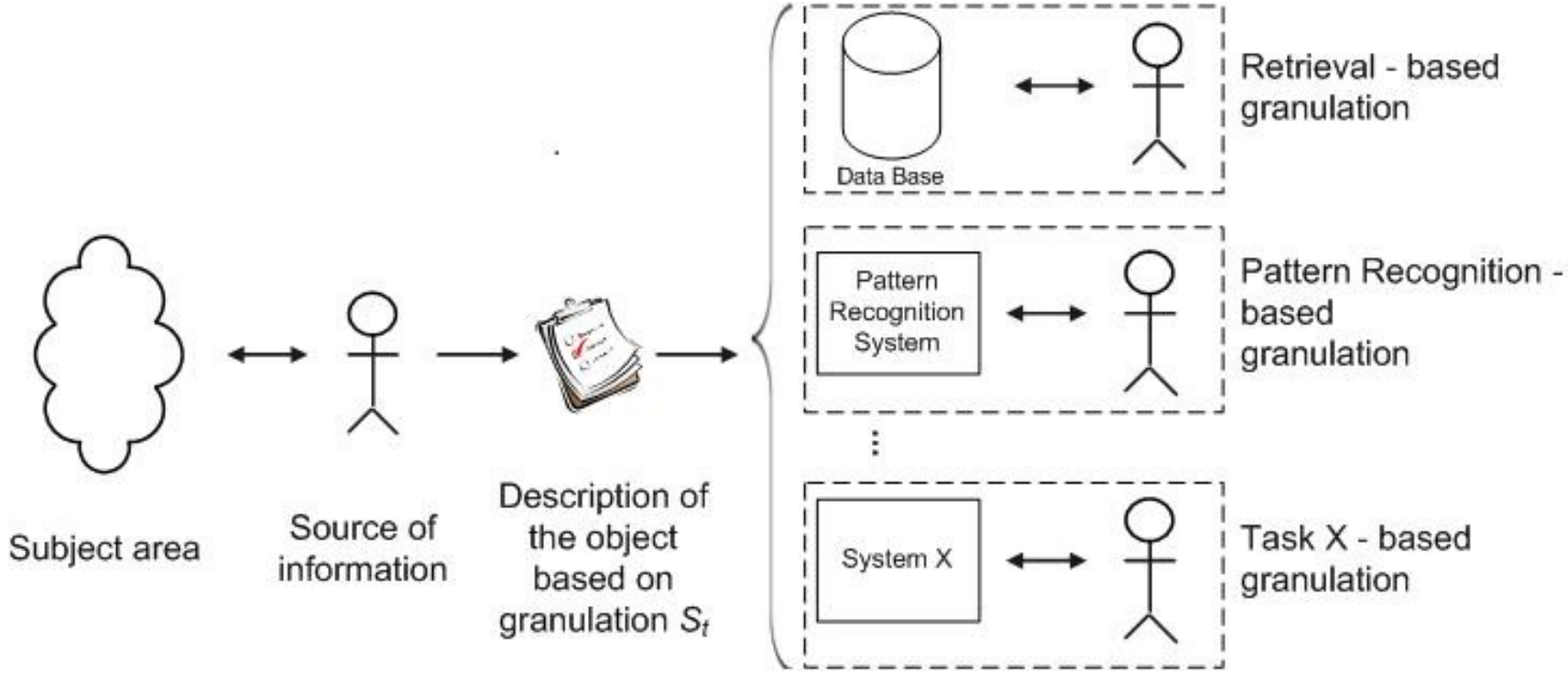
$$\underline{IL}_X(U) = \underline{IN}_X(U) = \frac{c}{t}(1 - \delta_2)\underline{\xi}(s_t),$$

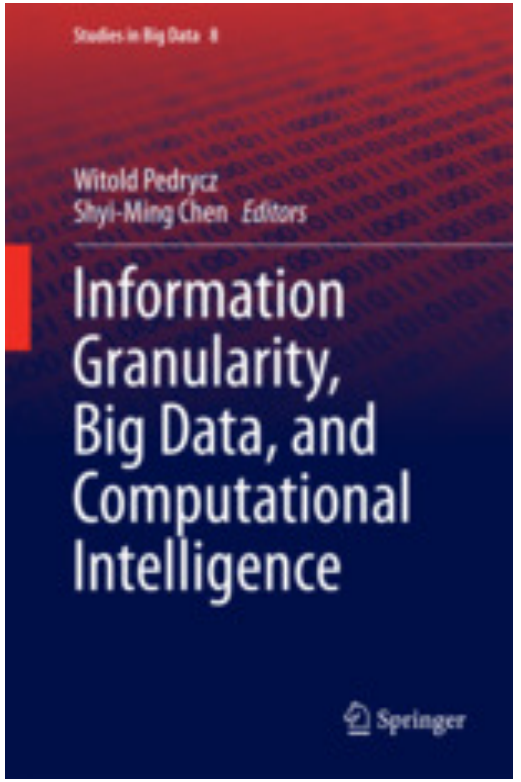
$$\overline{IL}_X(U) = \overline{IN}_X(U) = \frac{c}{t(1+2\delta_2)}\left(\frac{(1-\delta_2)^3}{3} + 2\delta_2\right)\overline{\xi}(s_t)$$

Method for selection of the optimum set of values : As the optimum set minimizing both Information loss and of information noise:

$$s_t^*: \xi(s_t^*) = \min_{s_t \in G(L)} \frac{\xi(s_t)}{t}.$$

Problem 2 (Perception-base computing): generalization

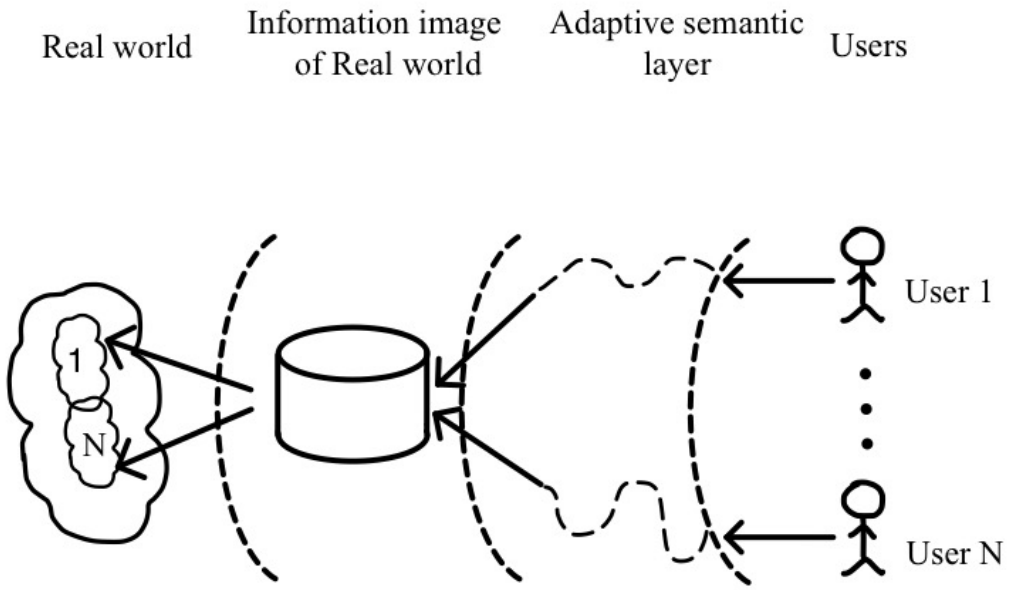


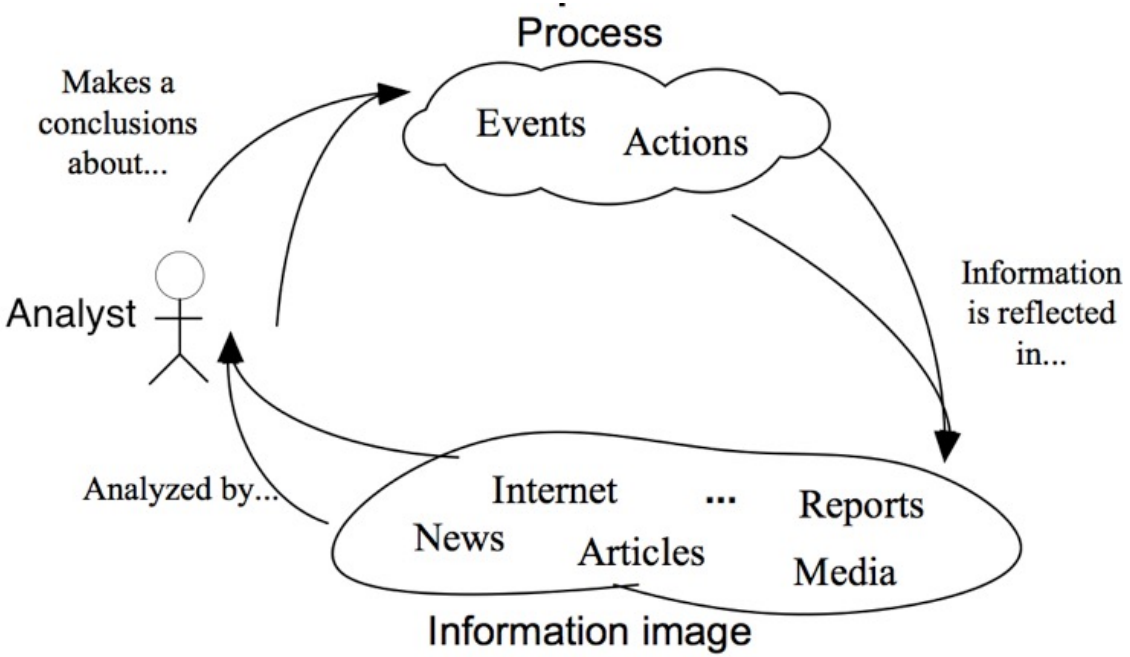


https://www.springer.com/gp/book/9783319082530

Hybrid Intelligence frameworks

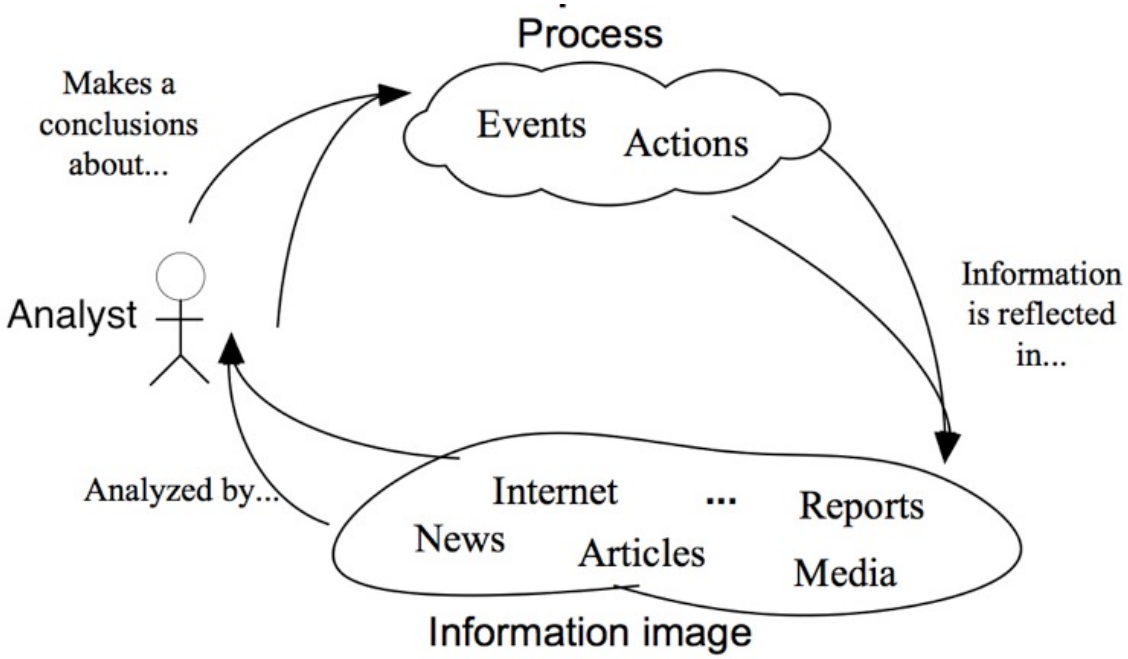
Evaluation and monitoring
of complex processes



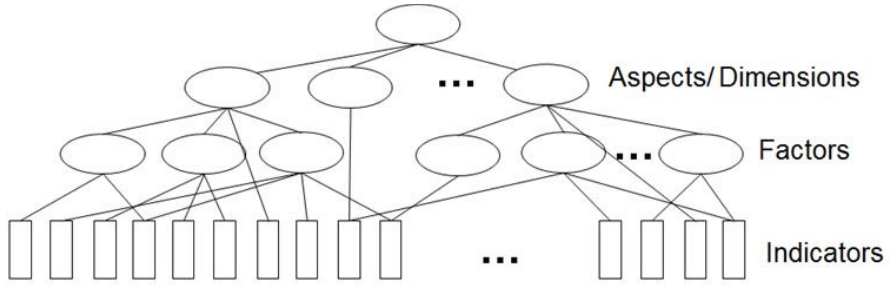


Personalization of digital world

Evaluation and monitoring of complex processes



Process has some structure (entities and their interrelations)
Presentation of entities and their interrelations in natural language is possible

