Materials of the Master class at DSPA-2023 in Moscow

Technology Review of the Optimization Theory School: - the Digital World after Solving the Shannon's Problem

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Annotation. The final possibilities and future lines of development of the Optimization Theory (OT) methods and technologies are analyzed, which are summarized in the main landmark monographs on OT and two reference books of ethe modern times, in which a complete solution to the great Shannon's problem is given: - simple high-confidence decoding of digital data when transmitted over traditional coding theory (CT) channels with a relatively high noise level. All of them can be used to solve the main task of applied CT – the creation of decoding algorithms for noisy channels of an even more complex type than those that have been considered so far in CT and in OT. The algorithms of OT are compared with other areas of CT in classical digital channels according to the triune criterion of NVC≡"noiseproofness-veracity-complexity". The special value of the block versions of the Viterbi algorithm (BVA) of the OT scientific school is noted. The fundamental impossibility of obtaining any parameters of the NVC criterion for decoders by calculation at high relative noise levels is emphasized, which leads to the need to design highly efficient decoding algorithms based on Optimization Theories methods implemented only on high-performance computing systems is stated. The problems of the difficult progress of modern TC, which in our country has been represented for a long time only by OT, are indicated. It is concluded that there are no other ways of the CT development for now and, apparently, there will never be at all. The reason for this is that the **applied CT is not a mathematical problem at all!** This is an ensemble of various computational (!) problems that have been completely and forever resolved in the theory and developments of the Russian scientific school of Optimization Theory of the noiseproof coding.

Keywords. Coding Theory (CT), Optimization Theory (OT), multi-threshold decoders (MTD), Viterbi algorithm (VA), Gaussian channel (AWGN channel), LDPC codes, self-orthogonal codes (SOC), decoders with direct metric control (DDMC), symbolic codes, polar codes (PC).

1. Introduction.

The completion in this millennium of the publication of the Russian scientific school a number monographs on Optimization Theory (OT) with a complete exposition of a fundamentally new coding theory (CT) [1-5,25,26], i.e. already modern OT, as well as the long-awaited Hand-book-2 [6] on coding for digital communications created conditions for a reassessment of the current state of applied CT and analysis of the preferred directions of its further evolution.

The OT has developed very special technologies based on computer computational and modeling methods for research and design of highly efficient error correction algorithms in noisy digital channels of all classical types, traditionally analyzed both in the former CT and in modern OT. The minimum possible linear complexity of decoding algorithms with the length of codes n and their optimal, best achievable veracity even from the point of view of theory when using sufficiently long codes correspond to the complete solution of the Shannon's problem: - the simplest highly reliable transmission of "digits" in almost the entire area of code rates R, less than the capacity of the channel C. Thus, the former unnecessarily mathematized CT has been completely transformed by the efforts of the OT scientific school into a number of convenient, detailed optimization-type procedures for the tasks of designing, researching and configuring error correction algorithms. Such procedures adapt well to the tasks of research of decoders of technologically accessible classes for all basic types of communication channels considered in the CT, which allowed the school to achieve really very high results in terms of complexity and efficiency among all error correcting algorithms analyzed in the applied CT.

The state and capabilities of OT algorithms in comparison with other methods are discussed below, as well as other important problems that have accumulated too much over the half-century period of stagnation of this most important science of the digital world. According to the long-standing tradition of the OT school, most of the references to the review literature are accompanied by active hyperlinks, which has long been a virtually mandatory tradition for all publications of the school OT.Thus, all readers of the review are provided with the most convenient operational access to many of the information mentioned in it, significantly facilitating the analysis of the OT results, **the only currently modern complete applied (!) coding theory**, which has been successfully solving the problems of creating algorithms for decoding digital streams for many years and forming conditions for solving new technological problems of information processing in conditions of its transmission over highly noisy communication channels.

