Centre for Advanced Study

at the Norwegian Academy of Science and Letters

Newsletter no. 2 • November 2002 • 10th year

Hunting for the best errors

Hans Munthe-Kaas (l.) and Brynjulf Owren look as if they are turning a desk organiser, but they are actually in the process of developing new methods of computer-based simulation and numerical analyses. These tools have become indispensable in today's society, and they are used for everything from long-term weather forecasting to the calculation of bridge constructions. The research group in mathematics at the CAS is developing these techniques further by hunting for the methods that contain the best errors. *See pages 2-3*

CAS seeks proposals for group leaders

The Centre for Advanced Study organises basic research on an international level. In December this year the Board is to evaluate candidates to head research groups that are to spend one year at the Centre in the research year 2005/2006.

The group leaders are chosen from among leading Norwegian researchers within the fields of the humanities, natural science/mathematics and social science/law. The groups are to have an international composition and will be fully funded by the Centre in co-operation with the Norwegian universities.

The Centre is now asking for proposals for candi-dates to serve as leaders. Proposals should include:

- The name(s) of the candidate(s), place of work and CV
- A brief description of the research group's theme and central problems posed in the project

More information is to be found on our Web pages: www.cas.uio.no

Any questions may be addressed to:
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Scientific Director, Professor Ole-Jørgen Skog, tel.:+47 22 12 25 11, e-mail: o.j.skog@cas.uio.no

The closing date for the submission of proposals is Friday 22 November 2002.

This year's groups

Aesthetics and Cognition:
This group is headed by Professor Jostein Børtnes and Professor Tomas Hägg of the University of Bergen (UiB).

Landscape, Law and Justice:
This group is headed by Professor Michael Jones of the Norwegian University of Science and Technology (NTNU).

Geometric Integration:
This group is headed by Professor Hans Munthe-Kaas of the UiB and Professor Brynjulf Owren of NTNU.

CAS: Ten years in the service of outstanding research *Se pages 4-5*

Editorial

Take care of those with talent

A famous Norwegian politician once claimed that it is typically Norwegian to be good. While this may be true in winter sports, it is a truth with modifications in the context of research. There are undoubtedly a few stars in Norwegian research, but not so many as we would wish. One of the problems may be that we are not good enough at taking care of those with great talent.

The CAS is an institution that is trying to do something about this problem. The foremost representatives of Norwegian and international research are invited here, so that they can spend one year doing research without any other obligations than their own research work, and with a budget that is generous by Norwegian standards.

The Centre was the first institution in Norway with the aim of stimulating outstanding research. The Centre was evaluated by the Norwegian Research Council in 1997, and has shown itself to be a success. The fundamental idea behind the Centre has now spread farther, and 13 centres of excellence are now being established in Norway.

Numerous prominent Norwegian and international researchers have been our guests in the course of the ten years it has existed. The projects have varied over a wide field – from attempts to explain variations in the lemming population to the study of two thousand year-old Buddhist writings, and from studies of distant galaxies to investigations of the effects of different political regimes.

This rich diversity is a distinctive characteristic of the CAS. In the Centre's premises researchers from very different disciplines and corners of the Earth are to work side by side and to stimulate one another to new and important insight.

Norwegian research is not particularly bad, but in an international perspective it is not outstanding either. If it is to become so, we must break with an egalitarian Norwegian tradition and become better at paving the way for the best researchers. The CAS wishes to contribute to this.

Professor Aanund Hylland, Chairman of the Board
Professor Ole-Jørgen Skog, Scientific Director

Mathematics without two lines under the answer:

Some errors are more equal than others

Computer-based simulation and numerical analysis have become indispensable tools for everything from bridge building and meteorology to Internet development and the pharmaceutical industry. The methods that are in use have on the whole been developed to produce the smallest possible errors, but the mathematicians at the CAS are treading new ground: They are hunting for the best errors.

