IMR-Waseda Workshop
Advances in pragmatic computational methodologies for fish stock assessment, human impact, and environmental factor on marine ecosystems

Date: 28-29 March 2023
Venue: Institute of Marine Research, Bergen
Pynten, IMR

This workshop is supported by:
Japan Scoiety for the Promotion of Science Kiban (S) No.18 H05290
(Prof.Taniguchi, M), Waseda Research Institute for Science & Engineering,
Institute for Mathematical Science

Program

28 March

9:30 – 9:40 Opening

Chair Solvang, Hiroko

9:40 – 10:20 Taniguchi, Masanobu, Waseda University, Japan
Philosophy of AIC

10:20 – 11:00 Kitakado, Toshihide, Tokyo University of Marine Science and Technology, Japan
Evaluation of prediction skills for population dynamics models

11:00 – 11:40 Skaug, Hans, University of Bergen, Norway
Spatial variation on multiple scales in line transect data; the case of Antarctic fin whales

11:40 – Let's take participant's photo

– 12:50 Lunch break

Chair Giannerini, Simone

12:50 – 13:30 Shimadzu, Hideyasu: Loughborough University, United Kingdom
Quantifying change in marine biodiversity

13:30 – 14:10 Ono, Kotaro: Institute of Marine Research, Bergen, Norway
Current advances and challenges in fish distribution modeling

14:10 – 14:50 Hansen, Cecilie: Institute of Marine Research, Bergen, Norway
Exploring combined effects of ocean acidification and fishing on the Northeast Atlantic cod in the Barents Sea

14:50 – 15:20 Coffee break

Chair Dolédec, Sylvain

15:20 – 16:00 Howell, Daniel: Institute of Marine Research, Bergen, Norway
F_{eco} – squaring the circle of ecosystem inputs into quota setting advice

16:00 – 16:40 Chen, Ying: National University of Singapore
An eXplainable multi-stage stochastic optimisation for bunker procurement planning

16:40 – 17:20 Giannerini, Simone: University of Bologna, Italy

Nonlinear Time Series Analysis of Coastal Temperatures and El Niño–Southern Oscillation Events in the Eastern South Pacific

17:30 – Dinner

29 March

Chair Hannisdal, Bjarte

9:30 – 10:10 Goto, Yuichi: Kyushu University, Japan

A novel test for interregional differences in catch per unit effort

10:10 – 10:50 Yanagihara, Hirokazu: Hiroshima University, Japan

Estimation of spatial effects by generalized fused Lasso for nonuniformly sampled spatial data using body condition data set from common minke whales

10:50 – 11:30 Dolédec, Sylvain: Université Lyon 1, France

Practicing multivariate analyses with ade4 package: from one-table to multiple tables analyses

11:30 – 12:30 Lunch break

Chair Shimadzu, Hideyasu

12:30 – 13:10 Kristian A. Haaga and Hannisdal, Bjarte: University of Bergen, Norway

Quantifying interactions in complex systems: towards reproducibility in practice

13:10 – 13:50 Solvang, Hiroko: Institute of Marine Research, Norway

Categorical data analysis using discretization of continuous variables to investigate the association in marine ecosystems

13:50 – 14:00 Closing

Speakers

Chen, Ying: National University of Singapore, Singapore matcheny@nus.edu.sg

Giannerini, Simone: University of Bologna, Italy simone.giannerini@unibo.it

Goto, Yuichi: Kyushu University, Japan goto.yuichi.436@m.kyushu-u.ac.jp

Haaga, Kristian A.: University of Bergen, Norway Kristian.Haaga@uib.no

Hannisdal ,Bjarte: University of Bergen, Norway Bjarte.Hannisdal@uib.no

Hansen, Cecilie: Institute of Marine Research, Bergen, Norway cecilieha@hi.no

Howell, Daniel: Institute of Marine Research, Bergen, Norway daniel.howell@hi.no

Kitakado, Toshihide: Tokyo University of Marine Science and Technology, Japan kitakado@kaiyodai.ac.jp

Ono, Kotaro: Institute of Marine Research, Bergen, Norway Kotaro.Ono@hi.no

Shimadzu, Hideyasu: Loughborough University, United Kingdom H.Shimadzu@lboro.ac.uk

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Taniguchi, Masanobu: Waseda University, Japan taniguchi@waseda.jp

Yanagihara, Hirokazu: Hiroshima University, Japan yanagi-hiro@hiroshima-u.ac.jp

Organizer

Taniguchi, Masanobu: Waseda University, Japan taniguchi@waseda.jp

Local organizer

Solvang, Hiroko: Institute of Marine Research, Bergen, Norway hiroko.solvang@hi.no