Since the readers of the review, as it turns out, immediately easily and quickly access a huge volume of publications of the OT school, we will allow ourselves, as we have already usefully done repeatedly, to point out several popular references that are convenient and very useful for the first reading of the materials of OT, where we indicate all the main graphical results by on characteristics of the OT decoders [5-7,9,11,12,15,25,26]. Note that the reference [15] refers to a very compact presentation of the absolutely complete theory of OT in English at only five pages and with graphs of experimental data of recent times. And the popular scientific color booklet [18], written with the participation of members of the Russian Academy of the Sciences and with a preface by Academician of RAS N.A. Kuznetsov, has long been read with special attention by supporters of OT and many specialists, along with new

readers who closely monitor the development of OT methods and technologies. The above links are quite enough both for the first acquaintance with the OT materials, and for its subsequent study. The absolute availability of various software resources [5-7], the most important working tools of the OT theory, is also always useful at all stages of acquaintance or intensive work with OT technologies.

It should also be noted that for the future, perhaps not too soon, restoration of scientific cooperation with abroad, our new monographs on OT are accompanied ***by their partially reduced texts translated into English*** in [7].

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See the presentation for the Master class at the Russian half of this portal.

2. Comparative merits of OT technologies.

According to the main results from the complexity N of the multithreshold decoding algorithms (MTD), i.e. the number of the simplest operations performed by them, is proportional to the length n of codes used: N~n. Other effective decoders are much more complicated than the OT methods, that is very significant.

Further, MTD decoders and all versions of the Viterbi algorithm (VA), including its block version (BVA), patented by the OT school, measure during their operation the distance of their decisions to the vector received from the channel [4-7]. This greatly simplifies decoding and at the same time increases the veracitythe of the final decisions to optimal ones. Among other classes of decoders of such a useful property of direct metric control (DDMC) there are no decoding methods at all.

It is also very valuable that MTD and VA operate only with small integers, that is especially important when implementing decoders for fast channels on high-speed computing facilities with a reduced number of commands and on FPGAs. And the difficulties of implementing decoders of other classes in comparison with OT algorithms turn out to be many tens of times greater at once, since those other algorithms almost always have to operate with real numbers, which is much more difficult to do on a fast element base with a reduced set of commands, for example, on signal processors [5,6]. The special importance of this property of OT decoders is demonstrated by one of their many ultra-fast implementations at ALTERA FPGAs in the SRI RAS, Moscow. The corresponding MTD for a satellite channel with an information processing (decoding) speed of more than 1 Gbit/s, created according the patent of the OT school, still has no analogues among other real developments for the Space. For this outstanding success in the field of projects of new space systems, SRI RAS was awarded the only Gold Medal for all the time of its participation in International Salons of Inventions [4 (p.148), 5 (p.173), 6 (p.118), 7, 8 (p.24), 18 (p.28, p.17)].

3. The absolute advantages of OT decoders.

As has been well known for many decades, it is very difficult to perform sufficiently accurate calculations for the parameters of the NVC criterion "noise-proofness-veracity-complexity" of effective decoders with a large relative noise level of a digital channel, in fact, it is simply impossible. It was this circumstance that became the main reason for the complete self-destruction of the former applied (!) coding theory (CT) as a mathematical problem, because as it turns out, the "theorists" of the whole world do not own computer design and modeling of their algorithms, and these "theorists" cannot fundamentally evaluate the main properties of decoders according to the NVC criterion with high probabilities of distortion of discrete data, i.e. with large relative noise levels in communication channels. Under these conditions, it is extremely strange to often see information about the complexity and reliability of algorithms, which, as it always turns out to be quite obvious, were not modeled by the authors. Nevertheless, there are unacceptably many such works (see [5-12,14,]). Many oddities in such results indicate that such authors have never carried out detailed step-by-step logical design and modeling of algorithms using their own special software. But since it is analytically impossible to evaluate any of the main parameters of decoders, the development of the former CT quickly, back in the 70s of that millennium, simply stopped. And it could not be otherwise, since mathematically solvable problems in applied CT, i.e., when creating decoding algorithms, actually never existed [5,6,8]! This is true even for all the simplest decoders of any type [5,6]. The only clear exception to this rule is algorithms for algebraic codes, which, however, always correct too small a proportion of errors in the received data and, therefore, can only work in channels with a very low noise level, which has long been of no interest to real communication systems.