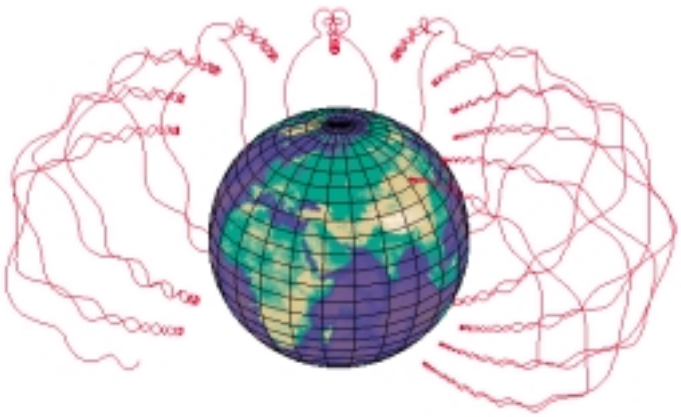
If you want to get closer to answering questions like "What is happening to our climate?" or "Is the solar system stable?", you are in practice obliged to make models that can be simulated in a computer. The same goes for questions like "Is the Gulf Stream going to turn?" and "Will this bridge stand up to a hurricane if it must at the same time bear the weight of a queue of 20 lorries?"

The techniques and methods that lie behind the omnipresent simulations have to a great extent been developed by basic researchers within mathematics and computer science. Professor Brynjulf Owren from the Department of Mathematics at the Norwegian University of Science and Technology and Professor Hans Munthe-Kaas from the Department of Computer Science at the University of Bergen are in charge of this year's research group at the CAS. The researchers are going to work on further developing the methods of computer-based simulation and numerical analysis. This work is taking place within a branch of mathematics that is called geometric integration.

"The traditional angle of approach in numerical analysis has been to make errors that are as small as possible, but we are much more concerned with the qualitative properties of the errors. This means that the mistakes that are made must not spoil any important properties of the systems," explains Owren.

Methods more important than machines

It is in the nature of things that simulations always contain errors. "We shall never get machines that are fast enough for us to be able to perform realistic simulations without error. Instead the fact is that faster computers bring about a greater need for better and more effective methods of calculation! The reason for this is that the faster the machines we have, the larger the systems we can simulate,



Roughly 100 years ago the mathematician Carl Størmer and his students calculated how charged particles can move in the Earth's magnetic field. Today the same problem could be solved in the course of an afternoon. (Illustration: H. Munthe-Kaas)

The Geometric Integration Programme at the CAS has brought together visiting researchers from 12 nations. More info: www.focm.net/gi/oslo0203.

and the more important the differences between a good and a bad method. In a number of subject areas the development of better methods has in fact been of greater significance than the development of faster computers over the past few decades," Owren explains.

The difference between small errors and qualitative errors can be illustrated with simple examples. "If you want to simulate the path of a robot moving over a globe-shaped surface, like the surface of the Earth, it is not very practical to use a model in which the robot moves in straight lines. As we know, the surface of the Earth is curved, and a straight line will sooner or later bring the robot up into the air or down into the ground. If we put rotation into the model instead of a straight line, we can eliminate this problem and get better calculations of the robot's path," explains Munthe-Kaas.

Is the solar system stable?

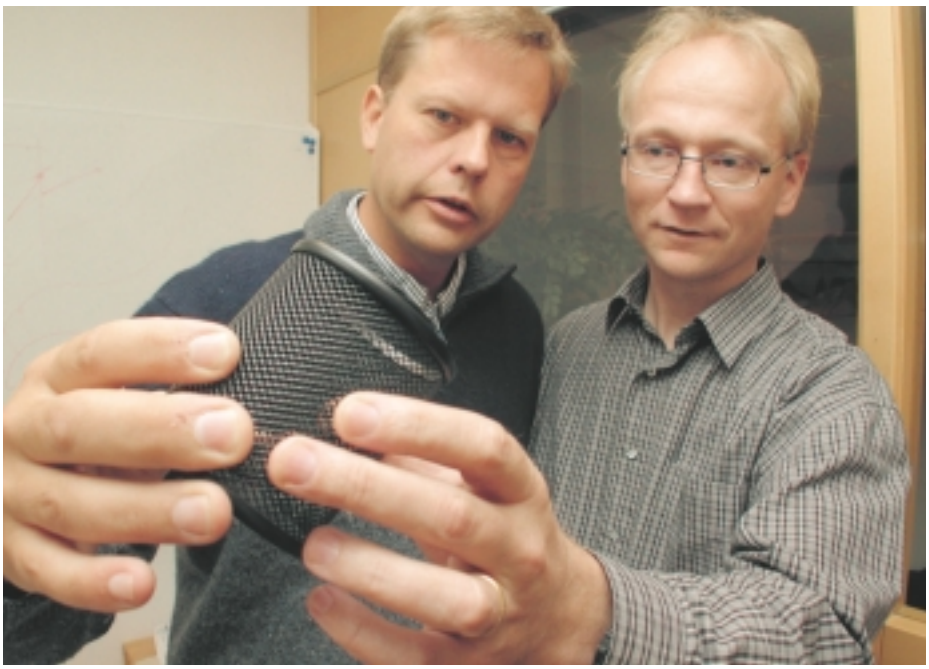
If a model with "incorrect" errors is used on the solar system instead, the errors can be very dramatic. "We can also perform a simulation of the solar system using three different methods, which all move the planets in steps of 10 days at a time. The simplest simulation builds on the Swiss mathematician Leonhard Euler's method, and moves the planets in spiral-shaped orbits where the energy in the system is constantly increasing. This leads to the disappearance of Saturn out of the solar system around the year 2120!", Munthe-Kaas explains.