Abstract

Chen, Ying: National University of Singapore, Singapore matcheny@nus.edu.sg
28 March, 16:00

Title: An eXplainable multi-stage stochastic optimisation for bunker procurement planning

Abstract:
Bunker procurement decisions have a considerable impact on the operating expenses of the shipping industry. Obtaining an optimum decision is, however, hampered by several obstacles, such as the need to anticipate future fuel prices, the incorporation of various uncertainties and capacity constraints into the model setup, and the requirement to understand the importance of features rather than just requiring black-box numerical solutions. This study proposes an eXplainable multi-stage bunker procurement planning (X-BPP) framework for the maritime sector to tackle the difficulties and build a bridge of confidence between algorithms and the conservative business sector. Specifically, a machine learning forecaster is developed to provide accurate and robust predictions of future prices from the short to the long term and for multiple bunker ports on the route. We show that forecasts can be facilitated into operation optimisation coherently via tractable reformulation. Kernel Shapley is employed to demonstrate the relative importance of features in non-linear and multi-stage stochastic planning. In a real-world implementation investigating practical knowledge and awareness of the unified planning framework, we find that the proposed framework can cut operating costs by a total of $257,541.51 on average for a fleet of six vessels over a 42-day Asia-North America trip based on a sample from July 2020 to December 2021. In the experiment during the Russia-Ukraine war, the framework could still save $351,247.71. We also find that important features vary between short- and long-term forecasting. This is a joint work with Wei Li, Qinghe Sun, and Mabel Chou Cheng-Feng.

Giannerini, Simone: University of Bologna, Italy simone.giannerini@unibo.it
28 March 16:40

TITLE: Nonlinear Time Series Analysis of Coastal Temperatures and El Niño–Southern Oscillation Events in the Eastern South Pacific

Abstract:
In this work, we study the association between El Ni{\~n}o-Southern Oscillation events (ENSO) and coastal temperatures in the Eastern South Pacific coast, characterized by the Humboldt Current System, using a unique set of 16 temperature time series from stations distributed between 18°S and 45°S. The spectral analysis indicates periodicities that can be related to both internal and external forcing, involving not only ENSO, but also the Pacific Decadal Oscillation, the Southern Annual Mode, the Quasi-Biennial Oscillation and the lunar nodal cycle. We carry out a nonlinear time series analysis motivated by chaos theory and focus on Lyapunov exponents. The asymptotic neural network test for chaos based on the largest global Lyapunov exponent indicates that the temperature dynamics along the Chilean coastline is not chaotic. Moreover, we use local Lyapunov exponents (LLEs) to characterize the local

stability of the series. Using a cross entropy test, we found that only two stations (Iquique--oceanic and Arica--atmospheric) located to the north of Chile have a significant correlation with ENSO, with Iquique being the station that presents very particular regional characteristics.

Joint work with
Berenice Rojo-Garibaldi
David Alberto Salas-de-Leon
Veronica Vazquez Guerra
Julyan H.E. Cartwright

Goto, Yuichi: Kyushu University, Japan goto.yuichi.436@m.kyushu-u.ac.jp
29 March, 9:30

Title: A subsampling-based test to detect interregional differences among small-sample time series in marine study

Yuichi Goto (Kyushu Univ.), Hiroko Kato Solvang (Institute of Marine Research), Masanobu Taniguchi (Waseda Univ.)

Abstract:
Management of fishery resources is important for stable supply of fishery products, prevention of extinction of living organisms, and adaptation implementation of impact of human activity in the marine ecosystem. Not more than 50 years have passed since climate change began to be recognized. If we use the data obtained by annual survey, it may include maximum 50 time points, which is a challenge for applying statistical time series analysis. To solve this, we propose a novel statistical method applicable to short time series. Our approach implements a statistical testing to investigate whether there are interregional differences for common species or oceanographic data recorded in some sub-areas of an ocean area. We demonstrate a simulation study to verify the proposed procedure. Furthermore, time series data observed in the North Sea is examined by the proposed statistical testing.

Haaga, Kristian A. and Hannisdal, Bjarte: Department of Earth Science, University of Bergen, Norway Kristian.Haaga@uib.no Bjarte.Hannisdal@uib.no
29 March, 12:30

Title: Quantifying interactions in complex systems: towards reproducibility in practice

Abstract:
Techniques from the field of nonlinear dynamical systems have long been considered to hold great promise for characterizing complex systems from observational data. However, this vast body of literature suffers from a lack of reproducibility due to missing or inconsistent code implementations of the corresponding algorithms, limiting their usefulness across disciplines. We here present the open-source software packages ComplexityMeasures.jl and CausalityTools.jl, written for the high-performance Julia programming language. These packages present a unified interface for quantifying complexity and detecting (directional)

associations in complex systems. To help enhance the accessibility and reproducibility of the methods, we have taken great care to create transparent and consistent code and a user-friendly interface. With thorough documentation and examples, we hope to lower the threshold for researchers from different fields to explore a variety of methods for complex system characterization. This software grew out of a project aimed at exploring new ways to disentangle causal interactions in complex earth systems on different time scales, e.g., paleoclimate records, but can be applied to observational data from any field.

