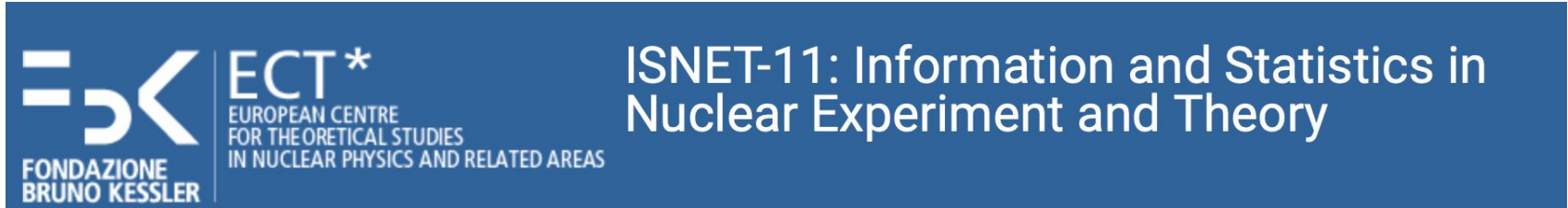


ISNET Introduction

Andreas Ekström
Chalmers University of Technology

Amy Lovell
Los Alamos National Laboratory

Welcome to ISNET-11



This workshop will gather leading international researchers in nuclear physics, statistics, and applied mathematics to discuss how statistical methods can enable progress on the frontiers of nuclear physics, spawn new directions, and catalyze techniques that ensure best use of data taken in nuclear-physics experiments.

Organizers: Andreas Ekström, Amy Lovell, Daniel Phillips



Information and Statistics in Nuclear Experiment and Theory

*The **mission** of the Information and Statistics in Nuclear Experiment and Theory (ISNET) community is to encourage, facilitate and develop the use of statistical and computational methodologies that maximize the knowledge gained from and quantify uncertainties in nuclear measurements and theoretical calculations.*

*We **do this** by combining domain knowledge from the nuclear physics research community with expertise in cognate fields of research and practice, such as statistics, mathematics and computer science.*

*The **main deliverables** of ISNET are conferences at which relevant research results & pedagogical materials are discussed and shared with the community.*



Past, present, and future ISNET Workshops

ISNET-1	2012 Krakow, Poland
ISNET-2	2013 Glasgow, UK
ISNET-3	2015 Trento, Italy
ISNET-4	2016 INT, USA
ISNET-5	2017 York, UK
ISNET-6	2018 Darmstadt, Germany
ISNET-7	2019 Gothenburg, Sweden
ISNET-8v	2020 East Lansing, USA (virtual)
ISNET-8	2021 East Lansing, USA
ISNET-9	2023 St. Louis, USA
ISNET-10	2024 Shanghai, China
ISNET-11	2025 Trento, Italy
<i>ISNET-12</i>	<i>2026 Berkeley, USA (Oct 5-9)</i>



Figure 1. Workshop participants.

There were no formal talks; most of the time was devoted to discussion. Based on the exchanges during the meeting, it is clear that the progress in quantification of theoretical uncertainties is badly needed, especially when planning the new experiments and experimental programs. [...] (NPN 23 (2) 2012)

ISNET-3 was at the ECT* exactly 10 years ago

Organized by *David Ireland, Witek Nazarewicz, Bartłomiej Szpak*

16 November 2015 — 20 November 2015

Who in the audience was there?

Who is “newer” to the ISNET community?

Then: ‘How do we quantify and propagate uncertainty in existing models?’, ‘The early days of EFT truncation errors’, ‘no emulators, not even gaussian processes, in talk titles’

Now: ‘How to build and deploy full Bayesian statistical workflows in nuclear physics?’,

Some trends in how ISNET method discussions have evolved over the years

The same core questions. We still ask how to quantify uncertainties, validate extrapolations, and identify informative observables — but we have learned more statistics and applied math!