The next method ("reverse Euler") behaves the opposite way round, and the planets are gradually drawn inwards towards. The third method is a simple combination of the two preceding ones, and shows the planets in beautiful elliptical orbits. "The first two methods destroy the physical structure, while the third keeps it. One can reduce the errors for all these methods, but if one is to answer important questions about the long-term development of the solar system over 100 million years, for example, it is of crucial significance that the methods we use 'err in the right way'," says Owren.

The second giant

Mathematicians who work on geometric integration build to a great extent on methods that were developed by Sophus Lie (1842-1899). "Lie is the 'second giant' in Norwegian mathematics alongside Abel. Until the last couple of decades Lie's theory of differential equations was mainly of theoretical interest, but with powerful algebra programmes that can be run on computers, his theory is coming at full speed into many applications" Owren adds.

"The fundamental mathematical techniques that are used in the description of all continuous processes, so-called differential calculus, were developed by Newton and Leibnitz in the 17th century. In the 19th century there was a development in which geometric ideas gained ever-increasing ground in the theoretical understanding of differential equations. This had begun with Sir Rowan Hamilton's reformulation of classical mechanics, and continued with Sophus Lie's studies of continuous transformation groups. Together with Henri Poincaré's geometrising of Hamilton's ideas, this created a completely new understanding of differential equations, which pervaded large areas of theoretical physics and pure mathematics in the 20th century. One can perhaps say that a geometric understanding deals with qualitative rather than quantitative properties of physical systems. Geometry is 'insight without calculations'", the two explain.



Hans Munthe-Kaas (l.) and Brynjulf Owren are turning a desk-organiser, but from a mathematical viewpoint it can be said that they are influencing the object with a rotation Lie group. Movements of this kind can be used to develop computer simulations and produce new methods that "err in the right way". (Photo: Bjarne Røsjø)

The third way

Computational Science is often called 'the third way' in natural-scientific research, in addition to theory and experiment. The purpose is to construct realistic simulation programmes or computer laboratories in order to study phenomena and processes in nature. This is a comprehensive interdisciplinary activity that requires insights into natural science subjects as well as mathematics and computer science.

A central aspect of computational science is the relationship between continuous and discrete processes. While the majority of physical systems develop gradually and continuously over time, all computer calculations are stepwise and discrete ("separated"). The water flows continuously over the whole sea, while a simulation must take place in a stepwise manner. Numerical analysis is a core subject that studies how one can solve continuous mathematical equations on a computer in the most efficient way and with the least possible number of errors.

"Computational science was introduced in Norway by Carl Størmer (1874-1957) in the early part of the 20th century. Størmer was inspired by Kristian Birkeland's studies of the Northern Lights, and wished to calculate what paths charged particles would follow in the Earth's magnetic field. He developed a method that made it possible to calculate possible paths with pencil and paper, and in this way Størmer and his students managed to account for the origin of the Northern Lights after 4500 hours of calculating by hand. In our day and age the same problem could have been solved in the course of a long afternoon," says Munthe-Kaas.