Hansen, Cecilie: Institute of Marine Research, Bergen, Norway cecilieha@hi.no
28 March 14:10

Title: Exploring combined effects of ocean acidification and fishing on the Northeast Atlantic cod in the Barents Sea

Cecilie Hansen, Solfrid Sætre Hjøllo, Erik Askov Mousing, Morten Skogen and Howard Browman

Abstract:
The Northeast Atlantic (NEA) cod stock in the Barents Sea is the world's largest cod stock, with a biomass around 4 million tons, and catches historically reaching up to 900 000 tons. In this study, we use an end-to-end ecosystem model to explore the possibility of stock collapse in NEA cod following the combined effects of fishing mortality and recruitment failure caused by ocean acidification (OA), as put forward in Hänsel et al., (2020). Two different recruitment functions were applied, one temperature-dependent, and one standard Beverton-Holt. Mortality caused by OA can supposedly remove 74.5% of the recruits (Stiasny et al., 2017), and a loss corresponding to this was applied in the model. The NEA cod stock showed no sign of collapse responding to the recruitment mortality caused by OA. The strongest driver by far was the fishing mortality, which will cause a stock collapse when high enough.

Howell, Daniel: Institute of Marine Research, Bergen, Norway daniel.howell@hi.no
28 March, 15:20

Title: F_{eco} – squaring the circle of ecosystem inputs into quota setting advice

Abstract:
Single species assessment models provide precise estimates of stock status and can give advice on sustainable fisheries quotas following precautionary Harvest Control Rules. In contrast, ecosystem models are generally not suitable for setting annual quota advice but they do provide the best ecosystem overview available. F_{eco} is a method which allows this best available information to enter annual quota advice, without loosing the advantages of the single species assessment models. The approach entails identifying indicators (either physical or synthetic model outputs) which track quantities of interest (for example stock productivity or food availability to predators), and then using these to scale up or down the pre-defined single species F_{target}, while not exceeding the pre-defined limit reference points (F_{lim}, B_{lim}). This approach allows for some influence of the ecosystem information, while retaining the advantages of the

current single species workflow, and importantly retaining the current level of precaution against stock collapse. The method also allows two different modelling frameworks to cooperate without the need to transfer exact values between models. The F_{eco} approach is being adopted in management in several regions, and gives a large degree of flexibility in accounting for ecosystem variability. Examples which fall under this framework include reducing catch to account for predator needs, variable stock productivity, and the use of risk assessment to potentially reduce catch if required to remain precautionary. While not all potential aspects of EBFM can be incorporated into this framework, it does provide steps which can be taken in the existing management system to improve the level of ecosystem knowledge in fisheries quotas.

Kitakado, Toshihide: Tokyo University of Marine Science and Technology, Japan
28 March, 10:20 kitakado@kaiyodai.ac.jp

Title: Evaluation of prediction skills for population dynamics models

Toshihide Kitakado, Laurie Kell and Rishi Sharma

Abstract:
Scientific assessment frameworks for wildlife and fisheries management are based on two main paradigms: “estimation of population status” and “evaluation of management procedure”. Normally, a population dynamics model is fitted to time-series data of population indices, removals and age/size compositions. The model is then used to assess historical population status relative to reference points, and to predict the outcomes of alternative management options. As a normal course of procedure, model diagnostics are conducted to test goodness of fit and inspect residual patterns. Given the ultimate goal of development of a management advice based on the fitted model, prediction error of the model should also be evaluated. Here, we propose a hindcasting approach as a method to evaluate models through their prediction skills. Models are retrospectively re-run by removing recent years’ data and the population trajectories are forecasted up to the most recent year to compare with the observed time-series of a population index (which is used in the original model fitting). The presentation introduces examples of application of the hindcasting approach and discuss possible caveats of the approach.

Ono, Kotaro: Institute of Marine Research, Bergen, Norway Kotaro.Ono@hi.no
28 March, 13:30

Title: Current advances and challenges in fish distribution modeling

Abstract:
Species distribution modeling (SDM) comprises many statistical approaches that allow understanding and possibly predicting changes in species distribution. This includes both parametric (e.g. GLMM), semi-parametric (e.g. GAMM), and non-parametric models (e.g. random forest, boosted regression models). In addition to modeling species distribution, the approach has also been increasingly used in fishery science (in supplement or instead of more traditional approaches based on design-based estimators) to build an index of population abundance which is later used in stock assessment models. In this presentation, I will talk about

recent advances in SDM in fishery science (e.g. multispecies modelling to "share" information across species, using fishery data to complement surveys, considering the vertical fish availability, considering fish movement, various treatment of covariate effects) but also some remaining challenges (e.g. data-limited species). Finally, I will touch upon the importance of simulation (and important components to include in the simulation) for testing future improvement in SDM techniques.