In OT the understanding that it will almost never be possible to accurately calculate the parameters of decoders came a long time ago, at the turn of the 60s. And computer-aided design with subsequent decoder modeling immediately became a powerful tool for developing, as well as evaluating and configuring parameters of the algorithms being designed and studied, which modern software of the OT school allows us to implement instantly. This multiplies the speed of research many times, and also resolutely reduces the possibility of serious failures and errors [8,16]. However, they must always remember that the proper development of theory and experiment is possible only with the preservation and active support of their inseparable deep unity.

Finally, we point out the third very significant advantage of all OT algorithms. In MTD decoders, really the simplest devices or programs, the only active device is the threshold element (TE). Since it works only with small integers, it can always be designed so that, taking into account the properties of the codes used, it will make decisions about decoded characters as if instantly, which was patented by the OT school [5-7] a long time ago. And this

immediately solved all the problems of implementing algorithms! After all, in addition to the fact that MTD decoders have the lowest possible complexity N~ n, it turns out that for these MTDs, the proportionality coefficient for n is also very small. And other algorithms always implement incomparably more complex calculations. So MTD methods have exceptionally great advantages in physical decoding speed due to the absolute simplicity of the algorithm, which has long been demonstrated by the software that is interactively recommended and can be used in [4-7]. In many such examples, when modeling the operation of MTD in noisy channels, decoding statistics with a volume of ~10^{10} bits may be collected with ordinary laptops during ~1 hour of modelling operation [6,8,9]. Truly, it is much easier and faster!

4. On the effectiveness of OT algorithms .

Note once again that the probabilities of decoding errors in OT turn out to be, even from the point of view of theory, the best for those very long codes that are used in MTD decoders. And this property is preserved in algorithms from up to the nearest vicinity of the Shannon's bound, i.e. almost near the capacity of the channel.

In particular, for technical means of communication, the remoteness of the working area for MtD decoders from the Shannon boundary of the order of 1 dB in binary Gaussian channels is absolutely sufficient, since this is only 26% more than the energy at which there can be no gain in decoding reliability and transmission energy at the selected code rate R at all, even theoretically. And real channels are also characterized by some drift of the parameters of the equipment and the ether, which can be up to 10%- 15% or more. So, further approximation of the decoder's area of operation to the channels capacity C for real equipment is not so important at all, especially since it always requires an extremely large increase in the decision delay at the output of the decoder used in this channel.

Of course, such a scientific task can be saved, including for the most unique and often very expensive channels of deep space communication. And in most technical applications, the long-existing results from binary codes are quite sufficient [4-8].

Further, as shown in [6-8], in erasing channels, the advantages of OT methods are very great. In the former very formal CT, the complexity of the erasure-restoring decoders, as in Gaussian channels, is usually at least N~n*(ln n), which for this much simpler case of restoring erased symbols, according to the OT school, immediately turns out to be an unreasonably complex problem statement, because in this case the positions of such symbols are known. And here, too, it is unclear how specialists from other areas in the CT determine the parameters of the corresponding decoders, since there is no way to calculate them here either. But these authors usually do not own modeling. And is it worth trusting those results then?

And MTD algorithms directly use the fact of knowing the erasure positions. And taking into account this obvious advantage of a more natural formulation of the problem, the value of the erased symbol is uniquely determined by the decoder performing a single substitution operation. And they don't need to calculate anything else! This determined the success of OT and in this area of decoder development. And the boundary of the working area of the algorithm in terms of the input probability of erased channel symbols in this case differs from the probability of p_c , at which R = C, by only ~ 2%. This means that in these channels, MTD has no competitors at all according to the NVC criterion [5-8,15]. Again, we emphasize that, as for other OT algorithms, a very careful selection of the codes used by the decoder is also necessary here, according to the criteria of minimal grouping of errors in the decoder itself [4-6]. But these technologies have been known for ~ 40 years.