The 10-year jubilee and opening of the Centre's 11th academic year were celebrated with a banquet to which former and present visiting researchers as well

Ten years' commitment to qu

"The CAS is one of the most important instruments of quality in Norwegian basic research. The Centre has become a meeting place for outstanding researchers from many countries.It has shown results on a high international level," says Kristin Clemet, the Minister of Education and Research.

Clemet wrote about the internationalisation of Norwegian research in the book "CAS Oslo 1992-2002. Advanced Study in a Norwegian Context", which was published in connection with this autumn's 10-year jubilee.

"One of this Government's objectives is to put more Norwegian researchers at the forefront of research. As a small country with limited research resources in an increasingly internationalised knowledge market, Norway is totally dependent on international research co-operation," wrote the Minister. In this connection the Centre for Advanced Study is playing an important role, by creating meeting places where Norwegian and foreign researchers can co-operate.

The Managing Director of the Norwegian Research Council, Christian Hambro, wrote that the Centre was an early instrument for stimulating high-quality research in Norway. "This effort has turned out to be quite successful. In recent years, the *Advanced Research Programme* and the *Centres of Excellence (CoEs)* are examples of other schemes that systematise elite research in Norway," Christian Hambro pointed out.

The Jubilee Book also includes a historical account of the establishment of the Centre, a

Conceived in 1988, born in 1992

The CAS was established in 1992, but the conception took place during a meeting at the Norwegian Academy of Science and Letters in 1988. Many of those who took part at both the conception and the birth, were also present when the 10-year jubilee was celebrated on 3 September 2002.

"The proposal to establish a Centre came up at a meeting in the Norwegian Academy of Science and Letters on 10 November 1988," said Gudmund Hernes in a speech at the jubilee celebration. Gudmund Hernes is now the director of UNESCO's International Institute for Educational Planning.

Hernes had many fingers in the pie during the establishment, inter alia as chairman of a Government-appointed Universities and Colleges Committee that was to submit proposals for raising the quality of basic research in Norway. He was also involved in the birth of the Centre as Minister of the Church, Education and Research from the autumn of 1990.

In 1988 the committee submitted a report with a proposal that a centre for advanced study should be established in Oslo. At the same time the Academy of Science and Letters was asked to make premises available. "The Secretary General of the Academy, Professor Leif Mæhle, was a strong supporter of the idea. I was invited to put the proposal forward at a plenary meeting, and afterwards the assembly broke a long tradition that there should never be applause after a presentation. Thus the matter was decided," Hernes related.

as key people from the establishment were invited. (Photo: Torstein Riiber)

Gudmund Hernes (left) and Rolf Seljelid. (Photo: Torstein Riiber)

ıality in Norwegian research

description of the way in which the Centre operates, a complete survey of earlier, present and future projects, and some select articles from the many research highlights in the course of ten years. The book may be ordered from the Centre's Administration.

To mark the jubilee a seminar was held in the premises of the Academy of Science and Letters in Oslo on 3 September 2002. After the seminar the opening of the Centre's 11th academic year was marked with a welcoming speech by the Chairman of the Board, Aanund Hylland.

Professor Dagfinn Føllesdal played an important part in the establishment of the Centre. At the jubilee seminar he gave a lecture on "The Quality of Norwegian Research". (Photo: Torstein Riiber)

The Universities and Colleges Committee was established by the then Minister Hallvard Bakke in 1987,who must be reckoned as one of the Centre's "fathers". In addition Gudmund Hernes made special mention of the industrial group Kværner's then Director General, Mikal H. Grønner. "Another person who should be mentioned is the politician Tora Aasland on the Parliamentary Standing Committee on the Church and Education. In the management of the Academy of Science and Letters the President, Carsten Smith, was one of those who brought the Centre into being, and we had good friends like Tore Olsen and Grete Ek Ulland in the Ministry," Hernes recounted.

New member of staff

Maria M.L. Sætre has been appointed to the newly established post of senior executive officer at the Centre for Advanced Study. This new appointment will contribute to the general strengthening of the Centre's administration and better service for the Centre's researchers. One of many duties will be the collection and systematisation of academic publications resulting from the research groups' periods spent at the Centre. Maria Sætre will also be responsible for maintaining and developing the Centre's Web pages.

Maria M.L. Sætre holds the degree of Cand. Scient. in Geology from the University of Oslo and was a research fellow in the Department of Geology.

