Our new successes -2020

Development of coding theory in Russia in the spring of 2020

Good afternoon, our dear colleagues in this unusual warm spring of 2020.

This welcome (and simultaneously debatable!) text is written for you by employees who are members of our Optimization Theory (OT) scientific school although many organizations with which the OT school cooperates are under quarantine. But just for this reason, keeping our common absolutely clear ideology, according to which our school, that bears the heavy burden of absolute world leadership **in applied** coding theory (and therefore must stand on its watch in science!), we continue to introduce you our OT main achievements in 2019 – 2020. We call this OT as the new "quantum mechanics" of information theory.

We guarantee that, as before, the logic of all our arguments will continue to be quite clear, systematic and very simple.

Let's start talking about our major successes over the past year and future plans.

First, we were able to put on our portal **www.mtdbest.ru** 2 more of our important books **in Russian**. As they say, the time had come.

1. Zolotarev V.V. Theory and algorithms of multithreshold decoding. // Edited by corresponding member of the Russian Academy of Sciences Yu.B. Zubarev, RF, M.: Radio and communications, Hotline-Telecom, 2006, 266 p.
URL: **https://mtdbest.ru/articles/теория и алгоритмы 2006.pdf**

2. Zolotarev V.V., Zubarev Yu.B., Ovechkin G.V. Multithreshold Decoders and Optimization Coding Theory // Edited by academician V.K. Levin, M., Hotline-Telecom, 2012, 238 p.
URL: **http://www.mtdbest.ru/articles/Zolotarev_OK2012.pdf**.

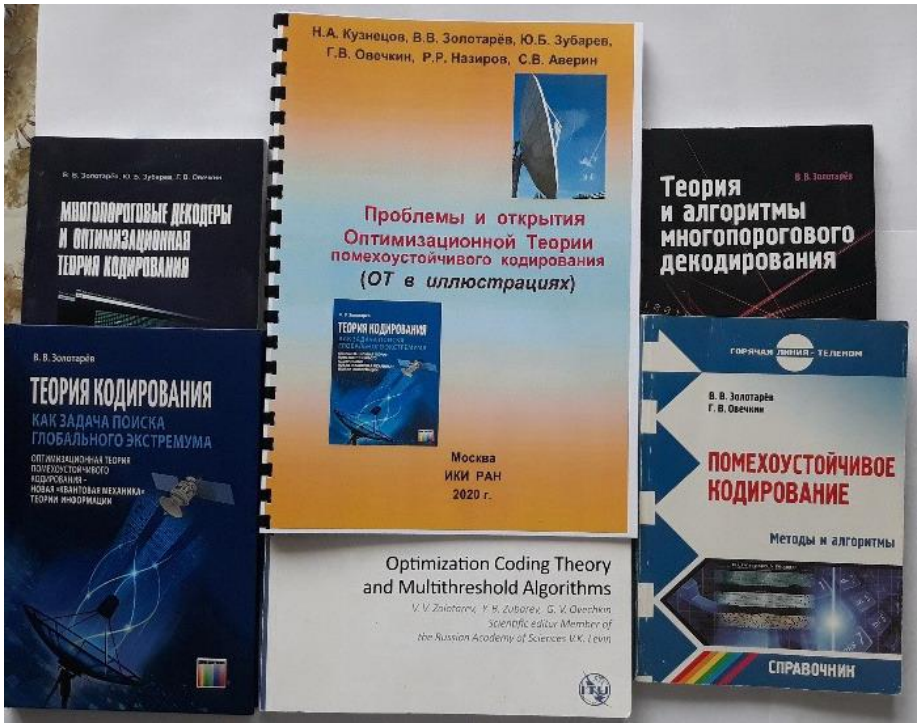
These monographs were published in 2006 and 2012. They were written by different teams of specialists. They provided solutions for all the main problems that our scientific school had to face in order to provide the world science with the most accurate and reliable information about the new coding theory at the moments of each these books publications. But these fundamentals are already presented in both books as they are understood in OT and now, in 2020.