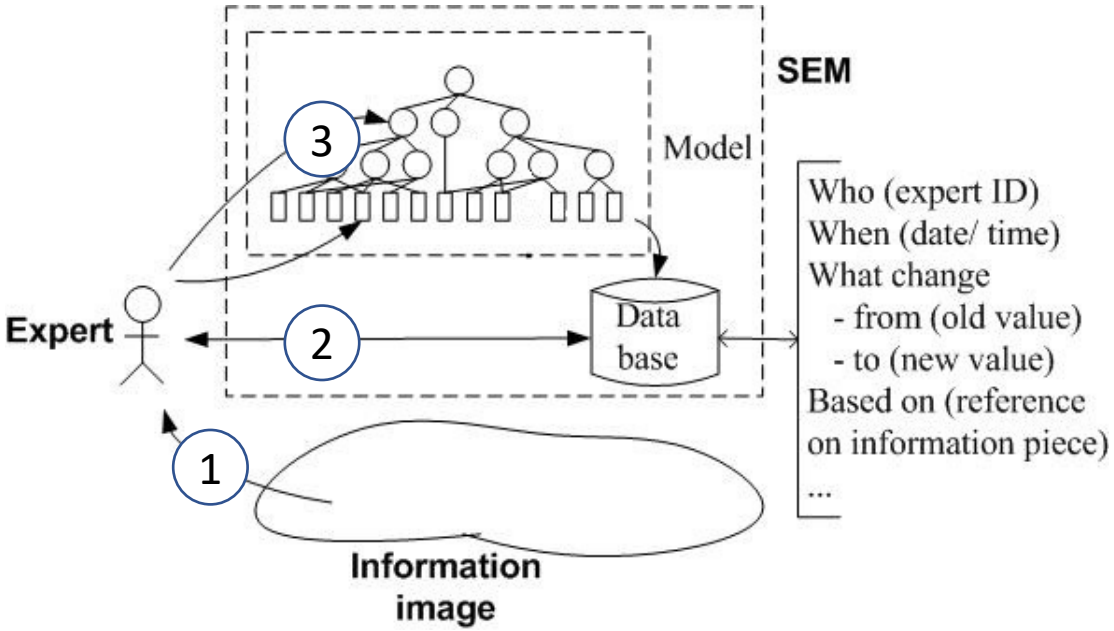


Information image:

- diversity of the information carriers
- fragmentariness
- multi-levels of the information
- various degree of reliability
- possible discrepancy
- varying in time
- possible bias

The **analysts** are an *active element* of the monitoring system
The analysts can form some *structure* (the ministry, agency, consulting group, etc.). In this case each expert of " the bottom level" deals with some part of a problem and works with elements of information image; experts of " higher level " deals with larger fragments of a problem or a problem as a whole.

SEM workflow



Result:
Up-to-date status of the process, confirmed by references to all available information.

Because model of the problem/process have hierarchical stricture, choice and selection (tuning) of aggregation operators for the nodes of the model is one more important issue in development SEM. We may formulate this problem as follows:

Problem 3. Is it possible to propose the procedures of information aggregation in fuzzy hierarchical dynamic systems which allow us to minimize contradictoriness in the model of problem/process in IMS?

It is shown [Ryjov, 1996] that it is possible to propose the following approaches based on different interpretations of aggregation operators:

- geometrical
- logical
- learning-based

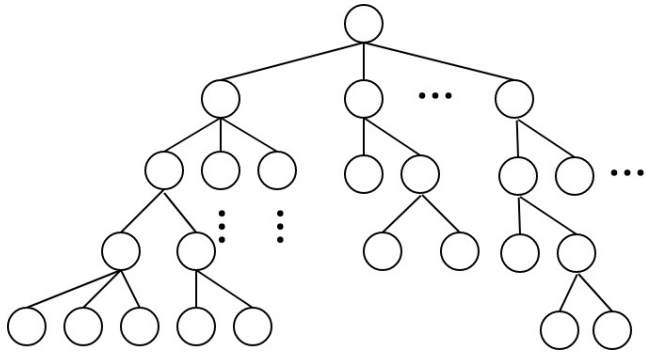
The last one includes learning based on

- bio-inspired algorithms (genetic, ant colony, swarm, etc. algorithms)
- neural networks.

Ryjov A. Information aggregation in fuzzy hierarchical systems. Intelligent Systems. V.6, Issue 1-4, Moscow, 2001, p. 341-364.
http://www.intsys.msu.ru/magazine/archive/v6(1-4)/ryzhov.pdf

Problem 3: main insides

Model:



Efficiency:

Graph of 50 nodes.

- Ant algorithm: 29 iterations, minimum path 4273
- Genetic Algorithm: 622 iterations, minimum path 4690

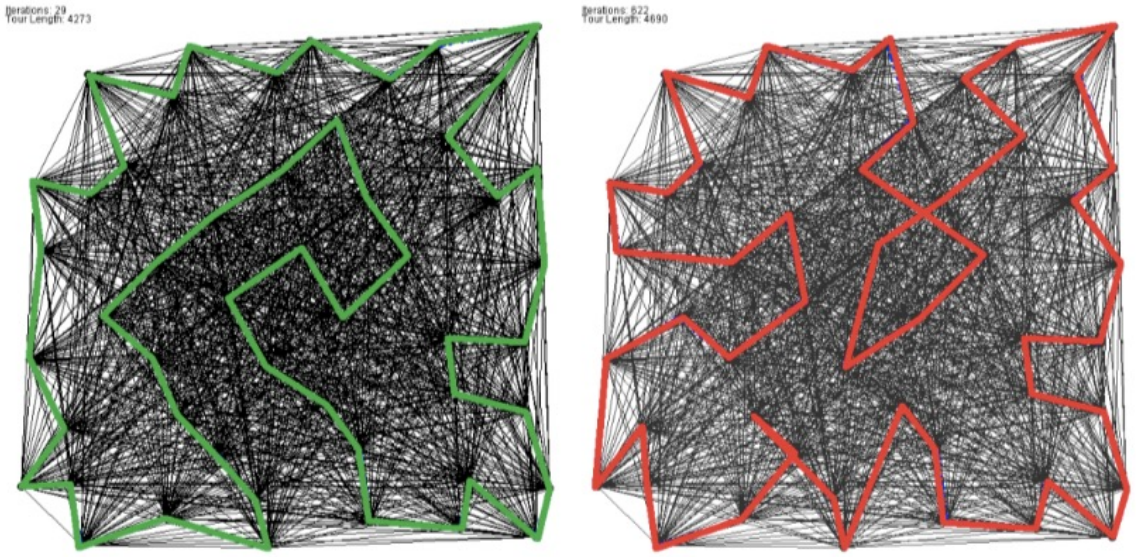


рис. 1: Результат работы муравьиного(слева) и генетического(справа) алгоритмов.

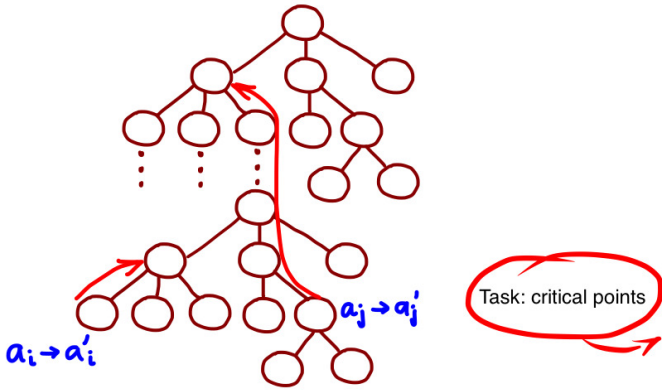
Interpretations: (1) the function of *k*-valued logic from *n* variables
- fuzzy subclasses of *k*-valued logic
(2) the ”sense” of the aggregation is ”and” or ”or”
- tuning of *t*-norms and *t*-conorms

Arihimedean *t*-norm $$H_\lambda = \frac{\mu_A \cdot \mu_B}{\lambda + (1-\lambda)(\mu_A + \mu_B - \mu_A \cdot \mu_B)}$$

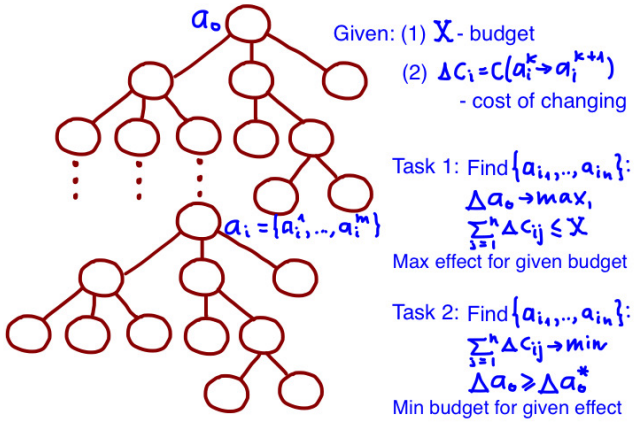
Arihimedean *t*-conorm $$H_\lambda^\star = \frac{\mu_A + \mu_B - (2-\lambda) \cdot \mu_A \cdot \mu_B}{1 - (1-\lambda) \cdot \mu_A \cdot \mu_B}$$

SEM analytics

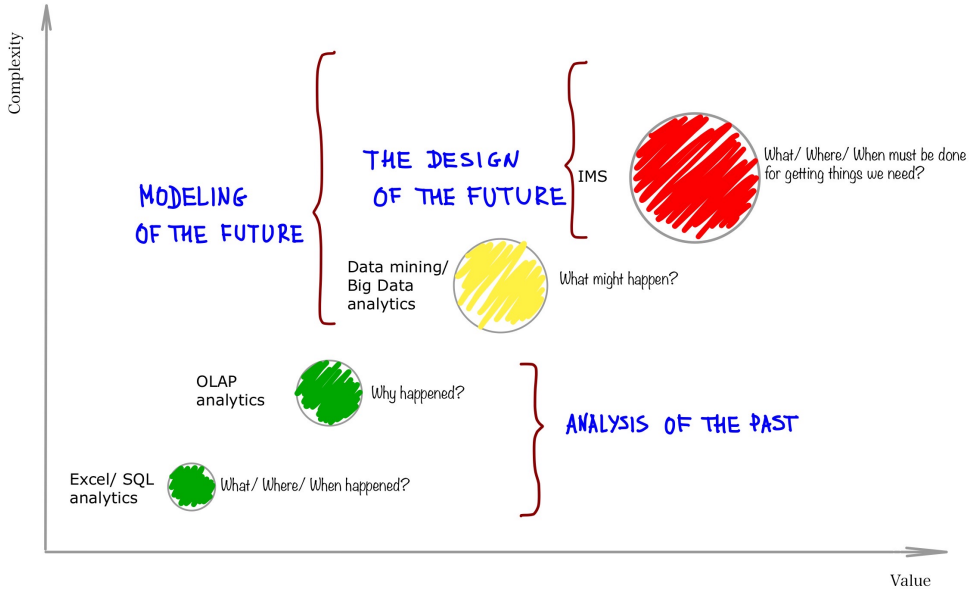
Direct problem



Inverse problem

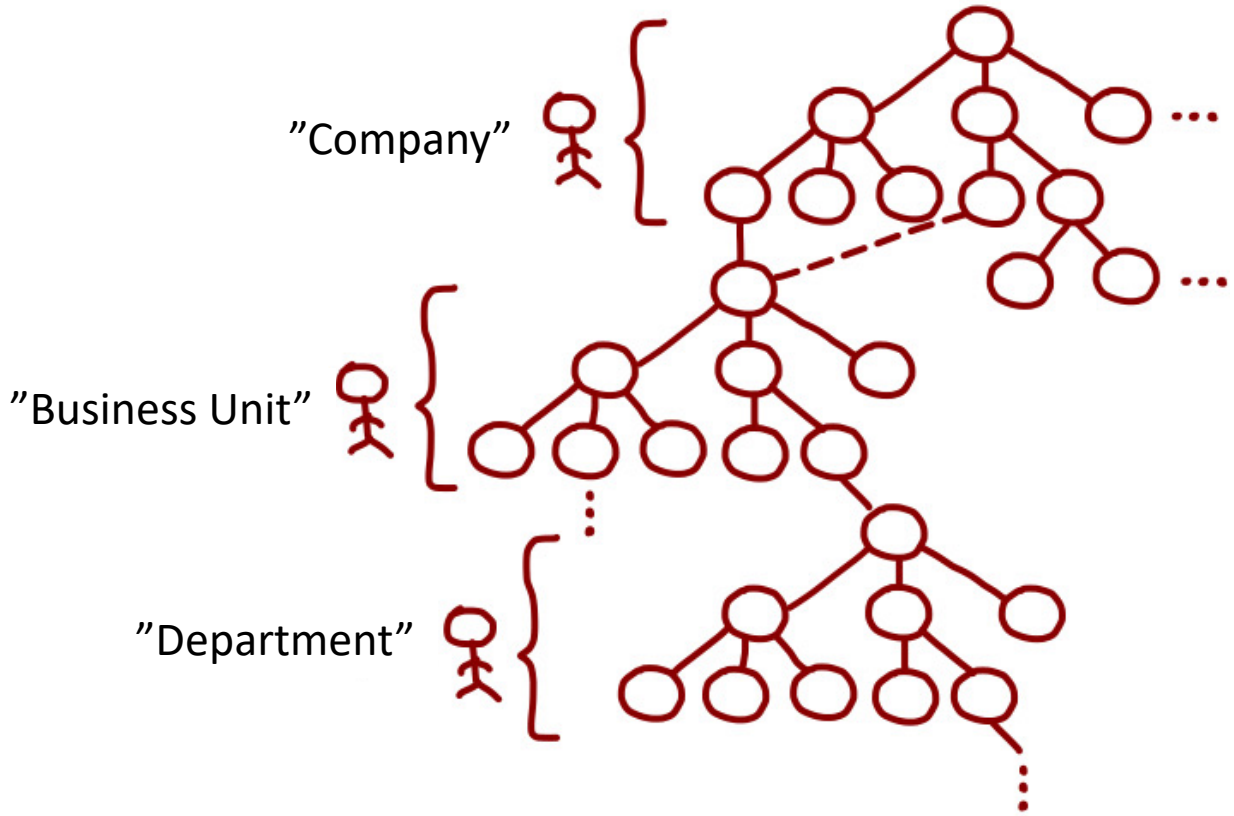


There is the opportunity of allocation ***"of critical points"***, i.e. such element(s) of the model, the small change of which can cause significant changes in a status of the whole problem.
The knowledge of such elements has large practical significance and allows to reveal "critical points" of the problem, to work out the measures on blocking undesirable situations or achievement desirable, i.e. somewhat operate the development of the problem in time in the desirable direction.