Shimadzu, Hideyasu: Loughborough University, United Kingdom H.Shimadzu@lboro.ac.uk
28 March 12:50

Title: Quantifying change in marine biodiversity

Abstract:
Emerging concerns underline unprecedented pressures responsible for the biodiversity crisis on Earth. Understanding the extent to which contemporary biodiversity change occurs has thus been a central interest for ecological sciences and conservation management. While various indices have been developed and used to quantify the state of biodiversity, these indices can sometimes contradict each other. A missing piece here is a unified aspect that offers a cohesive implication over these diverse biodiversity measures.
The talk begins by elaborating on the classical ecological concepts of biodiversity, namely alpha-, beta- and gamma-diversities, and provides a little formal interpretation based upon abundance distributions. We then show that a particular change in species abundance distributions corresponds to a specific concept of biodiversity. This fact implies that quantifying a difference between two abundance distributions is equivalent to measuring the change in biodiversity; in other words, commonly used biodiversity indices are, in fact, an estimator of distributional deviation from one to another. We demonstrate how our framework encompasses the critical concepts in biodiversity study and provides more insight into the ecological community dynamics we observe.

Skaug, Hans: University of Bergen, Norway Hans.Skaug@uib.no
28 March, 11:00

Title: Spatial variation on multiple scales in line transect data; the case of Antarctic fin whales

Abstract:
Line transect sampling is a widely used survey method for estimating animal density or abundance. When recording such data an observer moves along a transect line and measures the perpendicular distance to each detected animal. We allow spatial variation in animal density to operate on two different scales: a long scale representing trends caused for instance by climatetic or terrain gradients, and a short scale representing abrupt shifts due to patchiness of the prey species and other finer scale effects. In addition, many animals' species form groups which from a line transect perspective constitute the observation units. We present a novel two-stage approach for modelling line transect data, that allows us to account for these properties. The first stage is a model for the location of animal groups and relies on a spatial Cox process formulation with a latent random field consisting of both a slowly varying Gaussian random field and an abruptly changing Markov modulated Poisson processes. The second stage is a

model for group size which relies on a zero-truncated negative binomial distribution with a mean which varies spatially via a (separate) Gaussian random field. Computationally feasible inference is enabled by implementing the model in the modelling framework TMB, using a series of implementation and inference tricks. We apply our approach to model the summer distribution and estimate the abundance of Antarctic fin whales in the Scotia Sea, based on data collected during the 2019 Area 48 Survey for Antarctic Krill. Our method suggests that the abundance is larger and has larger uncertainty than previously estimated. We validate our approach with a simulation study based on the fitted model, showcasing that our model stands strong.

Solvang, Hiroko: Institute of Marine Research, Bergen, Norway hiroko.solvang@hi.no
29 March, 13:10

Title: Categorical data analysis using discretization of continuous variables to investigate the association in marine ecosystems

Solvang, K.H (IMR), Imori, S. (Hiroshima University), Martin, B (IMR)., Lindstrøm, U (IMR, Arctic University of Norway)., Haug, T (IMR), Nils Øien (IMR)

Abstract:
Recent climate change and fluctuations in the environmental conditions of oceans have affected the spatial distribution of both zooplankton and fish species known to be the potential prey of marine mammals. Investigating the directional association among biological communities and oceanographic factors is important for exploring connection or cooperative link in the ecosystem, which may support to consider causal relationships among them. For this purpose, a relevant and practical statistical method is required to link presence/absence observations with biomass, abundance, and physical quantity obtained as continuous real values. These data are sometimes sparse in oceanic space and too short as time series data. To meet the challenge, we provide an approach based on applying categorical data analysis to present/absent observations and real number data. This approach consists of two steps as the procedure used for categorical data analysis: 1) finding the appropriate threshold in order to discretize the real-number data to apply an independent test; and 2) identifying the best conditional probability model to investigate the possible associations among the data based on statistical information criterion. We conduct a simulation study to validate our proposed approach. Furthermore, the approach is applied to two following datasets: 1) collected during an international synoptic krill survey in the Scotia Sea west of the Antarctic Peninsula to investigate association among krill, fin whale (*Balaenoptera physalus*), surface temperature, and depth; 2) collected by ecosystem surveys conducted during August-September in 2014–2017 to investigate association among common minke whales, the predatory fish Atlantic cod, and their main prey groups (zooplankton, 0-group fish) in Arctic Ocean waters to the west and north of Svalbard.