For information about our newest 2018 book **in Russian** "Coding Theory as a Global Extremum Search Problem", see the page **http://www.mtdbest.ru/books.html** at our web portal. There are also various (and this is very important!) critiques and reviews of this monograph at this page, which already generalized the entire OT theory, which at a good technological level solved all the problems that Claude Shannon once posed to the world science in the field of ensuring high reliability of digital data in conditions of large distortions during their transmission and storage. You can find it from the author, online, in large stores, and from the publisher **www.techbook.ru** or on the site

www.findbook.ru . The photo below shows the main books, which show all the basic OT results.

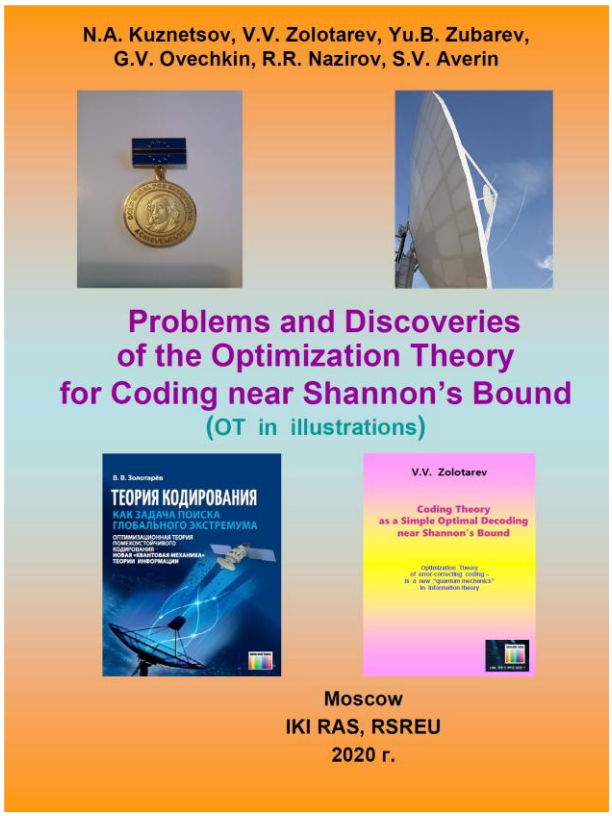
Recall that this monograph was also published with the support of the RFBR in RF. That is why you can read it freely on the portal **www.rfbr.ru** in the section of books published with the support of the RFBR (in Russian too).

As it has been repeatedly confirmed by leading experts of the Russian Academy of Sciences, we can now say that **our scientific school has completely solved the problem that K. Shannon posed 70 years ago**. At the moment, for all classical channels and **for all the best known class of codes** can be find effective technological solutions **for the optimal (!!!) decoding with the minimum possible complexity, i.e. proportional to the length of the code**. And we know that this minimum possible decoding complexity simultaneously provides exactly maximum-likelihood decision for those long codes for which the Viterbi algorithm (VA) can no longer be used in principle, because we have long been accustomed to the fact that in coding theory optimal decoding corresponds to a best solution, with the complexity exponentially increasing with the code length ***n***. So all the same, for MTD, the optimal decision is achieved precisely when the complexity of the code is linear relatively the length ***n***, which is the essence of the **superrevolution** that OT made.