Finally, for special non-binary codes with majority decoding, called symbolic, the scientific school OT 1 invented and patented a special simple algorithm, also converging to the optimal decision with linear complexity. But the Reed-Solomon codes (RS) discovered 60 years ago have a quadratic complexity of their decoding algorithms $N \sim n^2$. For real-world applications, RS codes provide only limited veracities due to their short length in all available implementation options. At the same time, error correction methods for all other types of non-binary codes are extremely complex or even fundamentally unrealizable for the same reason [9]. It is important that the Viterbi algorithm for non-binary codes with a large alphabet is always ineffective [5,6]. This especially distinguishes the majority non-binary MTD algorithms, called symbolic and proposed before 1985, among all other methods.

It seems surprising that, despite the importance of non-binary codes and the weakness of RS codes, the use of symbolic codes, which have long been comprehensively reviewed in OT and fully published, has not been noted anywhere in the last 35 years [5-9]. The reason for this, perhaps again, is that no one of «theorists» during this time has been able to model non-binary threshold element (TE), although they are actually as easy to implement as binary ones. However, for 20 years now, the symbolic modeling programs of the OT school have also been publicly available [4-7]. And at the same time, it is also impossible to find even just the results of modeling long-published symbolic codes from anyone. There is nothing!

Does this mean that science has long reached a fundamentally unrecoverable level, at which comes the complete incompetence of its very vast branches of industries and the "scientists" who flourish there? After all, in the applied CT, all the troubles arose and began to multiply simply because no one knows anything, does not learn, does not understand and, therefore, does not want to do, including making experiments. But loafing in the "theory" - it is always welcome! No one will accuse you that no one needs any formula in this or that an article. For "mathematicians" such comments are unacceptable in principle!

By the way, sometimes it's a pity. And specifically in CT an experiment is always modeling by programming tools. And there is nothing else and there will be nothing also! There is nothing similar as replacing the wires in the coils of a magnetometer, or cleaning optics with alcohol as it is in physics. Alas! Real programming with concrete troublesome innovative projecting and subsequent modeling of new algorithms is absolutely hellish work, compared to which the galleys are a resort! That is why "theorists" have never been inspired by such a fate during the 50 years of the sad existence of the "formula" CT. And in this case, will the school have worthy successors of its theory and technologies based on a clear and logical basis of OT, which, however, require the mandatory further creation of large-scale software design tools of the highest innovative and necessarily optimization level? - We'll see. Time will tell!

In the meantime, the former extremely mathematized CT and its adherents simply cannot model, correctly design decoding algorithms, propelly choose the formulation of the next tasks, as well as harmoniously develop theory and experiment [8-12, 14-16]. So, we need to change something strongly. And – undoubtedly - a lot. And what exactly is we have indicated something above. In fact, while there are worries, problems and only then, perhaps, some well-deserved successes, there is - a sea!

5. Key properties of OT technologies

The former coding theory (TC), which has gone into oblivion, rigidly proved to the "theorists" that TC is not a mathematical problem at all. But – then which is it ?

The success of OT is determined by the fact that it is a very compact, perfect, unified three-component theory consisting of theories of searching global extremums of functionals (SGEF), generalizations of the Main Theorem of Multithreshold Decoding (OTMTD) and the Theory of Error Propagation (TEP). These three components of OT did not exist at all in the previous CT which allows us to consider OT the new full modern theory of noiseproof coding, which opens up huge opportunities for accelerated development for digital communication technology. And all three components of the new OT are held together by a common software that successfully solves all those OT problems that do not have simple finite formula expressions within the framework of previous CT. It was with the advent of OT, completely different from the old CT, that the decoders created by it in all parameters of the NVC criterion "noise-proofness-reliability-complexity" became the best even theoretically. And this is the complete solution to Shannon's great problem of simple high-reliability communication via digital channels with a high relative noise level, with which a number of our colleagues agree, including those at the Russian Academy of Sciences, who consider the complex of scientific and applied results of the OT school to be an outstanding Nobel achievement of Russian science [5,7,8,17,18].

We emphasize here once again that the success and leadership of the OT scientific school, which was far ahead in theory, in its methods and technologies of the rest of the digital world for ~25 years, determined the software that this school intensively created for 50 years on the basis of its subtle estimates of the parameters of codes and algorithms using all the components capabilities of its three theories.