Dolédec, Sylvain: Université Lyon 1, France sylvain.doledec@univ-lyon1.fr
29 March, 10:50

Title: Practising multivariate analyses with ade4 package: from one-table to multiple tables analyses

Abstract:
The ade4 package incorporates a variety of multivariate techniques for analysing single (PCA, CA , MCA, Hill & Smith), two (co-inertia analysis, niche, RDA, CCA), three (RLQ analysis) and >3 data tables (STATIS, STATICO, MFA, MCOA). In this presentation, I will describe briefly the mathematical principle behind the package and those techniques appropriate to analysing the species-environment relationships (co-inertia), the trait-environment relationships (RLQ), and their dynamics (STATICO).

Taniguchi, Masanobu: Waseda University, Japan taniguchi@waseda.jp
28 March, 9:40

Title: Philosophy of AIC

Abstract:
In statistical model selection, we have to infer the order p of parametric models from data. The best known rule for determining the true value p_0 of p is probably Akaike's Information Criterion(AIC). In this talk we propose a generalized Akaike's information criterion(GAIC), which includes the usual AIC as a special case, for general class of stochastic models(i.e., i.i.d., non-i.i.d., time series models etc.). We derive the asymptotic distribution of selected order \hat{p} by GAIC, and show that \hat{p} is not consistent (i.e., over estimated).
Next we suppose that the true model g would be incompletely specified, and be "contiguous" to a fundamental parametric model. Under this setting we derive the asymptotic distribution of \hat{p}. In comparison with the other criteria, e.g., BIC and HQ, we show that GAIC has admissible properties. That is, we elucidate what AIC aims. (co-work with J.Hirukawa).

Yanagihara, Hirokazu: Hiroshima University, Japan yanagi-hiro@hiroshima-u.ac.jp
29 March, 10:10

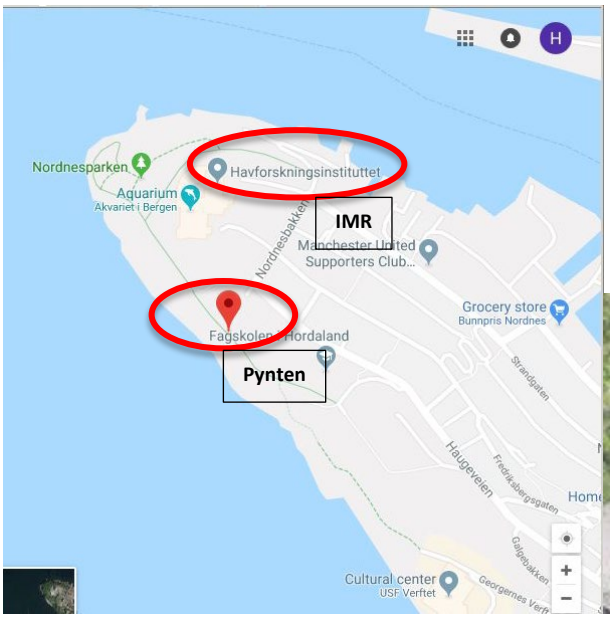
Title: Estimation of spatial effects by generalized fused Lasso for nonuniformly sampled spatial data using body condition data set from common minke whales