We are extremely happy to present you our booklet also, which actually has a very unusual and interesting format for science comics: "Problems and Discoveries of the Optimization Theory for Coding near Shannon's Bound". It is shown at the photo on next page. This is what we call our convenient way to display graphically the most significant OT results, which are accompanied by comments, the emotionality of which, as we are sure, helped us to show correctly many OT ideas and technologies. You can rewrite it from the first English page of our portal **www.mtdbest.ru**.

or via hyperlink
URL: https://mtdbest.ru/articles/e-comics.pdf



We also remind you that the collective monograph in English "Optimization Coding Theory and Multithreshold Algorithms", published by ITU in its Anniversary year 2015, can be viewed and, of course, rewritten from the Russian web page

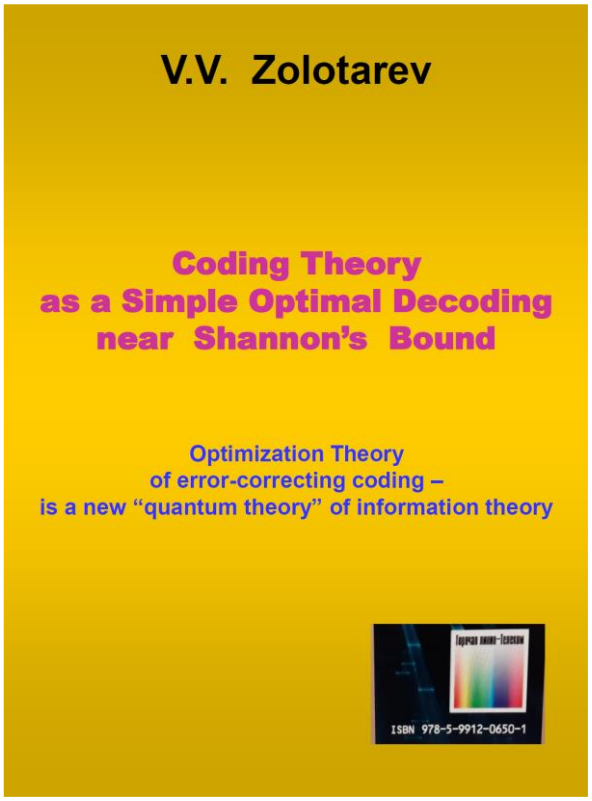
http://www.mtdbest.ru/books.html .

It is also available via a hyperlink:

URL: **https://mtdbest.ru/articles/Zolotarev_ITU.pdf**.

This book provides a detailed unique description of the most complex problem of coding theory: **the error propagation (EP) theory** in majoritarian (threshold) decoding. It was just EP that pointed out how to create the multi-threshold decoders and the required codes so that **the MTD would work near the Shannon's bound**. This book's cover you can see at the upper page.

Further on the same web page you can find our newest monograph "Coding Theory as a Simple Optimal Decoding near Shannon's Bound (Optimization Theory of error correcting coding - is a new "quantum mechanics" of information theory)» . You can see it at the next page.



You can rewrite it using a hyperlink **https://mtdbest.ru/articles/mtd_book_2019.pdf** .

In this monograph, we fully describe all the main results, that allow us to claim that **we have solved all the problems of classical coding theory**, even at the highest possible noise levels.

Well, that's all about books for now. **It's quite enough. Read it please**.

And then we suggest that you pay special attention to what we will tell you in this spring message. We will briefly explain that the coding theory had come into the next qualitative phase of development, into the new "quantum mechanics" of information theory, as we called our Optimization Theory (OT) noise-resistant coding.

So:

The old "classical" applied coding theory has completely ended its existence.

But why is it so?

And what is it instead?

We have already written many reports, made many presentations at the plenary sessions of several conferences, and published a number of articles in various respected scientific journals in Russia about the change of epochs in modern coding theory. You can read about this on our portal **www.mtdbest.ru** . By the way, **the comics** - it is just about this!