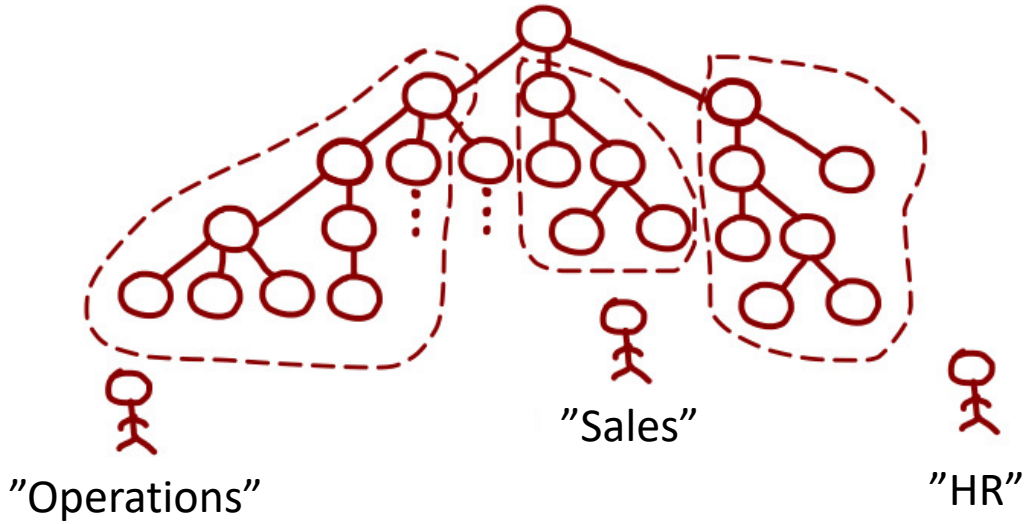


SEM decomposition

Horizontally

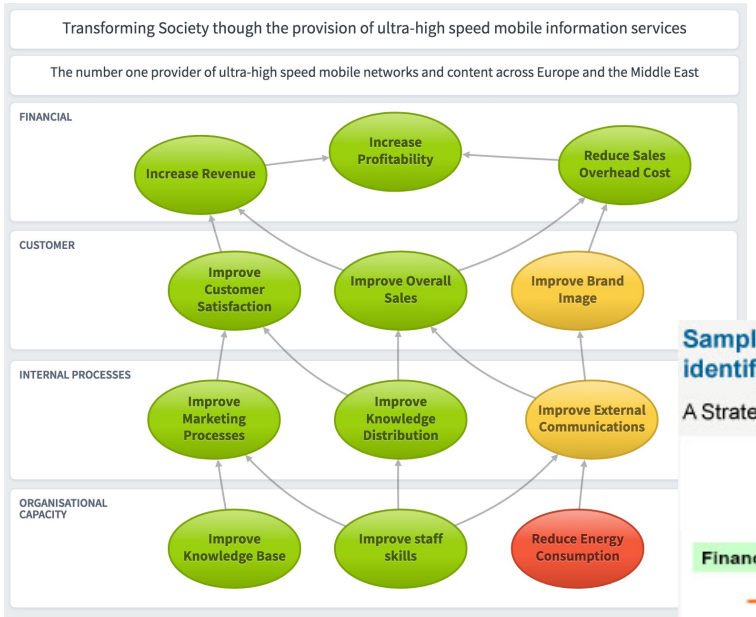


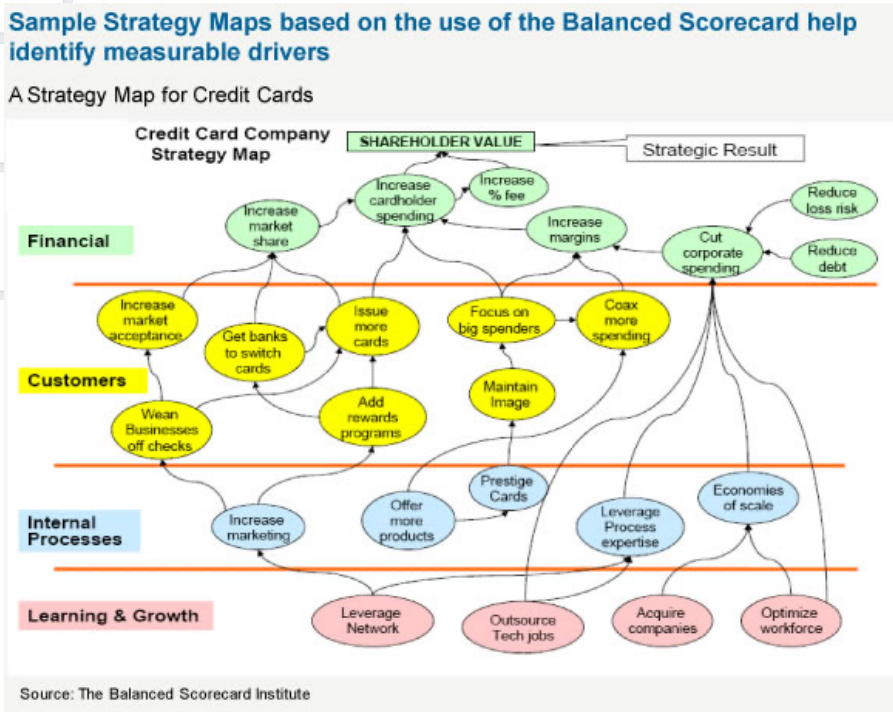
Vertically

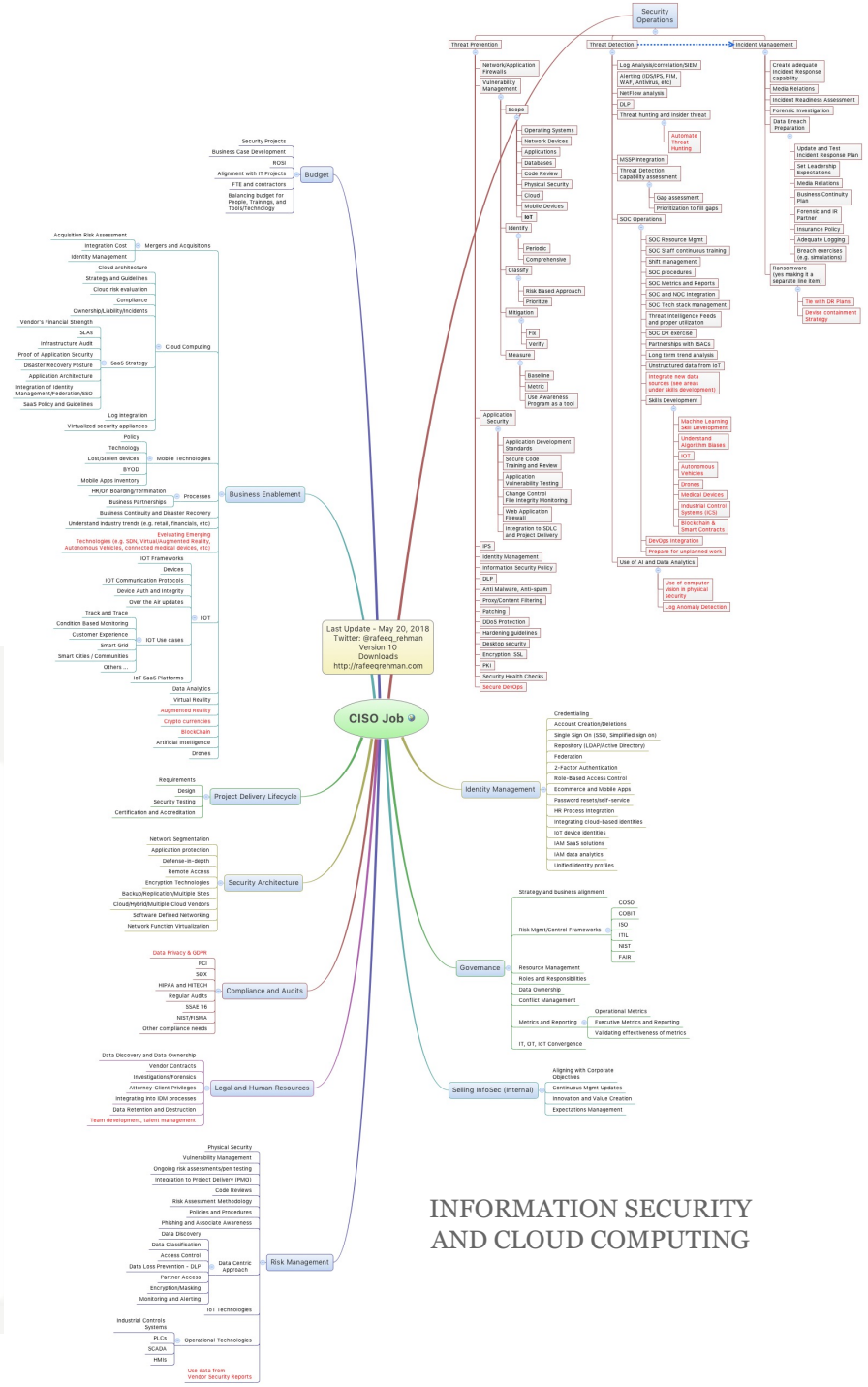


We can start from the most ”simple”/ ”understandable” unit and add other further after getting the necessary experience