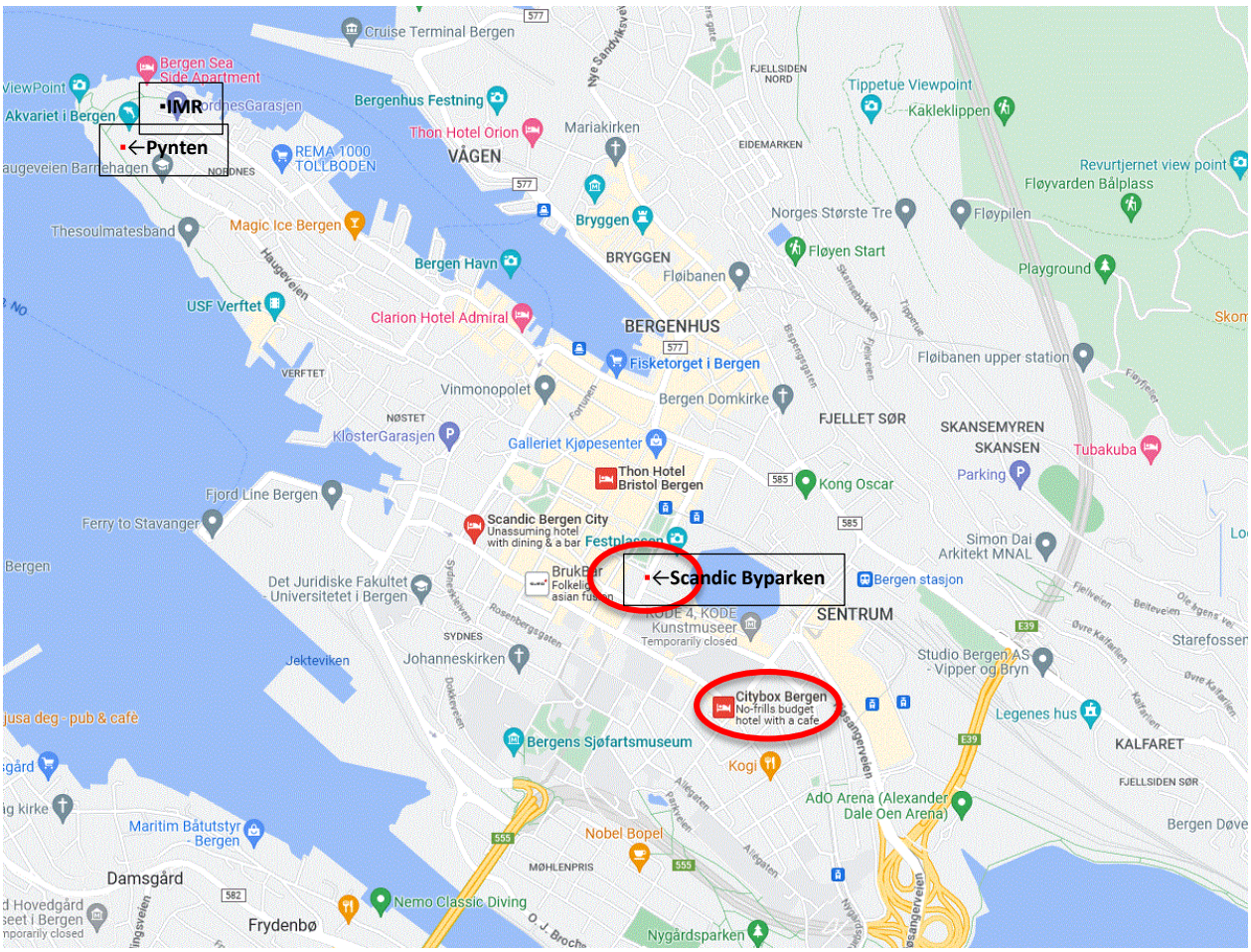
Hirokazu Yanagihara (Hiroshima University, Japan), Mariko Yamamura (Radiation Effects Research Foundation, Japan), Mineaki Ohishi (Tohoku University, Japan), Keisuke Fukui (Hiroshima University, Japan), Hiroko Solvang (Institute of Marine Research, Norway), Nils Øien (Institute of Marine Research, Norway), Tore Haug (Institute of Marine Research, Norway)

Abstract:
When dealing with spatial data, it is important to clarify the influence of spatial effects to a response variable. In this paper, we focus on a method for estimating spatial effects. The idea here is to estimate spatial effects by dividing the space to be analyzed into smaller spaces, i.e.,

to estimate spatial effects not continuously but discretely. From an adjacency information of each segmented space, we consider an estimation method that joins the neighboring spaces by using the generalized fused Lasso. This procedure is expected to be robust for nonuniformaly in a distribution of spatial data, because only the adjacency information between the data is used instead of using the coordinates of the data. For model flexibility, effects other than spatial one to a response variable are estimated in penalized spline regression. The penalized spline regression is optimized via the generalized ridge regression in order to reduce the time required optimizing smoothness.