And now we will briefly recall the essence and causes of that great event, which, undoubtedly, should have happened a few ten years ago, somewhere in the

region of the 90s of that Millennium, or even a little earlier. We hope that all the main points of the completed changes, which we will urge you to pay attention to, will be clear and useful for you. This will allow you to interact better with the staff of our scientific school and now just with the huge and extremely useful for all our network portals **www.mtdbest.ru** and **www.mtdbest.iki.rssi.ru** . We offer you the conditions to switch to the study of Optimization Theory (OT) in a much more natural style, with a full understanding of the situation, which has now become that the only working theory that actually continues to develop the entire **applied** theory of noise-proof coding. Note that we usually add the word "**applied**" to OT almost all the time, everywhere and always. This means that we are talking about creating noise-proof coding algorithms, the applied goal of the theory. But in fact, this is the main and in fact **the only goal of coding theory**. So this clarification is intended to emphasize the meaning and main purpose of coding theory. And essentially we are just writing about a complete solution for the great Shannon's problem, which is the most valuable of all the scientific results of information theory for our digital information world over the past 40 years of development.

It is also necessary to recall that, as it is well known, the Shannon's bound is absolutely elastic, as the speed of light for material bodies, and therefore it is fundamentally unattainable. And this can be freely survived. But it is possible and necessary to approach it, that we have been doing for many decades. **This is just the essence of the development of OT algorithms.**

We will emphasize further that if we consider the communication channels that the coding theory has analyzed for many decades, then in fact we have changed the entire applied coding theory. To do this, we have created and patented a lot of algorithms that no one could study, model and use until now. And now this is extremely strange. Unfortunately, despite the fact that we have already published more than 600 scientific papers and about 10 monographs (***2 English books also***!), nevertheless, we must admit that almost no one really knows our OT. And this is despite the fact that we do not hide anything, and it is not difficult to learn OT. Indeed, the basis of OT are the simplest, widely known for more than 50 years majoritarian (threshold) decoders, discovered by James Massey! Well, here, however, there is also our new special branch – various modifications of the Viterbi algorithm (VA), including its block versions (BVA). But VA has been known for more than fifty years also. Moreover, it is even very much loved by all engineers. And there is one more useful and very good circumstance that helps the study of OT: **the entire OT** is at several decimal orders of magnitude **smaller (!!!)** by volume, than the former very plump "classical" theory, which is very weak in its results.

Indeed, working with OT requires an extremely small number of formulas, which are always very easy to deduce, but allow you to make all the necessary estimates for all classical communication channels and for all our algorithms. Take a few minutes and scroll through the web portal **http://www.mathnet.ru** . There is a lot of work on the "coding theory" . At 15, 30, and sometimes even at 50 pages with a dozens cross-references, many strange relationships are displayed that no one will ever be able to check and (**it's important!**) which no one in applied

coding theory needs at all. And in OT, some of these tasks are solved on the basis of simple reasoning on a single page and then allow you to get immediately simple formulas that are really very necessary for evaluating the real capabilities of OT algorithms! There are many such cases with that "theory".

We are much more simple!

Still, OT is not very familiar, is it? But why? Yes, because all these simple and well-known majority algorithms are always supported by sophisticated highly intelligent software, which **has also been created so far only by us**. And this software should also be understood, i.e., they should at least just be able to use. And it would be nice - Oh, horror! :) – to write a little more soft for your specific needs. Yes, literally hundreds of books "about codes" are full of "super-calculations" with pseudo codes and yet do not contain a single graph for at least one of all those extremely strange "algorithms" that clever "near-scientists" can endlessly combine. But they are absolutely unable to tell us anything specific about **the noiseproofness** of the "algorithms" they have "discovered", and, moreover, about **their specific complexity**. Yes, it is very "scientifically" style, but it is impossible to understand anything. And note that here we are forced to write many of the usual terms in quotation marks. There is nothing to be done, there are simply no decent exact names for such activities. Therefore, after such courses "about codes" no one can learn anything.

Yes, there are problems with programming everywhere. Even just using "low-level" programs, i.e. written in universal assembler-like simplest, but now very convenient languages such as C++, in contrast to the same "everyday " WORD, is, of course, very difficult, and with unaccustomed and really very hard. And note that the slogan "programming - is the second literacy!» for our second "smartphone" decade, - it has become completely irrelevant, as if unnecessary. But, alas, this is a great pity. This is the most important part of the current disaster in the coding theory!