“Small is beautiful”

"When I was travelling around visiting Nobel Prize winners and other international top researchers to discuss how elite research is to be organised, they were all in agreement on one point. Everything really new within basic research comes from small communities," says the leader of the Top Research Programme, Professor Rolf Seljelid.

"Everything really new within basic research comes from small communities," says the leader of the Top Research Programme, Professor Rolf Seljelid. (Photo: the Top Research Programme)

Rolf Seljelid was the primus motor behind the establishment of the Norwegian Top Research Programme in Medicine and Biomedicine in 1996, and has been chairman of the steering committee right from the start.

The Top Research Programme came into being after the Norwegian Research Council had been on the receiving end of sharp criticism, from Professor Seljelid among others, at the beginning of the 1990s. The result was that the Research Council played the ball into his court and asked for views on what ought to be done to promote quality in Norwegian research. He was given the opportunity to travel around asking about a dozen of the world's foremost researchers.

"They all said roughly the same thing. They said that with the potentials that Norway has, we ought to seek out the best among the younger researchers. Let them have long-term and good financial conditions, protect them against unnecessary and trivial disturbance, but don't let them become isolated. And most important of all: Let them do what they want! That's when people are most creative," Rolf Seljelid recounted in his speech on the occasion of the Centre's 10-year jubilee.

Professor Seljelid came back to Norway with clear views on what ought to be done, and in the course of time he was given the go-ahead to establish a programme with a basic grant from the Research Council of approx. 5 million kroner per year. In addition he has obtained between 6 and 7 million kroner from private sponsors and investors.

"The most important thing I have to say today is that good basic researchers must be allowed to follow the direction in which their talents point," Professor Seljelid maintained.

Generation change creates new possibilities

"We must exploit the coming generation change in Norwegian research to create a new generation of researchers with strong international networks. Communities like the CAS, the Simula Centre, the Sars Centre and the Norwegian Polar Institute have demonstrated that we are fully capable of attracting top researchers from abroad," said State Secretary Bjørn Haugstad from the Ministry of Education and Research.

Haugstad made it clear that the main objective of the Government’s research policy is to raise the quality of Norwegian research. "I’ve been asked to speak on internationalisation, which is closely connected with quality. The vast majority of countries use some form of international standard as a basis when they measure quality, and participation in international networks demands high quality. There are first and foremost two prerequisites that must be in place to create quality, and they are resources and priorities," he said.

The chairman of the Board of the CAS, professor Aanund Hylland, greeted the audience at the jubilatory seminar (the picture), and passed the word to State Secretary Bjørn Haugstad. (Photo: Torstein Riiber)

"But in addition to resources and priorities we need people. We must use both salary and overall working conditions to make it attractive for the best to become researchers. Furthermore, Norwegian researchers must travel abroad to make themselves visible and to get themselves networks, and we must pave the way for researchers from abroad to be able to come to Norway," said Haugstad.

In May 2002 the research journal Nature described Norway as a research nation under the heading "Low pay, great scenery". "We must offer more than mountains and fjords and low pay. Among the most important things we can offer are ambitious communities with the time and resources to conduct research on a high international level. But good research conditions are probably more important than pay," the state secretary commented.

Aesthetics and Cognition

Professor Jostein Børtnes and
Professor Tomas Hägg,
University of Bergen

The project will study the development of a specific anthropology and aesthetics within Christian Orthodox theology from the Cappadocian Church fathers (4th cent. AD) to Dionysios the Areopagite (ca. AD 500) and Maximus the Confessor (7th cent. AD). Cappadocian anthropology represented something wholly new: it was based on the mystery of the Incarnation, that God became man through Jesus Christ. Byzantine aesthetics was founded on the same mystery; it was developed in connection with the theology of the icon, something that sets it apart from Judaism, Islam as well as Western theology. The doctrine of the deification of man has left deep traces in the anthropology of all Orthodox peoples, not least in Russia; for instance, in the novels of Dostoevsky and Pasternak, this idea still determines the representation of the characters. Moreover, anthropology and aesthetics are intertwined there, as they are in Byzantine art and literature. By studying some key texts by leading Greek theoreticians of the early creative phase of Orthodox theology, the project will try to clarify the relationships between anthropology and aesthetics in this tradition.