- **From error bars to Bayesian workflows:** First workshops had a focus on covariance analysis and parameter estimation; recent workshops integrate priors, likelihoods, model discrepancy, posterior predictive distributions, and more connected inference pipelines.
- **From single models to ensembles and emulators:** The focus has also broadened from tuning specific EDFs/forces to using and developing emulators, model mixing, and machine learning tools
- **From analysis to experimental design:** there's now a clear push for uncertainty and information to help guide which experiments to perform, where theory needs improvement, and how to prioritize in research programs.
- **Went beyond nuclear physics** in some meetings (weather forecasting, philosophy, particle physics, astrophysics,...)

Some ISNET history, connections, and projects that have come out of ISNET

More ISNET output!

Two special issues in J Phys. G, interesting to see how the topics and ISNET evolve

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Journal of Physics G: Nuclear and Particle Physics

Enhancing the interaction between nuclear experiment and theory through information and statistics (ISNET)
[2015 J. Phys. G: Nucl. Part. Phys. 42 Issue 3](#) Guest Editors: David Ireland and Witek Nazarewicz



Journal of Physics G: Nuclear and Particle Physics is proud to bring this seminal focus issue to the nuclear physics community which is designed to help researchers bridge the gap between experiment and theory. Inspired by the ISNET workshops (Information and Statistics in Nuclear Experiment and Theory), we expect that the techniques, discussions and ideas presented in the issue will be critical to advancing our understanding of the link between nuclear theory and nuclear experiment. I hope that you enjoy this issue and share the methods and ideas with your colleagues, collaborations and students.

I would like to thank our Guest Editors David and Witek as well as all of our authors for putting together this outstanding issue.

Colin Adcock
Publisher, [Journal of Physics G: Nuclear and Particle Physics](#)

Editorial
[Enhancing the interaction between nuclear experiment and theory through information and statistics](#)
D G Ireland and W Nazarewicz 2015 *J. Phys. G: Nucl. Part. Phys.* **42** 030301

Open abstract View article PDF

Latest papers
JPhysG welcomes additions to this issue to further enhance the links between nuclear theory and experiment.

[Bayesian parameter estimation for effective field theories](#)
S Wesolowski et al 2016 *J. Phys. G: Nucl. Part. Phys.* **43** 074001

Chat

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Journal of Physics G: Nuclear and Particle Physics

Focus on further enhancing the interaction between nuclear experiment and theory through information and statistics (ISNET 2.0)
Guest Editors
Dick Furnstahl Ohio State University
David Ireland University of Glasgow
Daniel Phillips Ohio University

Following on from the hugely successful [first edition](#) in 2015, Journal of Physics G: Nuclear and Particle Physics is delighted to announce a second focus issue inspired by the ISNET workshops (Information and Statistics in Nuclear Experiment and Theory).

The previous edition aimed to provide a much needed community resource in linking nuclear theory with experimental work. In the intervening years the ISNET workshops have continued to provide a platform for techniques, discussions and ideas that are critical to advancing our understanding of how to interpret experimental results, together with their uncertainties, and how to rigorously assign uncertainties to nuclear-physics calculations that are compared with these experiments.

This issue aims to again capture the full range of developments at this important interface, through a collection of up-to-date, in-depth articles, that will be of great interest to most researchers working in nuclear physics today.

The articles listed below are the first accepted contributions to the collection and further additions will appear on an ongoing basis.

Papers
OPEN ACCESS
[Wave-packet continuum discretisation for nucleon–nucleon scattering predictions](#)
Sean B S Miller et al 2022 *J. Phys. G: Nucl. Part. Phys.* **49** 024001

Open abstract View article PDF

ISNET website <https://isnet-series.github.io/>

ISNET Series Website

The online knowledge base of the Information and Statistics in Nuclear Experiment and Theory (ISNET) series

Home

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Welcome

This site is the online home of the ISNET community. The purpose of this site is to host information about past and future meetings, publications, and to maintain a base of knowledge about statistics and nuclear physics resources such as articles, textbooks, and websites.

Become a member by joining our email list

Send an email with *subscribe* in the body (empty subject) to isnet-request@lists.chalmers.se
Confirm subscription by replying to listserv email

Resources

This page links to schools and training courses and their resources.