In fact, over the past many decades, you have never seen complete data for any of the "great" algorithms for just three specific and understandable parameters:

"complexity-reliability-noiseproofness" .

Nowhere!

But why? And simply no one (among "encoders-men"!) can write reliable simulation programs that can quickly, accurately, and clearly demonstrate the real numbers of **complexity, noiseproof** possibility, and **veracity** that are the only ones needed to specialists for the coding equipment development. And why such programs are needed? Yes, just to measure and determine these parameters. (We have already given you calibration measurement programs and comments on them on our web portal. Do you remember it?). These three parameters are necessary for the chief designers of digital systems to make decisions about the choice of certain methods to ensure the required reliability of digital flows in the designed networks and other complex information systems.

And here we come to the heart of the problem.

Wouldn't it be easier just to count them?

Well, no and no!!! No one, anywhere, will ever be able accurately to determine the real complexity and calculate the decoding **error probabilities** for any really efficient algorithms near the Shannon's bound! **Never!** Neither in terms of complexity, nor in terms of efficiency, which includes reliability and distance to the channel capacity. **It is absolutely impossible!** This is the only thing that **the "classical" coding theory has been able to prove for all 60 years** of its sad and almost tragic existence. The only ray of light for it was flashed when a concatenated coding method was proposed for convolutional codes with VA and RS codes. But quite decent characteristics of this scheme were determined by VA. And I can't remember anything more than that. **There are nothing!**

So software models give an absolutely accurate answer right away **(!!!)** on all three of the above main criteria for encoding. They do it in just a couple of minutes or, in some complicated cases, in a few hours. But this is truth if the models and everything else in them are done correctly! And remember that software, sorry, good software is always created **very difficult and extremely slow**. That's where it all becomes clear, isn't it?

In fact, it turns out that the "classic" coding theory in principle can not answer at all any of the main questions that the great Claude Shannon once posed. But then it turns out that it has not found **for 60 years** any analytical methods for calculating the above mentioned key parameters of encoding systems near the capacity of the channels and, therefore,

"that" coding theory is not a mathematical problem at all, as all these decades were absolutely sure many thousands of people who for some reason enrolled themselves as specialists in this branch of information theory.

This means that we have also come to the answer to the main question: why does the OT school claim to be the leader in coding theory?

Why is this so?

And is it really true?

Yes, we have actually answered this most difficult question. More than 50 years ago, the OT scientific school, along with the most complex theoretical researches, also started developing full-scaled software systems that, at various stages of OT development, based on its theoretical developments, provided the main parameters estimations of all codes and simulated coding systems developed by our school. Conversely, complex experiments with codes based on flexible intelligent models of algorithms helped to select the next most important tasks on which the theory should focus its attention. It was then that it became absolutely clear that solving the problems of creating decoding algorithms is a joint problem of a very sophisticated theory and an inventive full-scaled experiment. All this is just demonstrated by the various successes of OT, which now combines, develops and studies all the best optimal algorithms: various versions of MTD decoders and a variety of implementation options for convolutional and block versions of the Viterbi algorithm (BVA). And they all have the lowest possible complexity! Several dozens variants of all these algorithms and their modifications have been patented by our school.

The combination of these circumstances determines the situation when the absolute leadership of OT is confirmed by the exact main numerical parameters of decoding algorithms, determined on the basis of a vast set of created various **software platforms** for all channels considered in the coding theory. And these platforms were developed on the basis of a complex original theory, which allowed us to solve all the problems of modern coding theory. At the same time, the results of using the platforms themselves, in turn, pointed the theory to the new problems of increasing the efficiency and speeds of decoders, which it had to solve further.

It is very timely to remind you that OT school **freely distributes all its software platforms** and advises all enthusiasts on modeling and programming methods. We give lectures and help you choose your first problems for research in the field of OT. We get now publishing the second reference book on coding theory. Do you want to help?

We invite everyone!