Recall that the eternal competition of theory and experiment in researches became especially acute in the 80s of that century, so much so that a number of very significant publications on this topic were even presented on the portal of the Russian Academy of Sciences [16]. And the OT school realized at the very dawn of its formation that almost all tasks in CT, as well as large-scale optimization-type problems in general, never have analytically presented final formula decisions. Innovative software of the OT school successfully solves many such problems that are obviously not formulated analytically, as well as those problems of the OT theory, even to the choice of which no scientific groups of our digital world have yet begun.

6. On the education development in OT theory.

The completion of theoretical research in the field of OT took place before **1985**, and its comprehensive verification of the experimental plan – by **1995**. The publication by the school OT its 16 books, as well as two reference books that allow them to try out and immediately directly apply computer tools for designing, configuring and testing decoding algorithms of our school, create all conditions for studying with varying degrees of detail and depth all types of MTD algorithms, as well as all modifications of the Viterbi algorithm, including the school's patented memory-saving two-parameter block versions (BVA) [4-7].

However, after 1986. no publications on the subject of OT are accepted by the editorial board of the ITP journal, which is determined by the standard responses of their reviewers to the authors of articles on OT, according to which "... the probabilistic characteristics of decoding are obtained only by modeling ..." or "... the author is not familiar with modern works on noiseproof decoding ..." and so on in the same spirit [19]. The level of "formula fetishism" demonstrated in the IITP has long been limitless. However, it is the traditional authors of the ITP from the IITP RAS, and 20 years after this extremely unqualified review of an absolutely revolutionary work on the topic of school OT achievements almost forty years ago, in non-binary codes, there is nothing new on this topic, at least partially approaching the level of the publication they did not accept, where the algorithm with linear complexity was described and optimal decoding of non-binary codes. There were no similar results in the world at that time, in general! Today's results of the OT scientific school on these character codes have become even more impressive [4,5,20,21]. We emphasize, by the way, that there is also no work at all abroad on non-binary codes with linear complexity and optimal

decoding [9]. Do they also not read anything? Partly, yes, that's true. Hundreds of our works in English have not been carefully read, including three of our fundamental monographs on coding (see about it [5-9]). It is because our results are not highly appreciated. However, the European Union has awarded only a few Russian scientists with the Gold Medal "For exceptional achievements" in science. It was just exactly due to OT theory.

But, returning to the topic, on the portal **www.mathnet.ru** a number of articles by the authors of the «IITP school» have demonstrated extremely low noiseproof and very high complexity of their algorithms, and by the way. the style of publications and these results does not allow us to understand how the parameters of the NVC criterion are determined there, since it is fundamentally impossible to calculate them. And those authors, as we know, also do not know modeling in principle. The newly published decoders of the "IITP school" are about 2 orders of magnitude weaker in terms of the input error probability (!) than the experimental results of the OT school at the same portal, published 30 years earlier (see about this [6]).

In the current situation, however, all dissertations on CT are still approved exclusively at the IITP RAS, all "Ph.D./D.T.S." on the subject allowed by this "citadel of science" preach decoding methods 30-40 years ago in their training courses on CT in universities, which in general completely stopped in the Russian Federation, the CT technologies development and actually all digital university education. There is still simply no one to train future specialists in OT technologies. Let us briefly note the most excessively "widely known achievements" in the field of "education" in Universities, the application and use of which should be avoided always and everywhere. One of the most dangerous in this sense is undoubtedly the manual "Fundamentals of Coding Theory" [13], which discusses algorithms for almost optimal decoding for medium-length codes with a complexity exceeding the number of atoms in the Universe (see about this: [6-8])!

But, in addition, block versions of optimal decoders (OD) based on well-known structures with convolutional codes are also offered for students to study there, for which the exponent of decoding complexity is twice as large as even the corresponding exponentially complex classical Viterbi algorithm (VA) for convolutional codes.