- [Learning from Data: Bayesian Methods and Machine Learning](#). This links to a course webpage and github repository for a Nuclear TALENT (Training in Low Energy Nuclear Theory) course held at the University of York in York, UK from June 10 to 28, 2019
- [Learning from Data: OSU Physics 8820](#). A course by R. J. Furnstahl on Bayesian statistics for physicists. Course material in the form of a Jupyter Book.
- [Learning from Data: Chalmers Physics TIF285](#). A course by C. Forssen on scientific data analysis using Bayesian inference and machine learning. Course material in the form of a Jupyter Book.

ISNET Board (formed 2022) & rotation of board members

- ❖ (Chair) Andreas Ekström, Chalmers University of Technology
- ❖ (Co-chair) Amy Lovell, Los Alamos National Laboratory
- ❖ Tanja Horn, The Catholic University of America
- ❖ David Ireland, University of Glasgow
- ❖ Alessandro Lovato, Argonne National Laboratory
- ❖ Jean-François Paquet, Vanderbilt University
- ❖ Agnieszka Sorensen, Facility for Rare Isotope Beams
- ❖ Özge Surer, Miami University
- ❖ Ian Vernon, Durham University
- ❖ Simin Wang, Fudan University
- ❖ Stefan M. Wild, Lawrence Berkeley National Laboratory
- ❖ Richard Wilkinson, University of Nottingham

Former members:

Daniel Phillips (chair 2022-2024)

Dick Furnstahl

Paul Stevenson

Matt Plumlee

Scott Pratt

Maria Piarulli

Junchen Pei

4 Board-members rotate out every 2 years. Next rotation summer 2027

Meets quarterly. Issues yearly calls for proposals to host the ISNET workshop.

ISNET Code of Conduct

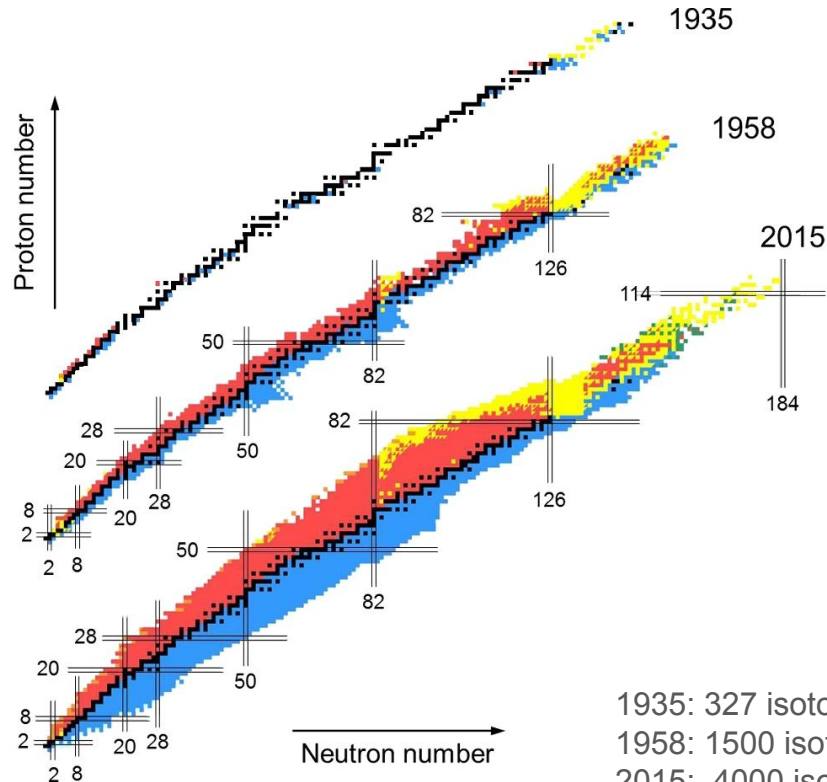
ISNET is committed to fostering a safe, diverse, inclusive, and equitable environment that values mutual respect and personal integrity. Therefore, all participants in ISNET activities will conduct themselves in a welcoming and professional manner, treating one another respectfully and considerately. Participants shall not discriminate against, harass, or bully other meeting attendees. Creating such an ISNET culture — one that is collegial, inclusive, and professional is the responsibility of all meeting participants and ISNET members.