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It should be emphasized that the problem of the correlation between Theory and Experiment is very old and very acute in the science, so much so that some publications on this issue have been presented even on the portal of the Russian Academy of Sciences (RAS). You can view one of them using this hyperlink:

https://mtdbest.ru/articles/theory_modell.pdf .

You will get convincing evidence that **this problem was not invented by us**. And although the article by this author, far from the problems of coding theory, does not mention the specific dramatic circumstances of a truly global crisis of our long-ago just very sad science, you will have the opportunity to make sure of the absolute reality of such a deep problem and even its complete decline. It was overcame thanks to the great hard work of the entire team of OT school.

Here are a few quotes from an article that drew attention to the RAS:

1.. **the opposition** of computer modeling and theory based on mathematical methods is **the Disease of the Century**.

2. Theorist working in any scientific field knows that not all problems can be solved analytically: for the vast majority of problems, **it is not possible to get exact or even approximate solutions.**

3. Combining the capabilities of theory and modeling is **a special profession** that requires **a combination of skills and talents** required by theorists of the last century and specialists in computer modeling of today. The T&M specialist will differ from both **the theorist and the programmer** in the same way that a **decathlete** in athletics differs from a runner, thrower, and jumper.

So we think that you will agree that the article seems to have been written about coding theory at the request of our scientific school.

And yet - no! So it's like everyone should at least know or guess about it, if they don't agree right away. However, some "theorists" were definitely completely unaware of this. Well**,** **here's the result!**

An even more detailed description of this coding theory crisis is provided (**again!**) **in our 2020 booklet** of leading members of the OT science school, which we have already mentioned above.

We suggest that you evaluate the opinions of OT scientific school and independent researchers, which will allow you to formulate your own personal opinion about the state of the coding theory.

We are always ready to cooperate with you, share our experience and software. We have developed a new reference guide on codes, which we are ready to work with you to finalize it to the publication level and also make publicly available. Members of our school can also read a series of lectures on Optimization Theory (OT), which contain coding methods in many of their various forms, as well as now a large number of new decoding methods, which are known as block modifications of the Viterbi algorithm (BVA), which we have also patented.

It is useful to recall once again that one of our realistic versions of BVA based on the technical requirements for decoders from NASA turned out to be about 16'000 times easier than other optimal methods for block codes, which were very aggressively proposed even for teaching students by some "activists" who have done absolutely nothing useful for science. Their vanity is meaningless and sad. And optimal decoding for all block codes is also a problem that has long been solved with the highest quality and minimal complexity. But "they" still don't know that either.

All this is the result of another completely inexcusable misfortune of many "specialists": - open and brazen laziness. **Yes!** There are many seemingly "highly qualified" subjects who do not read anything and have not studied anything for a very long time also, but do not even hide that they are confident in their status as "unapproachable". However, they are absolutely always ready to teach others. But usually they only know what happened 25÷40 years ago. This is a huge problem for our science. Such "smart people" - the sea. And it's nothing. They prosper. They do not even suspect that science is significantly updated every 4÷7 years. What do you think about it? Are there many such instances around you?

But be prepared for the fact that not everyone will always admire your even the most outstanding results. We hope you now understand why. **Such is a life!**

Well, once again, we note that our comics are written by a wide range of the best specialists of the scientific school on Optimization Theory. You can rewrite it from the first main page of our portal **www.mtdbest.ru** . We hope that it will also be very useful for everyone.

So, dear colleagues, create innovative teams that must have good programmers, as our experience has shown us, who are fluent in, for example, the C++ language, and start working in a new boundless **Universe of Knowledge**. It is formed now in the sphere of our coding theory by a fusion of fine high theory and intelligent innovative software, which has received the common name as Optimization Theory. **And there are no other ways!**

Our science is only here!

Undoubtedly, we will continue to provide comprehensive assistance to all true "pioneers" who have entered **this new broad path of true Science.**

OT scientific school