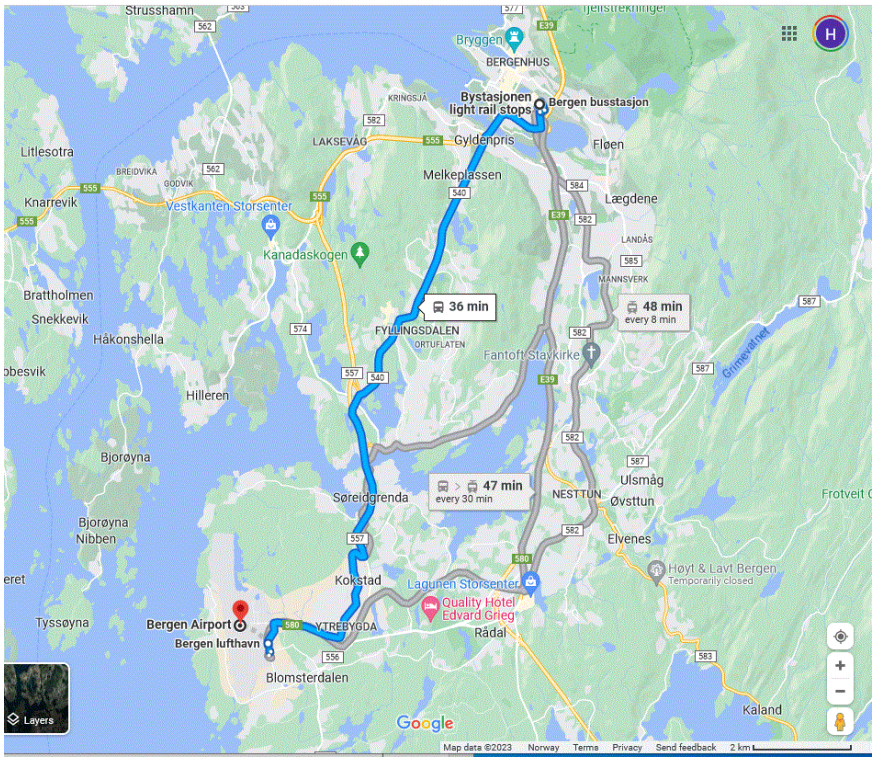
How to get Pynten?





From your accommodation, it takes around 30-40 min on foot. Please find the rout using Google map on your mobile from ‘your location’ to ‘Norwegian Institute of Marine Research’. We will meet at main entrance of IMR around 9:15 on 28 of March. From the behind of the main building of IMR, if going to left direction against the coast, you will find Pynten right side in the playground. It takes a few minutes from the behind of the building. If the entrance is locked, please call Solvang +47 4822 0478.

From Bergen airport (Flesland) to the centrum: The easiest way is use Light Rail called ‘Bybane’.



1

Byparken › Bergen lufthavn

Frå Byparken	Måndag – fredag: Første avgang				Kl. 6.30–9.30	Kl. 9.30–13.30	Kl. 13.30–18.00	Kl. 18.0–20.00	Kl. 20.00–23.30 (kvart 10. min)					
Byparken	5.45	6.00	6.10	6.20					00	10	20	30	40	50
Bergen busstasjon	5.47	6.02	6.12	6.22					02	12	22	32	42	52
Danmarks plass	5.53	6.08	6.18	6.28					08	18	28	38	48	58
Sletten	6.00	6.15	6.25	6.35					15	25	35	45	55	05
Fantoft	6.03	6.18	6.28	6.38	Kvart 5. min	Kvart 7.–8. min	Kvart 5. min	Kvart 7.–8. min	18	28	38	48	58	08
Nesttun terminal	6.08	6.23	6.33	6.43					23	33	43	53	03	13
Mårdalen	6.13	6.28	6.38	6.48					28	38	48	58	08	18
Lagunen terminal	6.16	6.31	6.41	6.51					31	41	51	01	11	21
Sandslivegen	6.20	6.35	6.45	6.55					35	45	55	05	15	25
Birkelandsskiftet term.	6.25	6.40	6.50	7.00					40	50	00	10	20	30
Bergen lufthavn Flesland	6.28	6.43	6.53	7.03					43	53	03	13	23	33

Frå Byparken	Måndag – fredag						Kl. 1.15–4.00 (kvart 15. min) Fredag				Siste avg. fredag
Byparken	23.45	0.00	0.15	0.30	0.45	1.00	15N	30N	45N	00N	4.00N
Bergen busstasjon	23.47	0.02	0.17	0.32	0.47	1.02	17N	32N	47N	02N	4.02N
Danmarks plass	23.53	0.08	0.23	0.38	0.53	1.08	23N	38N	53N	08N	4.08N
Sletten	0.00	0.15	0.30	0.45	1.00	1.15	30N	45N	00N	15N	4.15N
Fantoft	0.03	0.18	0.33	0.48	1.03	1.18	33N	48N	03N	18N	4.18N
Nesttun terminal	0.08	0.23	0.38	0.53	1.08	1.23	38N	53N	08N	23N	4.23N
Mårdalen	0.13	0.28	0.43	0.58	1.13	1.28	43N	58N	13N	28N	4.28N
Lagunen terminal	0.16	0.31	0.46	1.01	1.16	1.31	46N	01N	16N	31N	4.31N
Sandslivegen	0.20	0.35	0.50	1.05	1.20	1.35	50N	05N	20N	35N	4.35N
Birkelandsskiftet term.	0.25	0.40	0.55	1.10	1.25	1.40	55N	10N	25N	40N	4.40N
Bergen lufthavn Flesland	0.28	0.43	0.58	1.13	1.28	1.43	58N	13N	28N	43N	4.43N