If you observe inappropriate comments or actions and personal intervention seems appropriate and safe, you are encouraged to intervene in ways that are, insofar as it is possible, considerate of all parties involved. ISNET members and meeting participants will not discriminate against, act in an inappropriate way, or make inappropriate statements related to others': age, race, ethnicity, perceived or actual social class, sexual orientation, gender identity, gender expression, marital status, nationality, political affiliation, religion, ability status, educational background, or any other characteristic protected by law. No kind of harassment (including sexual harassment) or bullying will be tolerated.

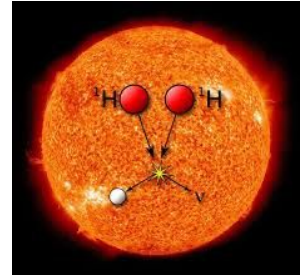
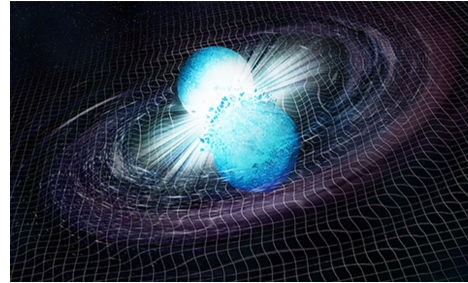
Bullying is unwelcome, aggressive behavior involving the use of influence, threat, intimidation, or coercion to dominate others. Harassment includes but is not limited to: inappropriate or intimidating behavior and language, unwelcome jokes or comments, unwanted touching or attention, offensive images, photography without permission, and stalking. Sexual harassment is unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature that creates an intimidating, hostile, or offensive environment.

Violations of this code of conduct policy should be reported to meeting organizers and/or members of the [ISNET Board](#), including the Chair, Andreas Ekström or Co-Chair Amy Lovell. Sanctions may range from verbal warning, to ejection from the meeting, to a suspension from future ISNET activities, to the notification of appropriate local authorities. Retaliation for complaints of inappropriate conduct will not be tolerated and will result in an escalated sanction.

Multiple data streams “from the cosmos and the lab”

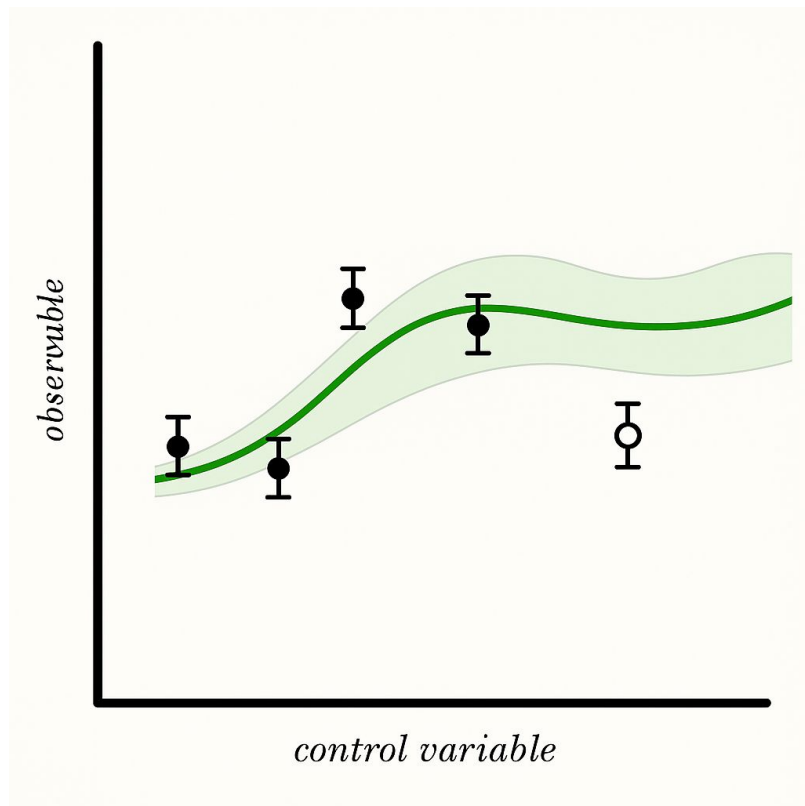


1935: 327 isotopes of 92 elements
1958: 1500 isotopes of 102 elements
2015: 4000 isotopes of 118 elements



- How do we quantify what we know, and what we don't know?
- How do we connect uncertain models to uncertain data?