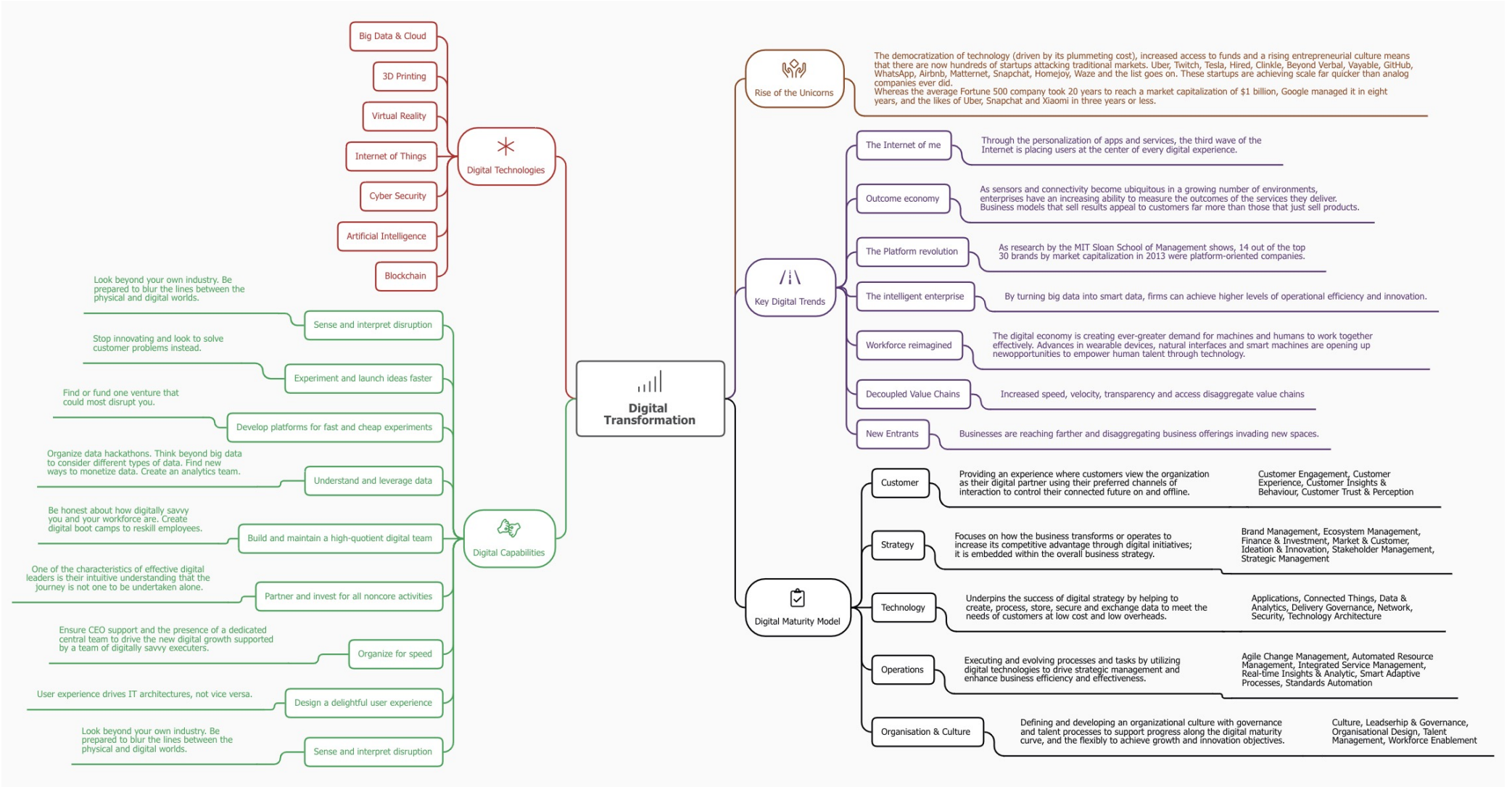
Models templates







Possible mindset for development own model



https://mindmapninja.com/603

Evaluation and monitoring of complex processes: examples

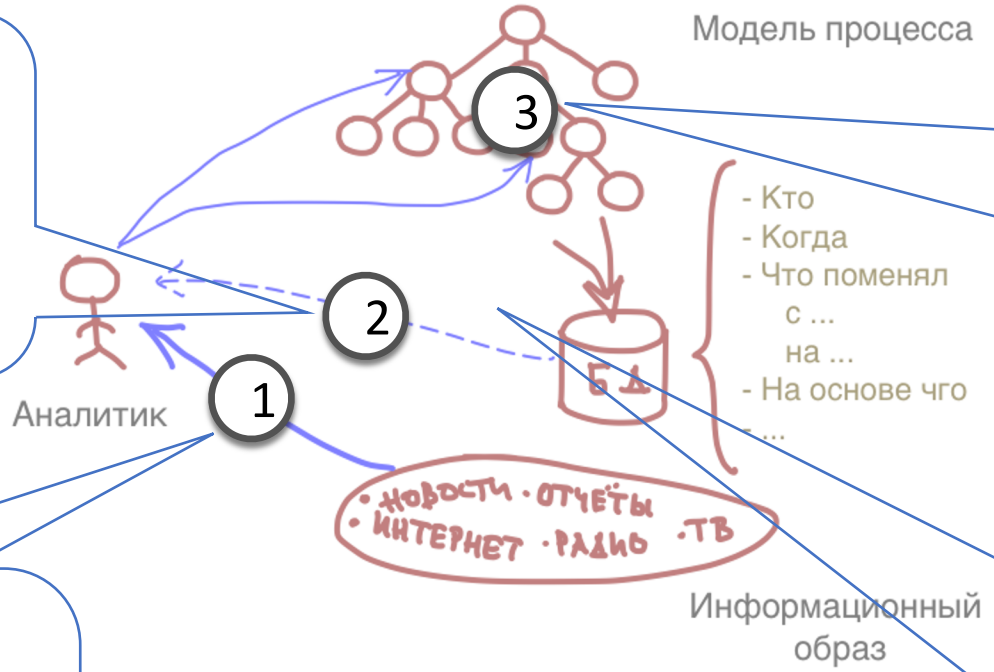
- System for monitoring and evaluation of state's nuclear activities (department of safeguards, IAEA)
- System for evaluation and monitoring of a socio-political process (RF government structure)
- System for evaluation and monitoring of risks of cardiovascular disease (center of preventive medicine of Ministry of Health of Russia)
- System for evaluation and monitoring of microelectronic devices' design (Cadence Design Systems)

Alexander Ryjov. Human-centric systems for evaluating the status and monitoring the progress for socio-political processes. Proceedings of the 8th International Conference on Theory and Practice of Electronic Governance, ACM Conference Publications (New York, N.Y., United States), 2014 c. 413-416. - https://dl.acm.org/doi/10.1145/2691195.2691285

Related tasks

Task-driven information granulation for

- Pattern recognition
- Decision Making
- Rule Induction



Automation of modelling based on

- Data Mining/ Big Data
- Machine learning

Aggregation and generalization

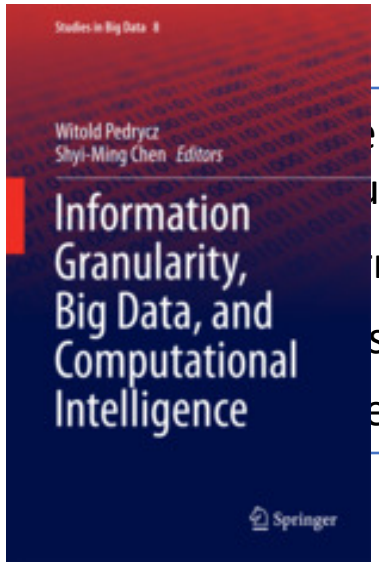
Personalization for

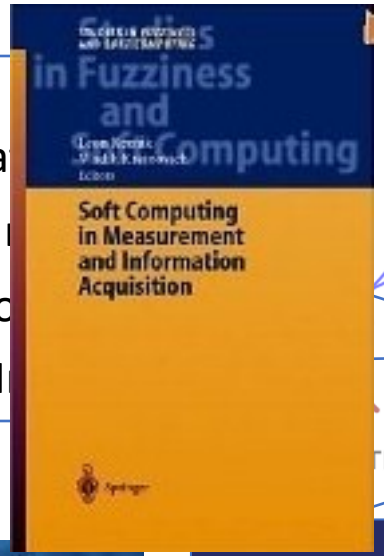
- Social Networks
- Smart Learning
- News
- Information retrieval

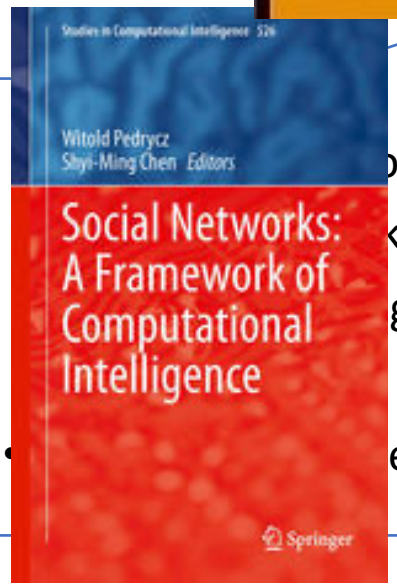
New applications

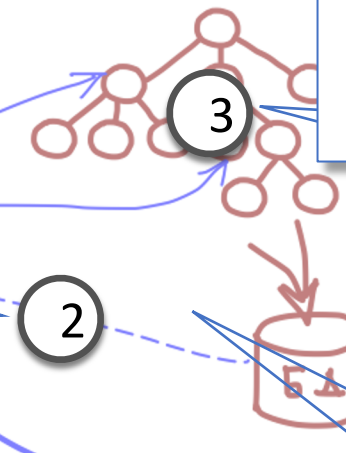
- Healthcare 4.0
- Smart learning for education
- Security
- E-government
- Smart City/Smart Region/ Smart Country