N | Nattavgang

Bybanen/linje 1 blir køyrd av Keolis AS
skyss.no, telefon 55 55 90 70

Byparken 0 minutt · Nonneseter 1 minutt · Bergen busstasjon 2 minutter · Nygård 4 minutter · Florida 5 minutter · Danmarks plass 6 minutter · Kronstad 9 minutter · Bryns stadion 11 minutter · Haukeland 12 minutter · Sletten 14 minutter · Slettebakken 16 minutter · Fantoft 18 minutter · Paradis 20 minutter · Hop 22 minutter · Nesttun terminal 25 minutter · Nesttun senterhus 27 minutter · Gråtebakken 28 minutter · Mårdalen 31 minutter · Skjold 33 minutter · Lagunen terminal 35 minutter · Råstølen 37 minutter · Sandslimarka 39 minutter · Kokstad 41 minutter · Birkelandsskiftet 45 minutter · Kokstadflaten 46 minutter · Bergen lufthavn 48 minutter

Gyldig frå 21. november. Skyss tar forbehold om endringar og trykkfeil.

1

Bergen lufthavn › Byparken

Frå Bergen lufthavn	Måndag – fredag: Første avgang			Kl. 5.41–8.41	Kl. 8.41–12.41	Kl. 12.41–17.11	Kl. 17.11–19.11	Kl. 19.11–22.41 (kvart 10. min)					
Bergen lufthavn Flesland	5.11	5.21	5.31					11	21	31	41	51	01
Birkelandsskiftet term	5.14	5.24	5.34					14	24	34	44	54	04
Sandslivegen	5.18	5.28	5.38					18	28	38	48	58	08
Lagunen terminal	5.23	5.33	5.43					23	33	43	53	03	13
Mårdalen	5.26	5.36	5.46					26	36	46	56	06	16
Nesttun terminal	5.30	5.40	5.50	Kvart 5. min	Kvart 7.–8. min	Kvart 5. min	Kvart 7.–8. min	30	40	50	00	10	20
Fantoft	5.36	5.46	5.56					36	46	56	06	16	26
Sletten	5.40	5.50	6.00					40	50	00	10	20	30
Danmarks plass	5.46	5.56	6.06					46	56	06	16	26	36
Bergen busstasjon	5.51	6.01	6.11					51	01	11	21	31	41
Byparken	5.54	6.04	6.14					54	04	14	24	34	44

Frå Bergen lufthavn	Måndag – fredag						Kl 0.26–3.11 (kvart 15. min) Fredag				Siste avg. fredag
Bergen lufthavn Flesland	22.52	23.07	23.22	23.38	23.52	0.08	26N	41N	56N	11N	3.11N
Birkelandsskiftet term	22.55	23.10	23.25	23.41	23.55	0.11	29N	44N	59N	14N	3.14N
Sandslivegen	22.59	23.14	23.29	23.45	23.59	0.15	33N	48N	03N	18N	3.18N
Lagunen terminal	23.04	23.19	23.34	23.50	0.04	0.20	38N	53N	08N	23N	3.23N
Mårdalen	23.07	23.22	23.37	23.53	0.07	0.23	41N	56N	11N	26N	3.26N
Nesttun terminal	23.11	23.26	23.41	23.57	0.11	0.27	45N	00N	15N	30N	3.30N
Fantoft	23.17	23.32	23.47	0.03	0.17	0.33	51N	06N	21N	36N	3.36N
Sletten	23.21	23.36	23.51	0.07	0.21	0.37	55N	10N	25N	40N	3.40N
Danmarks plass	23.27	23.42	23.57	0.13	0.27	0.43	01N	16N	31N	46N	3.46N
Bergen busstasjon	23.32	23.47	0.02	0.18	0.32	0.48	06N	21N	36N	51N	3.51N

N | Nattavgang

Bybanen/linje 1 blir køyrd av Keolis AS
skyss.no, telefon 55 55 90 70

Gyldig frå 21. november. Skyss tar forbehold om endringar og trykkfeil.

* ‘lufthavn’ means airport. ‘Flesland’ means the location name of a town in Bergen municipality.

* For Bybane, if you stay at Scandic Byparken, please get off at Byparken, or if you stay at Citybox Bergen, please get off at Bergen busstasjon. Other options are taking bus and taxi.
Buss goes to the centrum from the bus stop A5 at the airport around every 30 min. Taxi goes to centrum faster, but it costs around/over 600 NOK in daytime.
The price of the single ticket using bybane or local bus (not airport limousine buss) is 40 NOK. You can use the ticket for any public transportation within 90 min in zone A after activation.

* For glossary boutique to buy water or light meal, using REMA 1000, COOP, or KIWI would be recommended. The products being sold at convenience store like Narvesen or 7-Eleven are usually more expensive.