And here it is very important that the block version of VA (BVA), patented by the OT school [4-7], has the same complexity as the original convolutional VA. For a number of specific well known implementations of convolutional VA, a similar OD based on the BVA of the OT school would be up to 10^4-10^6 times simpler than the OD offered to students in [13]. There is nothing more meaningful in that manual at all. Nevertheless, for many years this book has been aggressively offered for study by university students. And there are no other manuals for specialists and students in the Russian Federation, except for the reference books of the OT school [1,6] and its new monographs [3-5] with

detailed methods, software platforms and specific technologies for designing, modeling and configuring all types of coding systems.

7. About other activities in CT

The absolute absence, as the OT school noted earlier, of the author of the manual [13] at least any knowledge about OT was once again confirmed as a result of his completely thoughtless participation in writing a "review" on coding for a respected telecommunications magazine. Because of the text published there by the author [13], which is extremely harmful for non-core specialists (here already - and with co-authors!) one of the heads of OT school had to postpone all his business and write his extremely negative comment on that "review" [22], the main conclusion of which is that the equipment in coding theory should be taught and known very well!

Published books on fast "new" decoding algorithms by various authors are also absolutely not such (see about this:[8,14]). The number of such "revelations" is increasing. But in the applied CT, in general, everything has been done for a very long time, even **before 1985** at all, by the OT school.

And finally, it is unclear how the "dissertations" on polar codes, which were recently defended with the active participation of the IITP RAS, can also not be characterized in terms of the NVC criterion, since the complexity of the "polar procedures" described there is approximately $\sim 10^4$-10^6 times greater than that of similar decoders of the OT school for symbolic (non-binary) codes, fully published almost 40 years ago. And, moreover, all the assessments of the Russian "adherents of the polar theme" were carried out by completely incomprehensible methods, and the results of experimental verification of the characteristics of the claimed algorithms, as it turns out, have not yet been presented anywhere and in any form. And, apparently, they will never be. We emphasize that many of their "bold fantasies", mistakes and outright deception were recorded in detail right at the defense of one of their "leaders of the Russian poles" by opponents and other participants in that extremely strange "process". The question of the reasons for the positive vote of the IITP RAS special council on the results of this extremely deplorable in every sense "event" also deserves a very strict analysis.

However, very dangerous attempts to advertise and distribute "polar methods" have already taken place several times. All these acts that destroy the fragile body of a very weak science about codes so far need to be urgently and abruptly stopped with appropriate strict organizational guidelines for personnel, research programs and management methods.

8. Conclusion.

In the conditions of a deep crisis of science and technology, the OT scientific school, after several generations of supporters of this school have completed a grandiose amount of scientific, methodological and technological work, has completed an important stage of creating an extensive complete set of design, configuration and testing tools for various types of the OT school decoders for all classes of channels considered in coding theory (CT). Since, according to the NVC criterion, OT algorithms have the best parameters even according to theory, the appearance of equally simple and efficient decoders of a completely different type is still very unlikely.

The long-term crisis in coding technologies has been completed due to the fact that the **applied CT**, engaged in creating good decoders for digital streams in highly noisy channels, **was not at all a mathematical task**, which was proved by that former to the limit formalized CT. The real successfully working OT turned out to be a set of very diverse technologies for solving the problems of searching for global extremums of special functionals defined on discrete sets with potential self-correction properties. These extremums are always achieved by specially tuned optimization algorithms implemented in the decoder design process exclusively by innovative computer methods of the OT school **on the basis of unique innovative software created during 50 years.** In principle, such very big problems of the digital world as the applied tasks of the CT cannot have any formulaic compact expressions. It was the large-scale development of such software for different channels and codes that determined the unconditional leadership of the OT theory, which provided accurate statements of the tasks solved by such software, as well as a very difficult interpretation of a large set of final results of the application of the unique OT school software, which really ensured the development of breakthrough technologies in applied coding theory, in its completely updated OT theory.