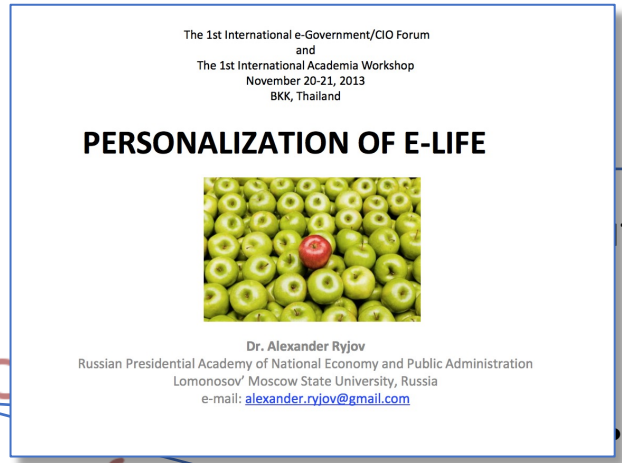
Related results

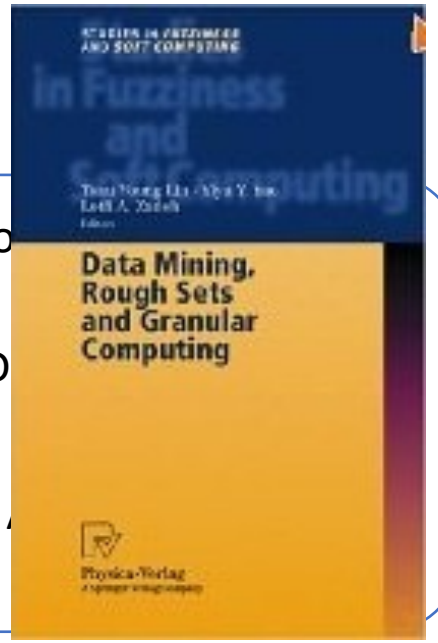




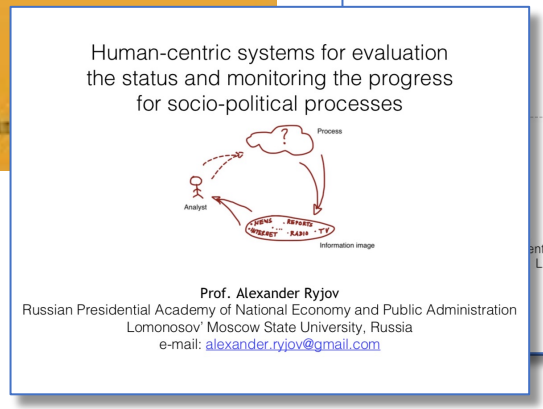


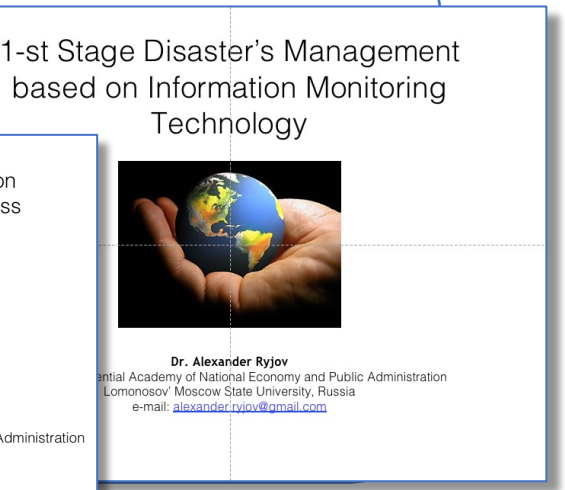






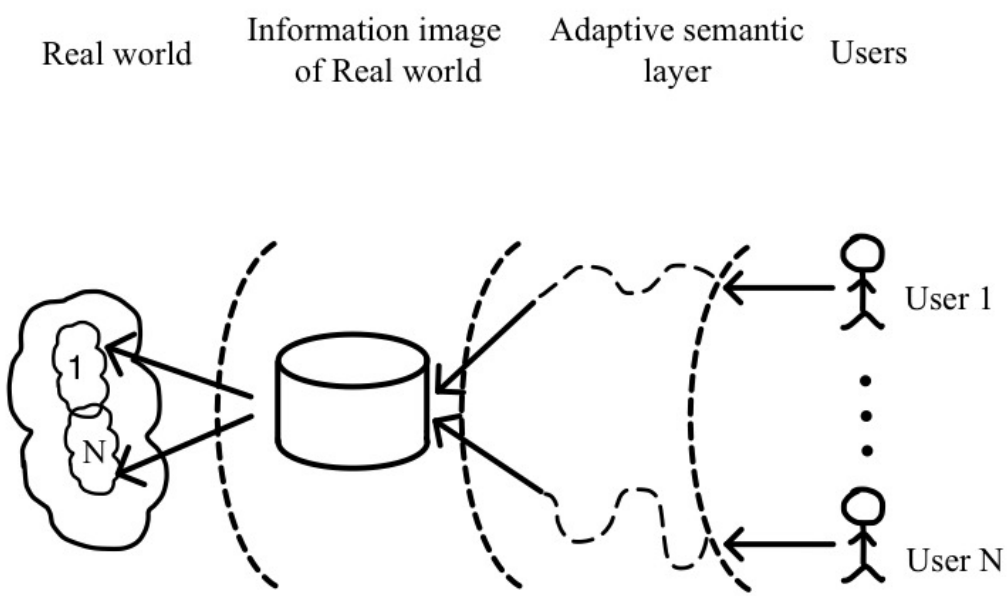
New applications

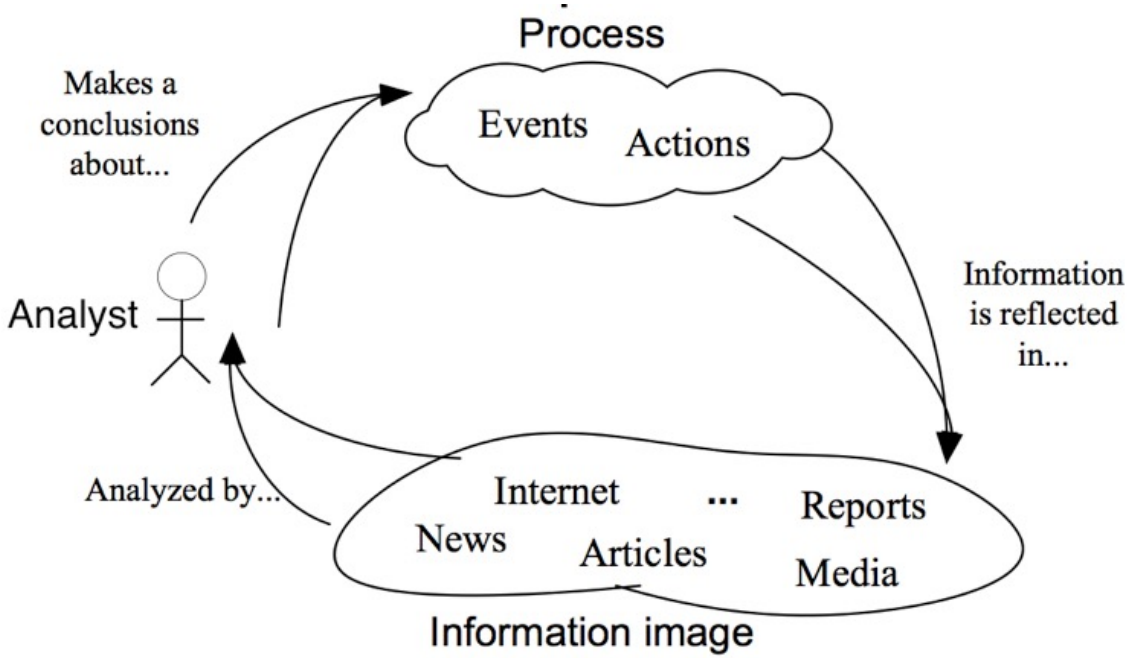




Hybrid Intelligence frameworks

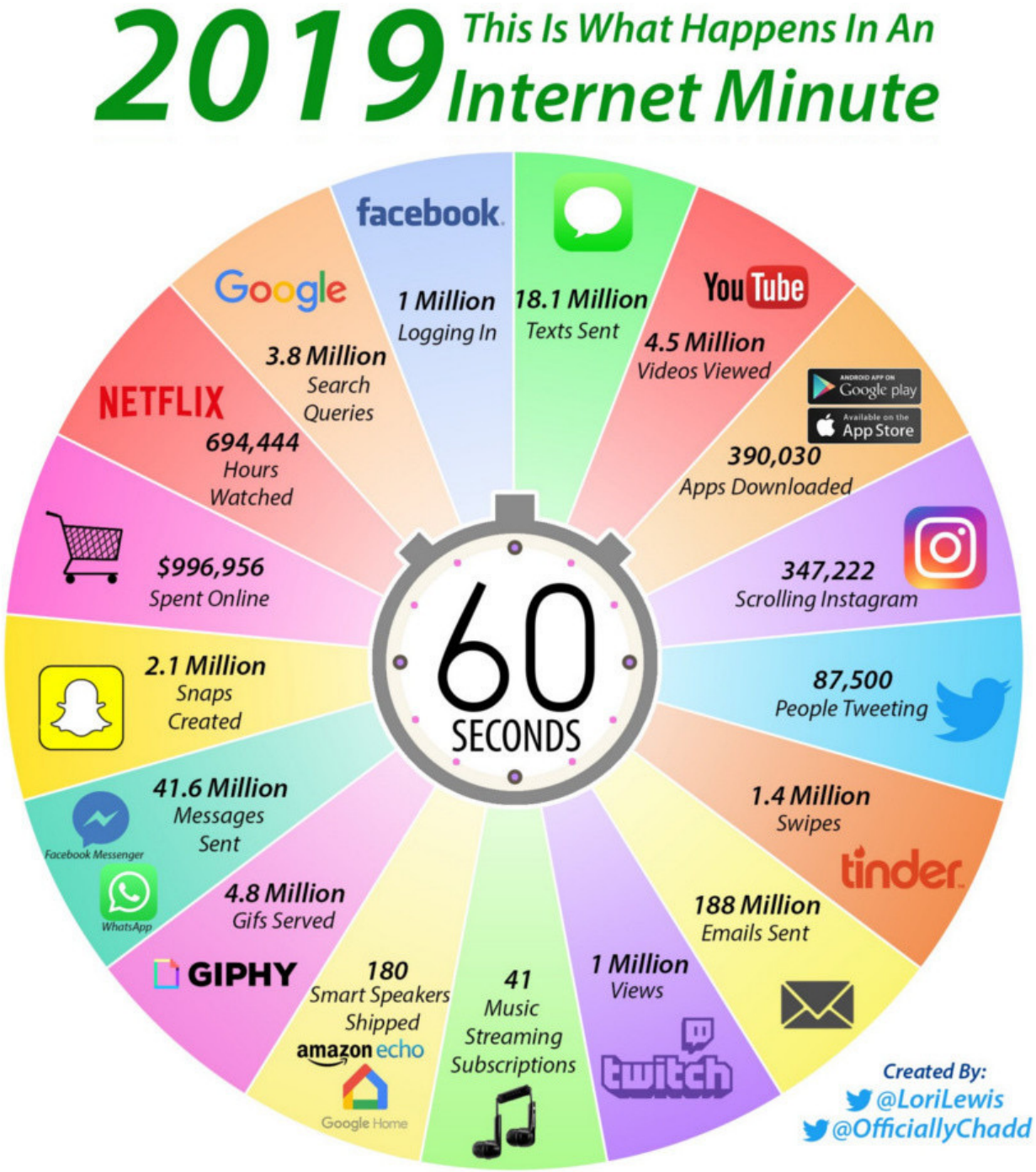
Evaluation and monitoring
of complex processes





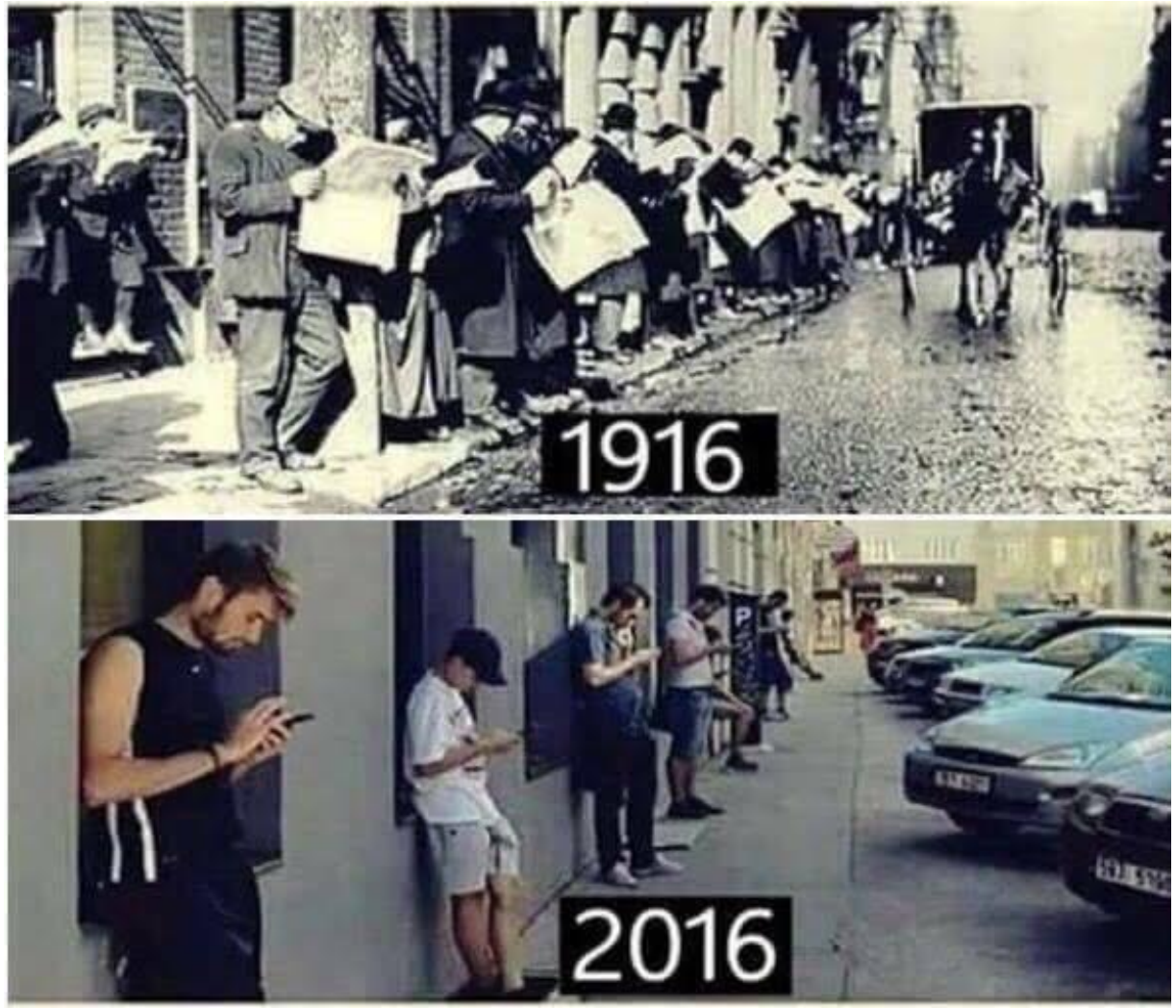
Personalization of digital world

How important is the digital world?

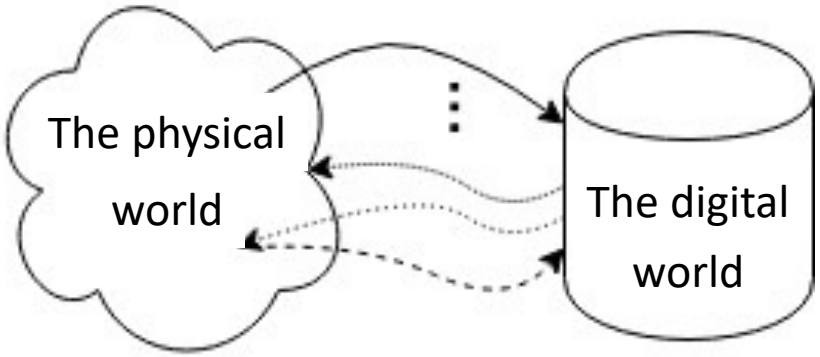


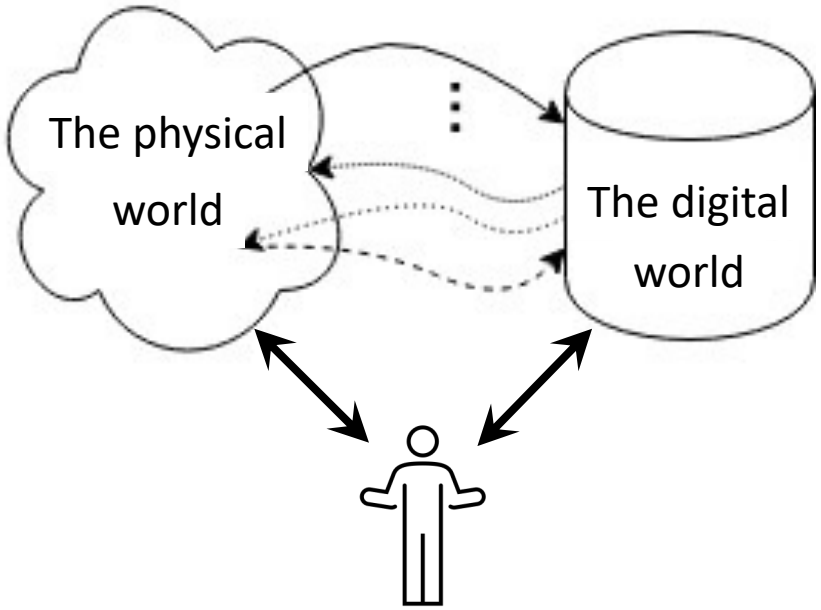
This is what happens in a minute on the internet
https://www.weforum.org/agenda/2019/03/what-happens-in-an-internet-minute-in-2019

How important is personalization?



Why do we need personalization?