Predictions are hard, especially about the future...



“All models are wrong, but some are useful”

Effective field theories introduce truncation errors

Many-body methods are approximative

Data, predictions, and parameters exhibit correlations

We need to assess how reliable our predictions are

- **What limits the predictive power in nuclear physics?**
- **Where to measure next?**

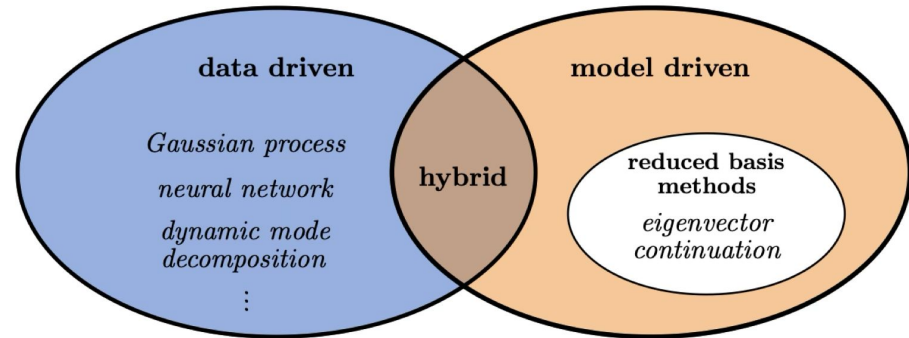
Computing nuclei typically requires HPC resources

Simulator = numerical solver for the Schrödinger equation

Emulator = computationally cheaper surrogate model for the simulator

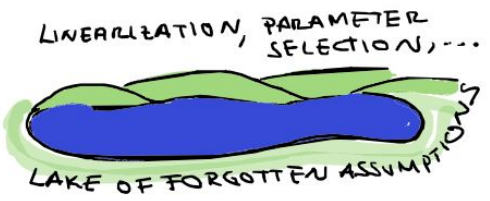
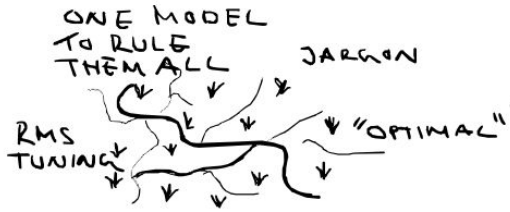


reduced order models

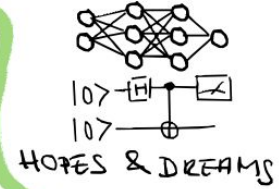
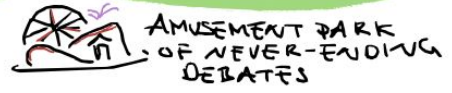


- How do we quantify emulation errors?