Landscape, Law and Justice

Professor Michael Jones,
NTNU Trondheim

A research theme on landscape, law and justice would provide a means of bringing together leading researchers in the disciplines of geography, history, legal history, sociology and landscape planning. The invited foreign and Norwegian researchers will come together to discuss philosophical and theoretical issues concerning justice, law and equity with regard to landscape. The term landscape incorporates a number of differing but overlapping ways in which the complex relationships between human societies and their physical surroundings are conceptualized. The particular focus in this project is the role of law and custom for the allocation, management and use of common resources.

The project will be organized in three subthemes:

- Historical concepts of landscape as an expression of law, justice and cultural practice relating to the community regulation of land and other common resources (cf. the medieval Nordic Landskapslover).
- Continuity and change in the landscape as a physical and cultural manifestation of human activity and institutions, focusing on the role of legislation and customary law, in a historical and geographical perspective.
- Legal implications and landscape impacts of environmental policies for the management of amenity resources and perceived common values in the landscape.

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Professor Ragni Piene
Professor Nils Christian Stenseth
Professor Erling Eide

The Centre for Advanced Study

The Centre for Advanced Study (CAS) is an independent foundation with a board appointed by the Norwegian Academy of Science and Letters (NASL) and the Council for Universities and Colleges. Prominent researchers from Norway and abroad are invited for one-year stays to engage in research in the Centre's premises in Drammensveien in Oslo, where the CAS is housed in the Academy's villa.

Each year the Centre's activities are organised in three research groups, each with from six to ten members. The work of each group is planned and organised around a common theme and headed by one or more outstanding researchers.

The groups are chosen from each of the following three areas:

- The Humanities
- Social Sciences/Law
- Natural Sciences/Medicine

The CAS is exclusively a basic research institution, where the participants have no other obligations than their own research. The Centre for Advanced Study is administered by a permanent staff of four and was officially opened on 1 September 1992.

The CAS Newsletter

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Free striving for learning

The idea of "advanced study" is a form of free striving for learning "to the utmost degree that the facilities of the institution and the ability and faculty of the students will permit". This was the stated purpose when the first centre for advanced study, at Princeton University in the USA, was established in 1930 as a postdoctoral research institution.

The first scientists came to CAS in the autumn of 1992. (Photo: Scanpix)

It was to take more than 20 years before the next centre of this type was established in the USA. When the Centre for Advanced Study in Oslo was being planned at the end of the 1980s, there were in existence still only seven pure institutions for outstanding research in the whole world, but in the course of the next decade the idea spread like wildfire. Rector Björn Wittrock at the Swedish Collegium for Advanced Study in the Social Sciences (SCASSS) wrote a brief historical account of developments in this area in the CAS jubilee book.

"Princeton University's famous Institute for Advanced Study (IAS) became the host institution to a number of the world's most famous intellectual refugees, like Albert Einstein, John von Neumann and Kurt Gödel. Maybe because of its very success the IAS was for a long time the only institute of its kind. The idea of replicating an institution of this kind seemed beyond the limits of practical possibility" Björn Wittrock writes.

However, in 1954 the Center for Advanced Study in the Behavioral Sciences (CASBS) was established in Palo Alto. This centre too rapidly achieved impressive academic results, and since then the IAS and the CASBS have been yardsticks for all subsequent projects. The next centre was the Netherlands Institute for Advanced Study in the Humanities and Social Sciences (NIAS) in Wassenaar, and in 1968 Germany got its Centre for Interdisciplinary Research (ZIF) at the University of Bielefeld.

Growing importance

In the second half of the 1970s the Americans got their National Humanities Center in North Carolina, and in 1980 the Wissenschaftskolleg zu Berlin, was established. The latter has since been accorded a position in the forefront within the German Federation's academic community.

Sweden got its SCASSS in 1985 in the ancient university city of Uppsala, and in 1992 a majority of the centres of advanced study started developing informal but ever closer co-operation. "There is now a growing number of initiatives not only in European countries, but also in countries like Japan, China and South Africa. Centres and institutes of advanced study are destined to play an ever more important role in the international scholarly landscape in the years ahead," Bjørn Wittrock points out.

The Centre for Advanced Study

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