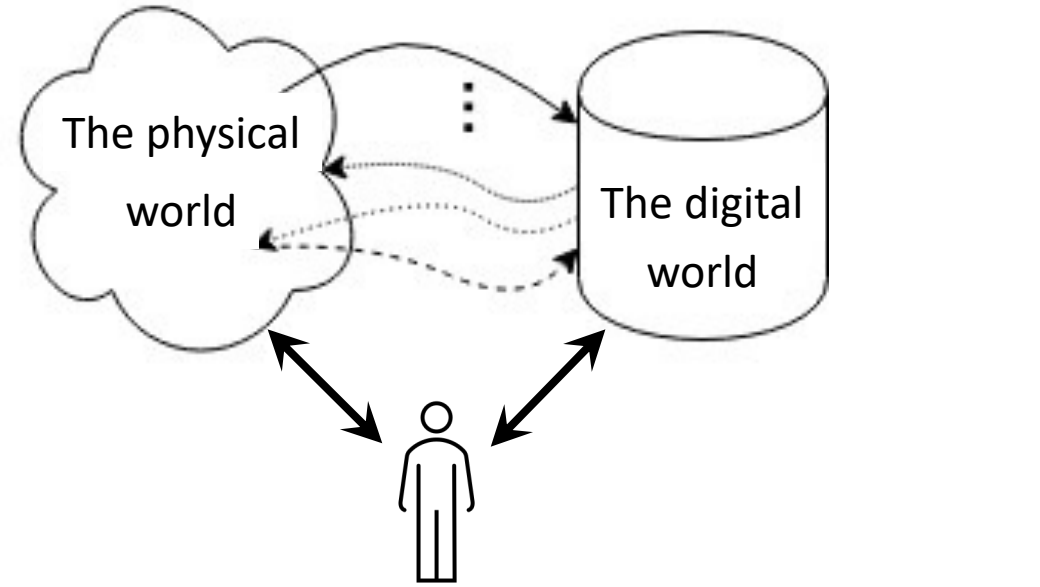


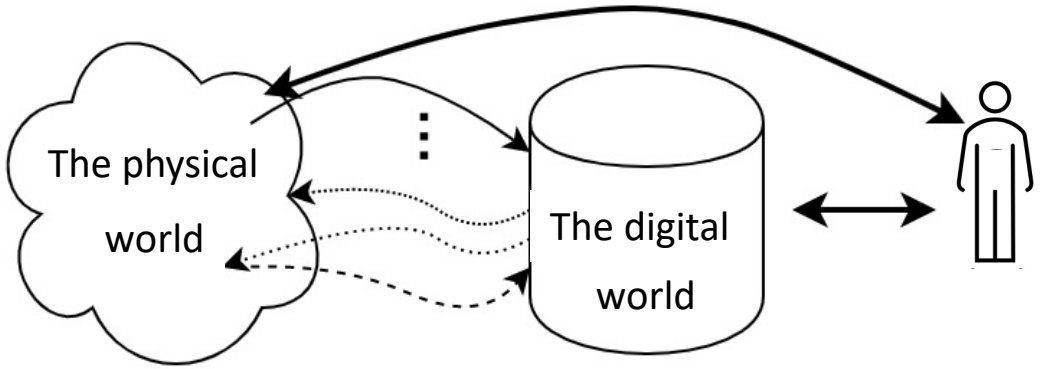
IDC & Seagate:

- in 2016 the data volume was measured at 16 ZB
- by 2025 this figure will increase to 175 ZB
- by 2025, about 20% of all information will play a critical role in everyday life, about 10% of this data will be supercritical.

Data Age 2025. The Digitization of the World From Edge to Core. An IDC White Paper – #US44413318
https://www.seagate.com/files/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf

What kinds of personalization are possible?





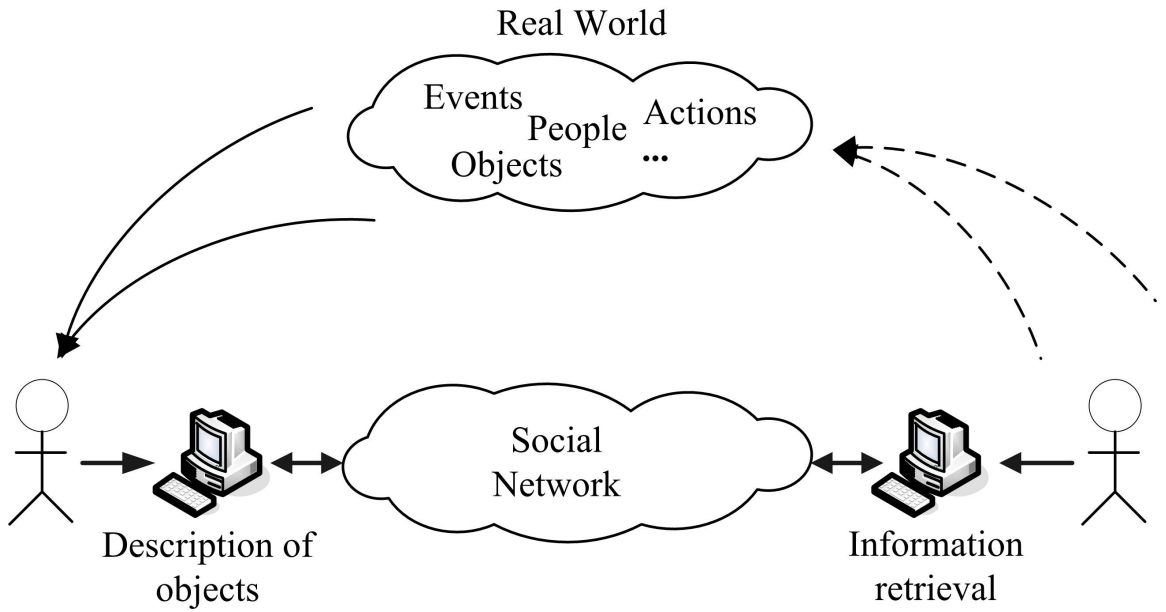
← Active component is a person

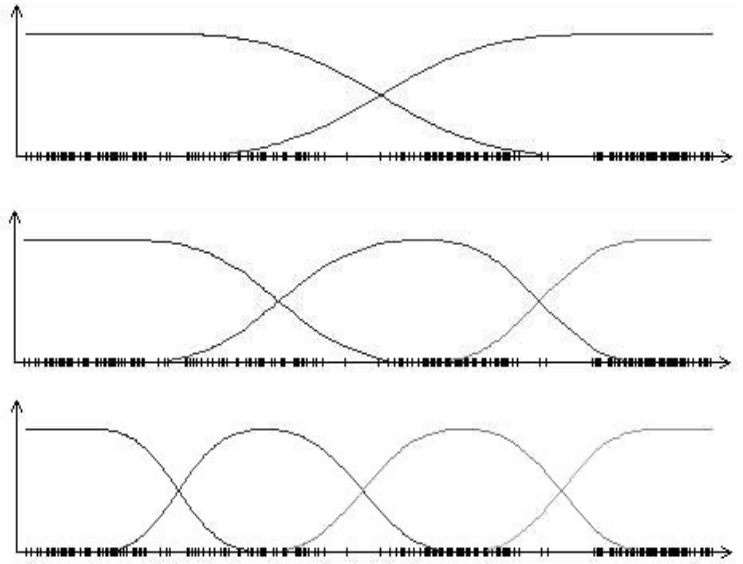
- Information retrieval

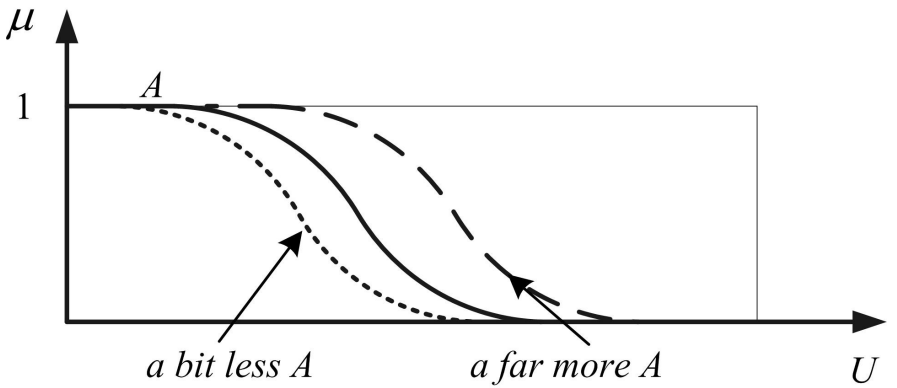
→ Active component is a computer

- Smart learning
- Digital habits

(1) Information retrieval



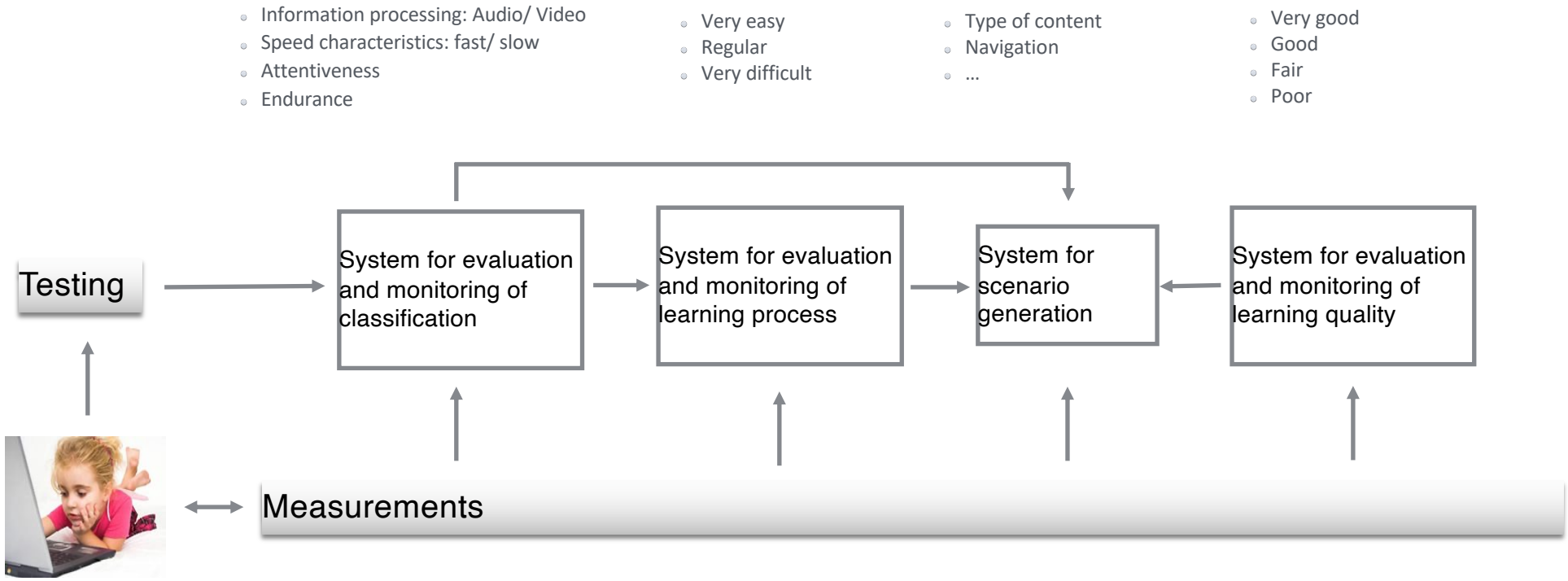




Ryjov A. Personalization and Optimization of Information Retrieval: Adaptive Semantic Layer Approach. In: Zadeh L., Yager R., Shahbazova S., Reformat M., Kreinovich V. (eds) *Recent Developments and the New Direction in Soft-Computing Foundations and Applications*. Studies in Fuzziness and Soft Computing, vol 361, Springer, Cham, 2018, pp. 15-24. DOI http://doi-org-443.webvpn.fjmu.edu.cn/10.1007/978-3-319-75408-6_2

Ryjov A.P., Ogorodnikov N.M. The method for personalizing information retrieval. Intelligence Systems. Theory and applications. Vol. 22, N 4, 2018, pp. 65-78 - http://intsysjournal.ru/pdfs/22-4/Rizov.pdf

(2) Smart learning: Minimal high-level architecture



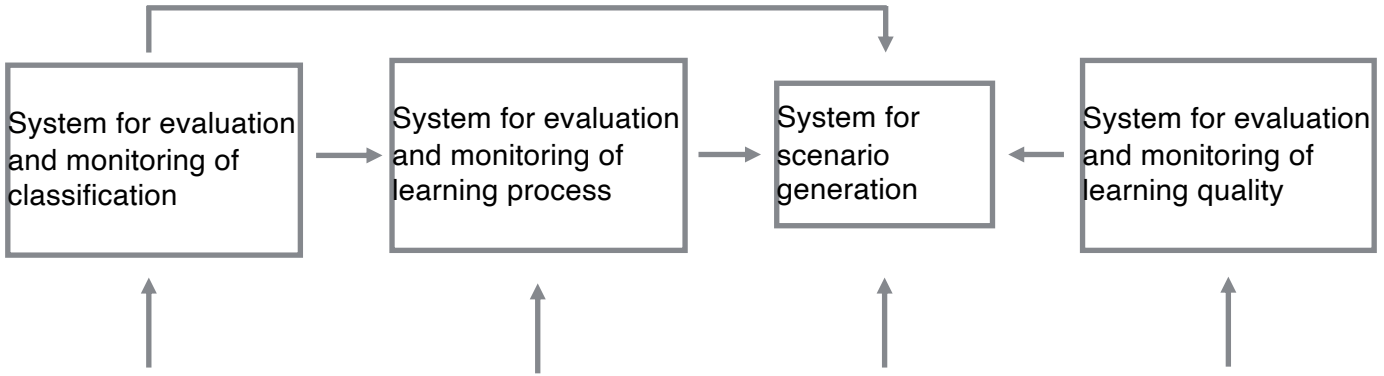
Ryjov A.P., Zhuravlev A.D., Vakhov A.N. Towards personification in smart learning systems. Intelligence Systems. Theory and applications. V.20, 2016, pp. 180-185. - http://intsysjournal.ru/articles/is2003/31_Ryzhov.pdf