MODEL LAND



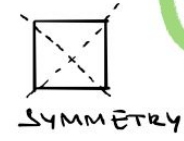
SWAMP OF MISCOMMUNICATION AND BAD PRACTICE



PHILOSOPHY



MATHS



KINGDOM OF PHYSICAL SCIENCE



BAYESIAN QUARTER



CLIFF OF SUBJECTIVITY

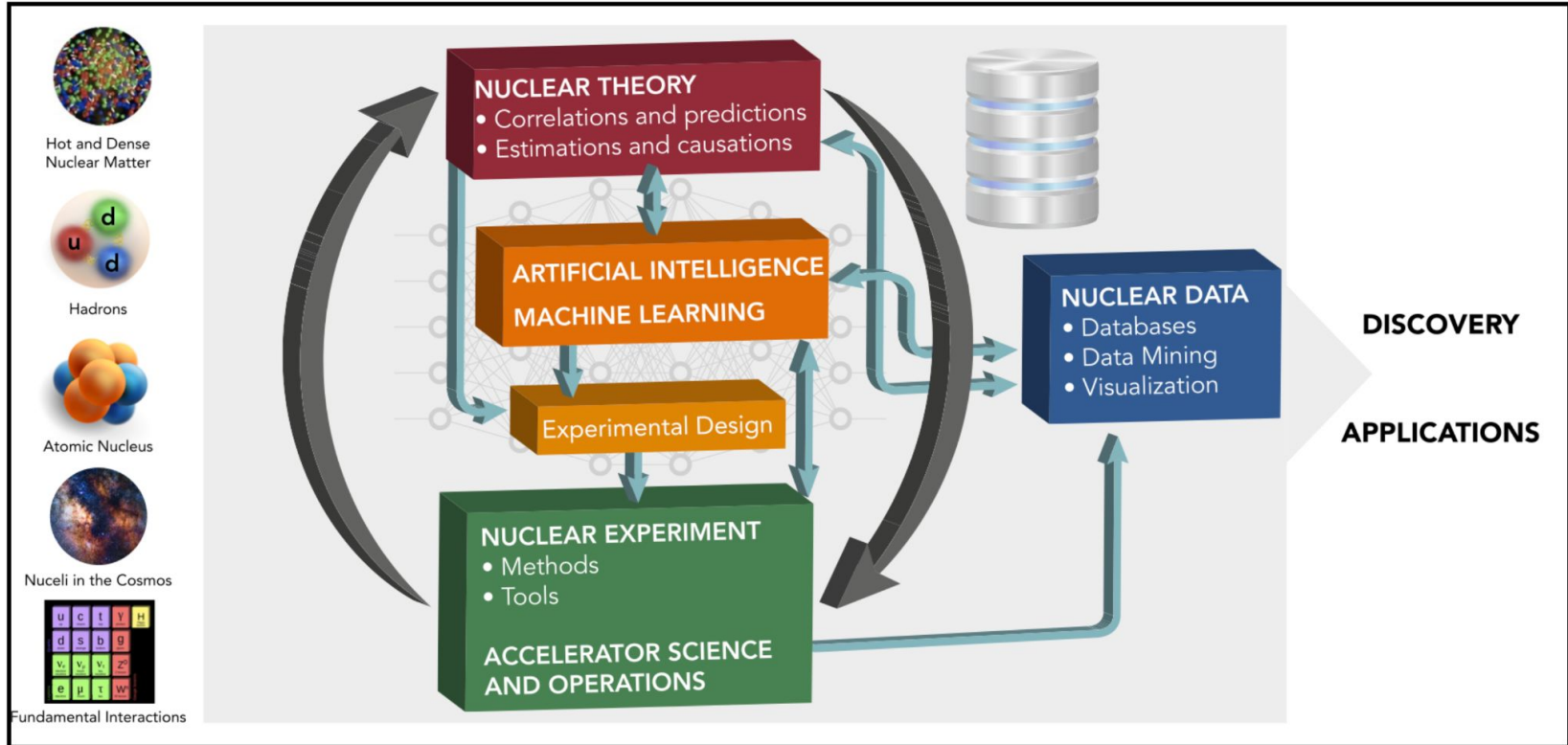
CLIFF OF FAITH IN CONVERGENCE

SEA OF SELF DELUSION



Inspiration: Thomson & Smith, Economics 13 (2019) Escape from model-land

Putting it all together: synergy!



We look forward to an exciting week full of discussions!

Monday	Tuesday	Wednesday	Thursday	Friday
Emulation	Calibration	Forecasting	Data	Synergy
	9:00-9:45: No stupid questions Christian Forssen, Dick Furnstahl, Daniel Phillips Send topics ideas to phillid1@ohio.edu			
Talks Schedule at: https://indico.ectstar.eu/event/247/timetable/#20251117				
Discussions (Friday ends with lunch at 12:45pm)				

We look forward to an exciting week full of discussions!

- Things to keep in mind if you are a speaker:
- The audience contains diverse backgrounds, avoid heavy jargon and technical physics details, focus on the connections between the statistics and physics.
- Engage in discussions! There's plenty of time built into the week for this.
- Talks are either 45 minutes (30+15) or 30 minutes (20+10).