The extreme importance of the obtained scientific and applied result: - a complete successful and in reality very difficult solution to the greatest problem of the digital world, formulated in 1948 by the great K. Shannon and has not yet been solved anywhere else in the world, except for the scientific school of OT, which completed work on this truly Nobel achievement after 50 years of grandiose efforts., - this importance lies in the fact that the final algorithms of the OT school, which are really the best according to the NVC criterion, have certainly remained extremely simple, understandable and absolutely accessible to the entire huge army of scientists, specialists, graduate students and engineers, since they relate to the simplest well-known methods of majority decoding and the extremely popular Viterbi algorithm, which, however, have now received in OT theory extensive opportunities in the field of special tuning of its parameters. Both of these classes of methods have long been well known to Russian specialists, as well as developers of digital systems throughout the

technologically advanced world. And as for the design features and mandatory final modeling of new inventive algorithms already based on fundamentally new large-scale tools and technologies of the very computer technology for the development of which decoding systems are being created, this is so natural, more than timely and mandatory transformation of the research system in coding theory, in our case, that harmony, as it seems to us, that many other branches of our super-crisis science can envy the new state of the entire theory of noiseproof coding.

But there are still few reasons for absolute joy and delight. Officials who have been destroying the Russian coding theory for many decades have not yet received what they deserved. Moreover, the groups that are comfortably and freely existing useless in the CT, who have retained illusions about the "mathematicity" of the CT and in their applied aspect, have not received any significant results for the design of decoding algorithms over the past ~ 40 years. This also determines all the strange pirouettes with many obviously failed search directions by different "authorized" from the IIPT "Ph.D./D.T.S." quite unusual and flop solutions for decoding algorithms, the brightest and absolutely catastrophic among which were, of course, polar codes (see the special page about them [23] on our portals). However, as supporters of the OT school have repeatedly been surprised, the complete inability of extremely uneducated and absolutely inadequate "theorists" to test their "thought forms about polars" in experiments that could be compared with the widely presented results in OT completely closed the entire development space for "polars". None of this very noisy Russian "rock band about codes" presented any results, and their individual data on the complexity and other properties of decoders for polar codes, which were, let's say, inadvertently indicated by domestic "dissertators", who for unknown reasons successfully defended themselves at the IIPT RAS, turned out to be absolutely unacceptable for any serious discussions. After all, it is impossible to somehow discuss without a smile their "revelations" that ".... in polar codes, all problems were solved much earlier than in OT theory ...." (see:[24, p.10]). But the OT theory has eliminated all the real technological problems of decoding "figures" for a very long time, and what that "theory from Russian polar explorers" has solved and achieved - no one knows this at all, because they have never reported this to our science. And the funny thing here is that the first very weak in every sense article on polar codes was published only **in 2009**, whereas the whole OT theory was completely and successfully completed together with all the applied CT problems 25 years earlier, **even before 1985**. So far, it is only obvious that the Russian "polar company" did not see OT theory with its 11 monographs under scientific editorship and with the participation of members and academicians of the Russian Academy of Sciences and its two reference books for a quarter of a century before its "defenses of dissertations", but boldly rushed to write its incredible "fantasies" on an extremely strange and extremely illogical "polar" theme. Is it possible to consider

Russian individuals behaving before their "defenses" and, of course, after them as insane degraders – we are completely uninterested in this. But the facts of the complete uncontrollability of Russian science in its most important aspects and branches blatantly testify to the need for a quick and tough reaction to all manifestations of destructive activity and extreme degradation of its individual officials and functionaries covered by them. Based on this, the participation in these processes of the IITP RAS deserves a completely independent rigorous investigation and relevant conclusions.

And in reality, nothing new has appeared in this millennium in terms of real progress in creating decoding algorithms. Yes, in general, it shouldn't. After all, the characteristics of OT algorithms according to the triune NVC criterion actually lie on the best bounds, even in a theoretical sense. The Shannon problem has indeed been completely solved at the highest scientific and technological level. So now it is necessary to further accelerate the development of OT technologies for new much more complex signal systems and telecommunications networks, which the OT school has also been gradually doing for a long time [2,3,20,21].

Once again, we emphasize that our unique, the only software in the world for creating effective simple decoders, as well as all the strict compact and balanced theory outlined in our monographs and reference books, are freely available and ready for use in the world of digital communication of the future humane information community of our planet, which, of course, is not at all fast, but will be undoubtedly built.

We invite everyone to cooperate!

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