- Information processing: Audio/ Video
- Speed characteristics: fast/ slow
- Attentiveness
- Endurance

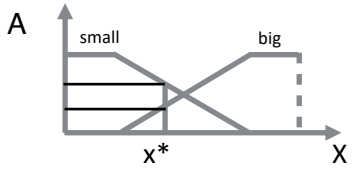
- Very easy
- Regular
- Very difficult

- Type of content
- Navigation
- …

- Very good
- Good
- Fair
- Poor



If ***A***=small и ***B***=big then **Z1**
If ***C***=medium then **Z2**
…



X=x*; Y=y*

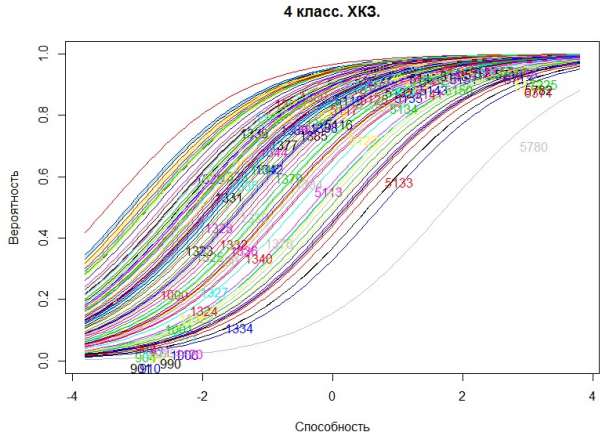
Logical tier (fuzzy rules)

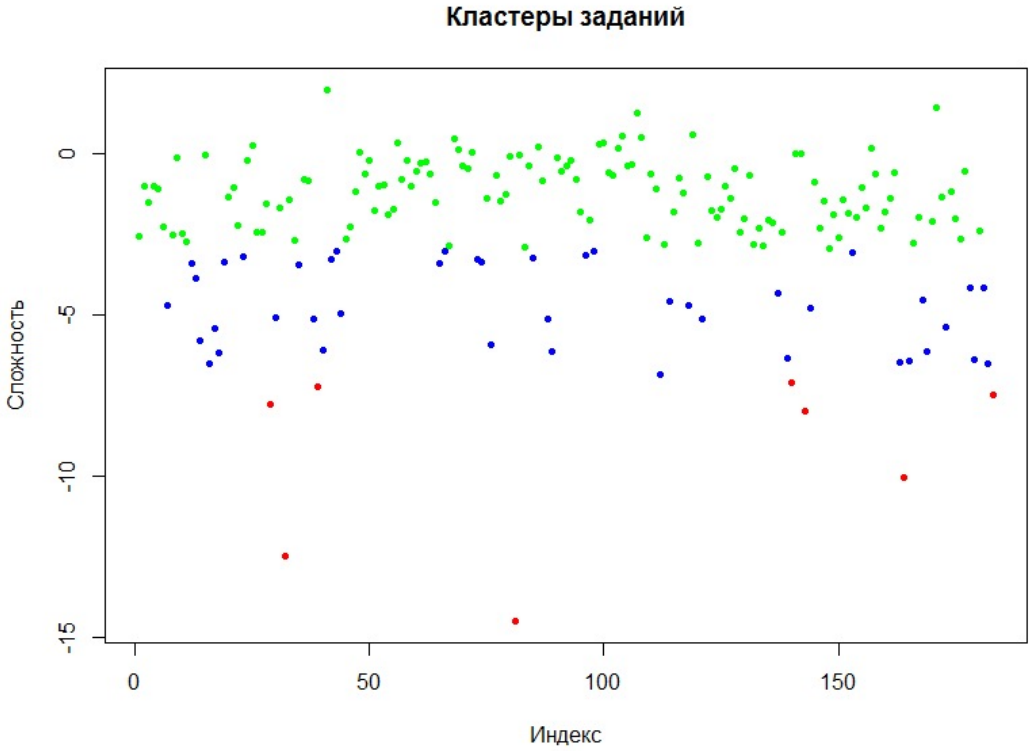
Linguistic tier (membership functions)

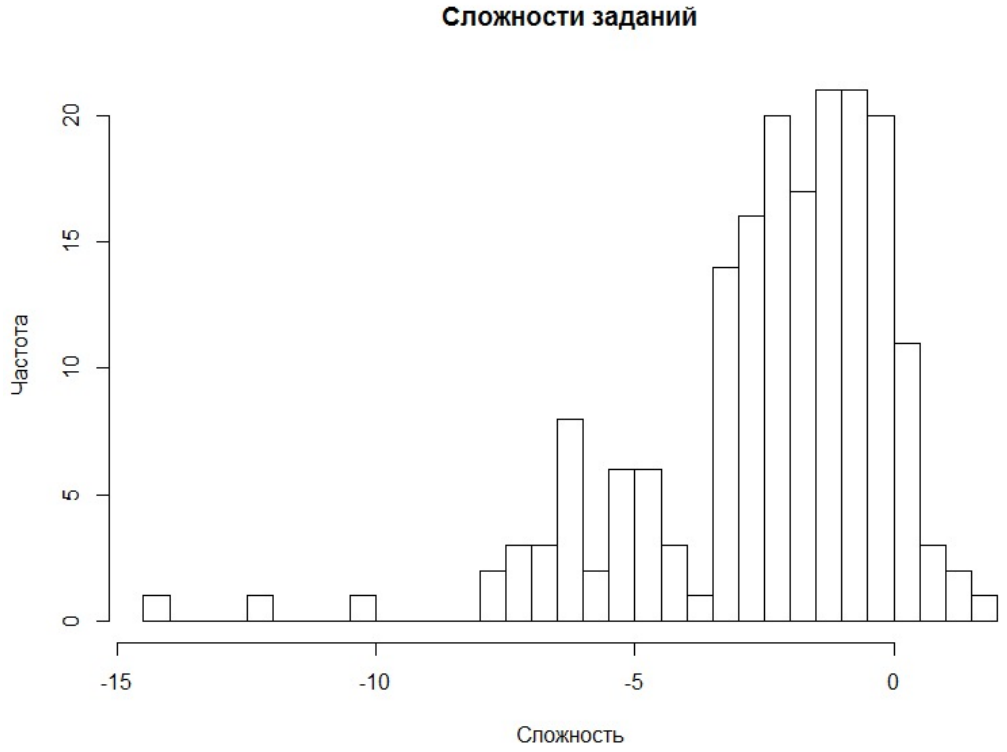
Initial measurements (numbers)

Tasks

IRT (Item Response Theory (syn: latent trait theory, strong true score theory, modern mental test theory))

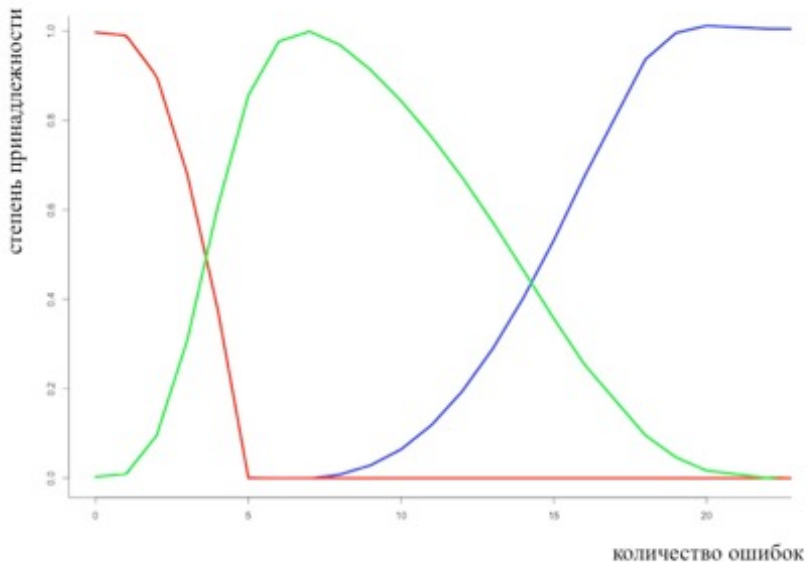


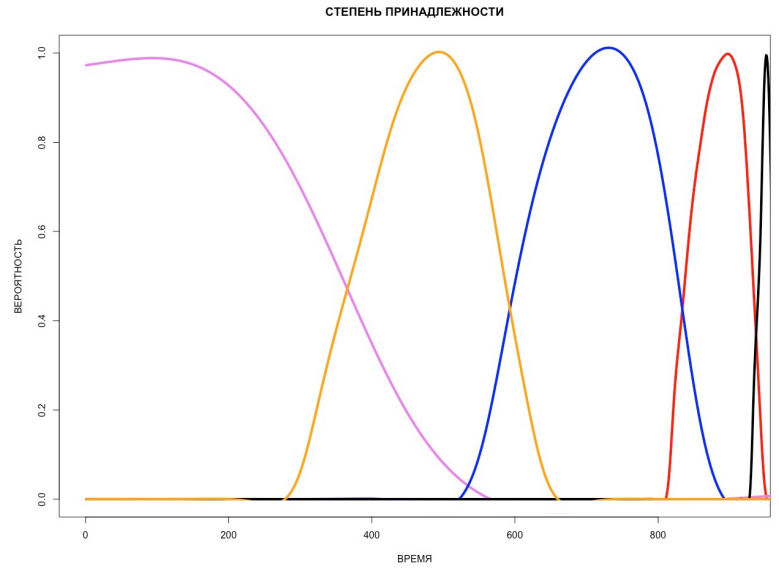




Students

c-means (FCM)

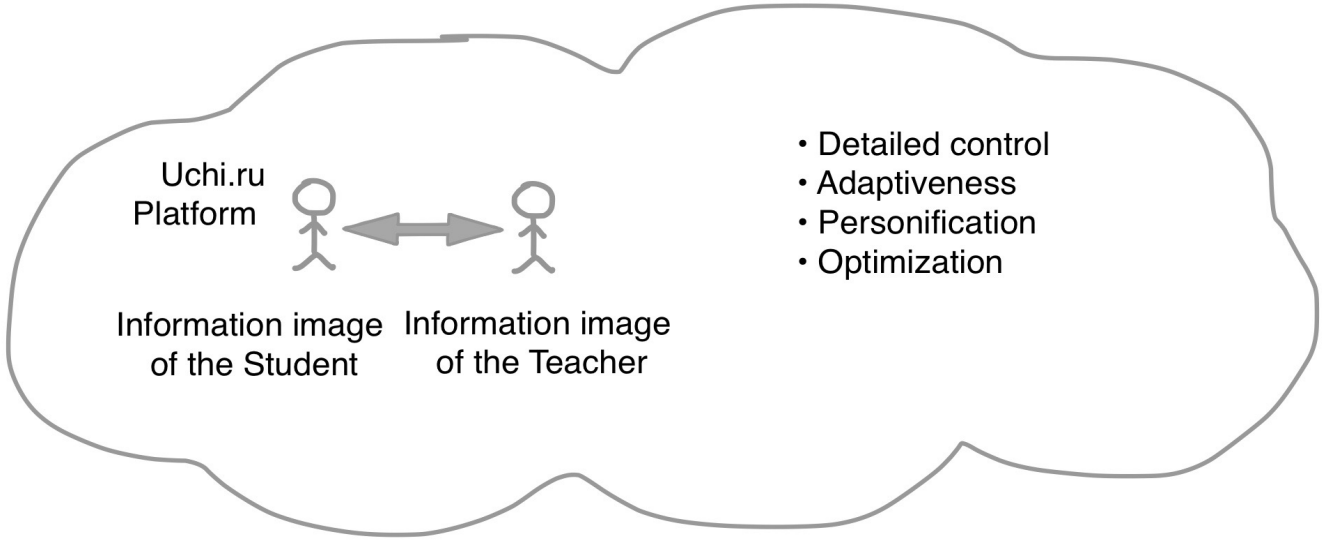


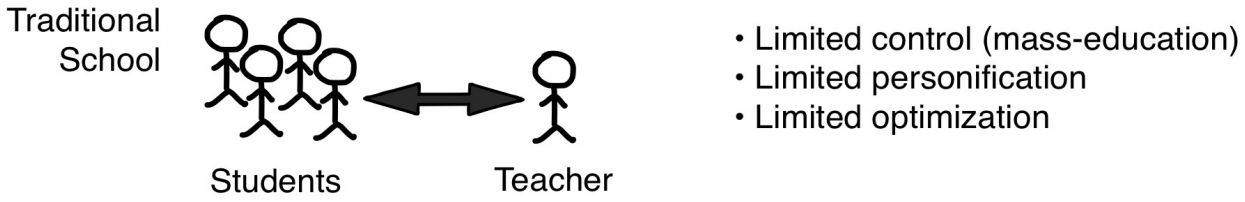


- Optimization:
  - Imbalance of classes
  - Fuzziness

Количество кластеров	Степень нечеткости	Дисбаланс
3	0,268	0,813
4	0.28	0,927
5	0.28	0,887
6	0.29	0,858
7	0.28	0,906
8	0.3	0,942

Hybrid Intelligence potential is 1:1 teaching



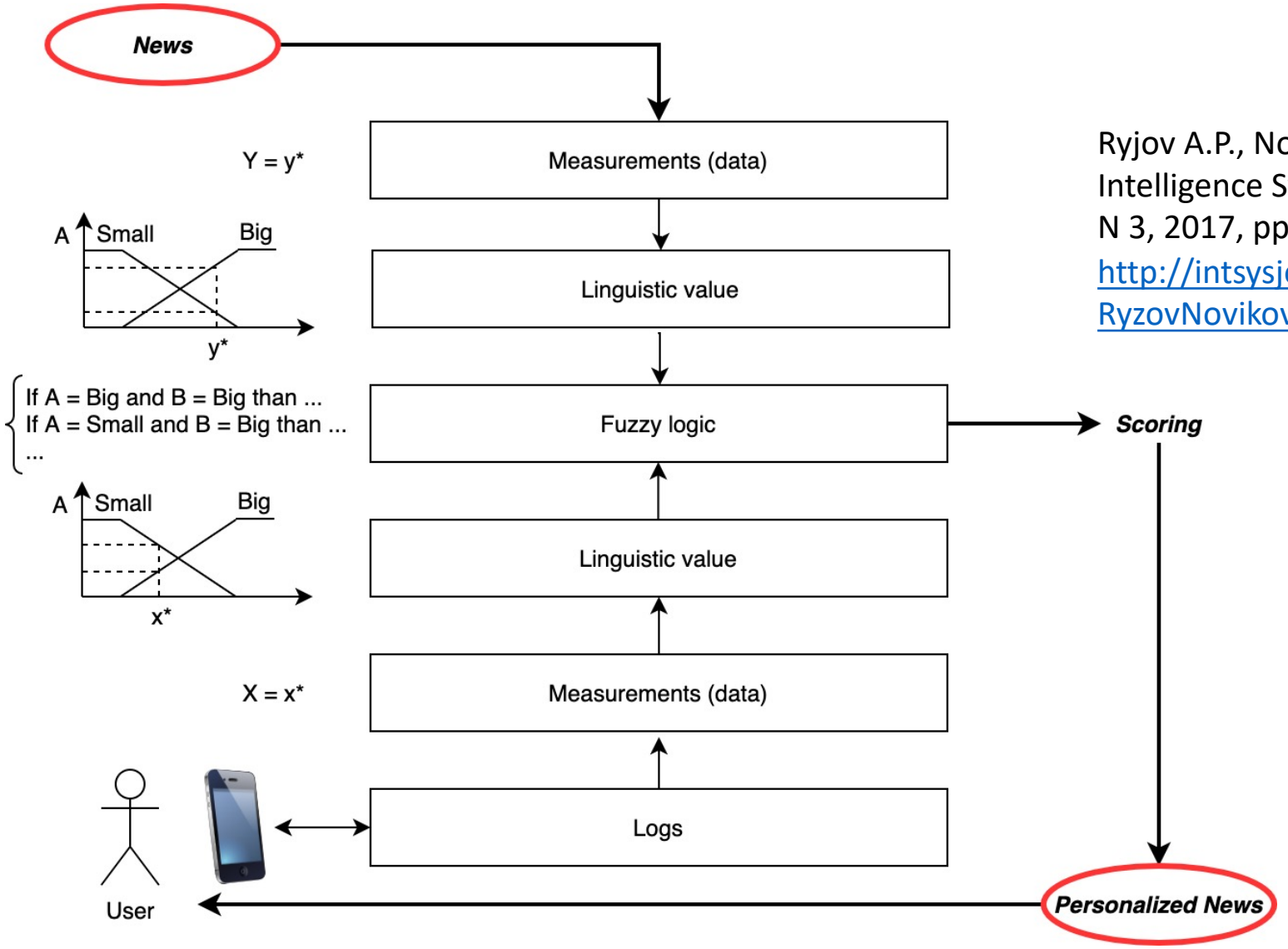


A. Ryjov, A. Vakhov, V. Krivtsov, and A. Zhuravlev. Personalization and optimization of learning based on technology for evaluation and monitoring of complex processes: Uchi.ru case study. The 2016 International Conference on Computational Science & Computational Intelligence. Ed. by: Hamid R. Arabnia, Leonidas Deligiannidis, and Mary Yang. Las Vegas, Nevada, USA, 15-17 December 2016, pp. 378 - 381.
DOI: 10.1109/CSCI.2016.0078

An education startup you've never heard of is now in 70% of US school districts (https://www.businessinsider.com.au/kiddom-startup-using-personalized-learning-in-most-school-districts-2018-1)

- A startup called Kiddom is in 70% of US school districts, and it's quickly enticing teachers with the "personalised learning" model.
- Personalised learning uses technology to tailor lesson plans to individual kids' abilities and learning styles.
- It's been endorsed by tech giants like Bill Gates and Mark Zuckerberg.

(2) Digital habits: news feed personalization



Ryjov A.P., Novikov P.A. One model of digital habits. Intelligence Systems. Theory and applications. Vol. 21, N 3, 2017, pp. 91-102. - http://intsysjournal.ru/pdfs/21-4/91-100-RyzovNovikov.pdf

When will personalization work?

- The first scenario will work when we need to find something important
  - Apartment
  - Car
  - Smartphone
  - …
  - Clothing (fashion industry https://www.labirint.ru/books/695465/
- The second scenario will work always when we agree to be "watched"

Resume

- Hybrid Intelligence is a practical (pragmatic) Artificial Intelligence
- The basic fundamental problems of Hybrid Intelligence are solved
- Frameworks/ scenarios of Hybrid Intelligence use are introduced
- Applications of Hybrid Intelligence for various types of organizations (international, federal, corporate levels) and various types of the problems (non-proliferation of nuclear weapons and materials, security, healthcare, microelectronics) are successfully developed and tested
- Vision and understanding for new applications (natural and technological disasters management, smart city/ smart regions/ smart countries, smart learning for education, smart healthcare, personalization and optimization for social networks/ information retrieval/ other interactions of humans with digital world, etc.) are proposed and discussed

Thank you!

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http://www.intsys.msu.ru/en/staff/ryzhov

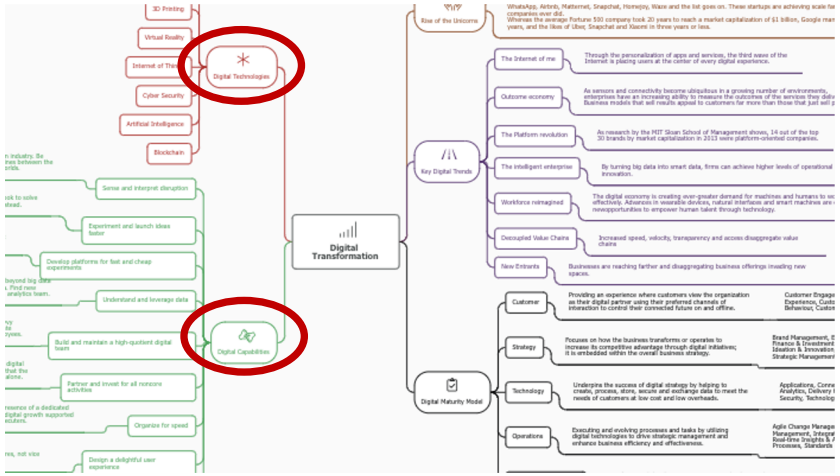
http://itm.ranepa.ru/node/566

See also: https://www.youtube.com/watch?v=IK0EATttbww

Backups

Possible mindset for development own model

Digital Technologies
- Big Data
- Shift to the Cloud
- 3D Printing
- Virtual Reality
- Internet of Things
- Cyber Security
- Artificial Intelligence
- Blockchain



Digital Capabilities
- **Sense and interpret disruption:** Look beyond your own industry. Be prepared to blur the lines between the physical and digital worlds.
- **Experiment to develop and launch ideas faster:** Stop innovating and look to solve customer problems instead.
- **Develop platforms for fast and cheap experiments:** Find or fund one venture that could most disrupt you.
- **Understand and leverage data:** Organize data hackathons. Think beyond big data to consider different types of data. Find new ways to monetize data. Create an analytics team.
- **Build and maintain a high-quotient digital team:** Be honest about how digitally savvy you and your workforce are. Create digital boot camps to reskill employees.
- **Partner and invest for all noncore activities:** One of the characteristics of effective digital leaders is their intuitive understanding that the journey is not one to be undertaken alone.
- **Organize for speed:** Ensure CEO support and the presence of a dedicated central team to drive the new digital growth supported by a team of digitally savvy executers.
- **Design a delightful user experience:** User experience drives IT architectures, and not vice versa.

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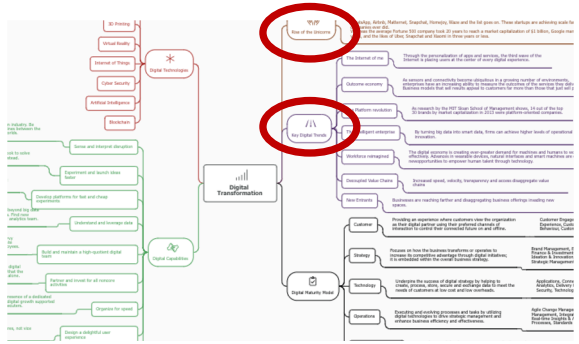
Possible mindset for development own model



Rise of the unicorns

•The democratization of technology (driven by its plummeting cost), increased access to funds and a rising entrepreneurial culture means that there are now hundreds of startups attacking traditional markets. Uber, Twitch, Tesla, Hired, Clinkle, Beyond Verbal, Vayable, GitHub, WhatsApp, Airbnb, Matternet, Snapchat, Homejoy, Waze and the list goes on. These startups are achieving scale far quicker than analog companies ever did.

•Whereas the average Fortune 500 company took 20 years to reach a market capitalization of $1 billion, Google managed it in eight years, and the likes of Uber, Snapchat and Xiaomi in three years or less.

Market forces that drive digitalization

•**Emergence of Ecosystems:** New ecosystems accessible through digital channels reduce switching costs

•**Reduced Ownership of Assets & Infrastructure:** Growth of data is accelerating, and is forcing issues around ownership, privacy, security, transparency, and trust

•**Reduced Barriers to Digital Entry:** Low barriers to digital entry blur industry lines

•**Decoupled Value Chains:** Increased speed, velocity, transparency and access disaggregate value chains

•**New Entrants:** Businesses are reaching farther and disaggregating business offerings invading new spaces

•**The Internet of me:** Through the personalization of apps and services, the third wave of the Internet is placing users at the center of every digital experience.

•**Outcome economy:** As sensors and connectivity become ubiquitous in a growing number of environments, enterprises have an increasing ability to measure the outcomes of the services they deliver. Business models that sell results appeal to customers far more than those that just sell products.

•**The Platform (r)evolution:** Rapid advances in cloud and mobile connectivity are dismantling the technological barriers and reducing the costs associated with establishing global platforms. These platforms offer huge potential for innovation and the delivery of next-generation services. In fact, as research by the MIT Sloan School of Management shows, 14 out of the top 30 brands by market capitalization in 2013 were platform-oriented companies.

•**The intelligent enterprise:** Advances in data science, cognitive technology and processing power have combined to open up the possibility of ‘intelligent enterprises’, built around smart machines and software intelligence. By turning big data into smart data, firms can achieve higher levels of operational efficiency and innovation.

•**Workforce reimagined:** The digital economy is creating ever-greater demand for machines and humans to work together effectively. Advances in wearable devices, natural interfaces and smart machines are opening up new opportunities to empower human talent through technology.

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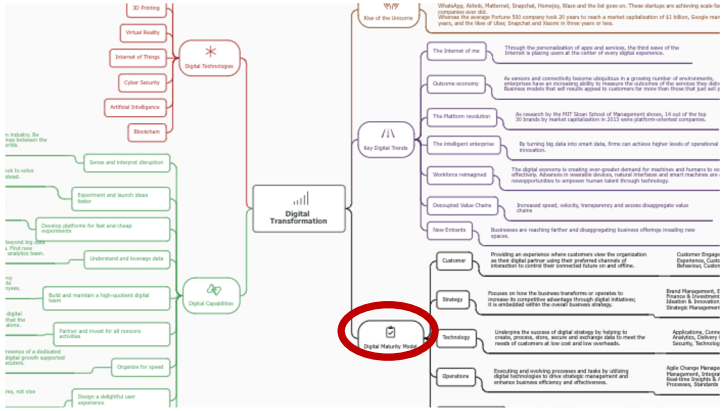
Possible mindset for development own model



Digital Maturity Model (DMM)

The DMM evaluates digital capability across 5 clearly defined business dimensions to create a holistic view of digital maturity across the organization

- **Customer:** Providing an experience where customers view the organization as their digital partner using their preferred channels of interaction to control their connected future on and offline
- **Strategy:** Focuses on how the business transforms or operates to increase its competitive advantage through digital initiatives; it is embedded within the overall business strategy
- **Technology:** Underpins the success of digital strategy by helping to create, process, store, secure and exchange data to meet the needs of customers at low cost and low overheads
- **Operations:** Executing and evolving processes and tasks by utilizing digital technologies to drive strategic management and enhance business efficiency and effectiveness
- **Organization & Culture:** Defining and developing an organizational culture with governance and talent processes to support progress along the digital maturity curve, and the flexibly to achieve growth and innovation objectives

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