

Biodiversity Computing 1.5 years after project start: Insights, Progress, and Challenges

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www.biocomp.gr (Crete lab)

www.exelixis-lab.org (Heidelberg lab)

Football Predictions

[Home](#) > [Statistics and Computing](#) > Article

Phylourny: efficiently calculating elimination tournament win probabilities via phylogenetic methods

Original Paper | [Open access](#) | Published: 16 May 2023

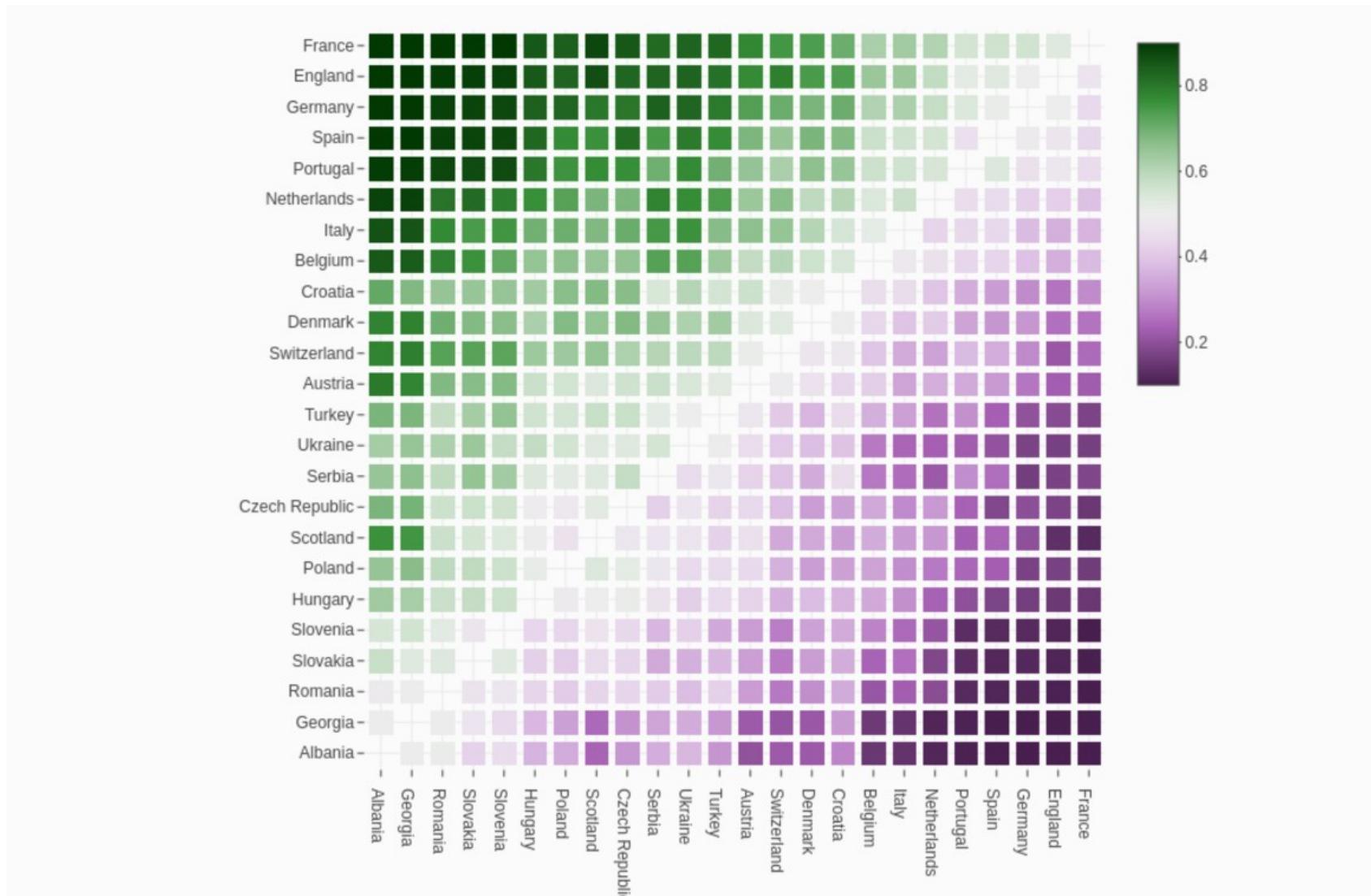
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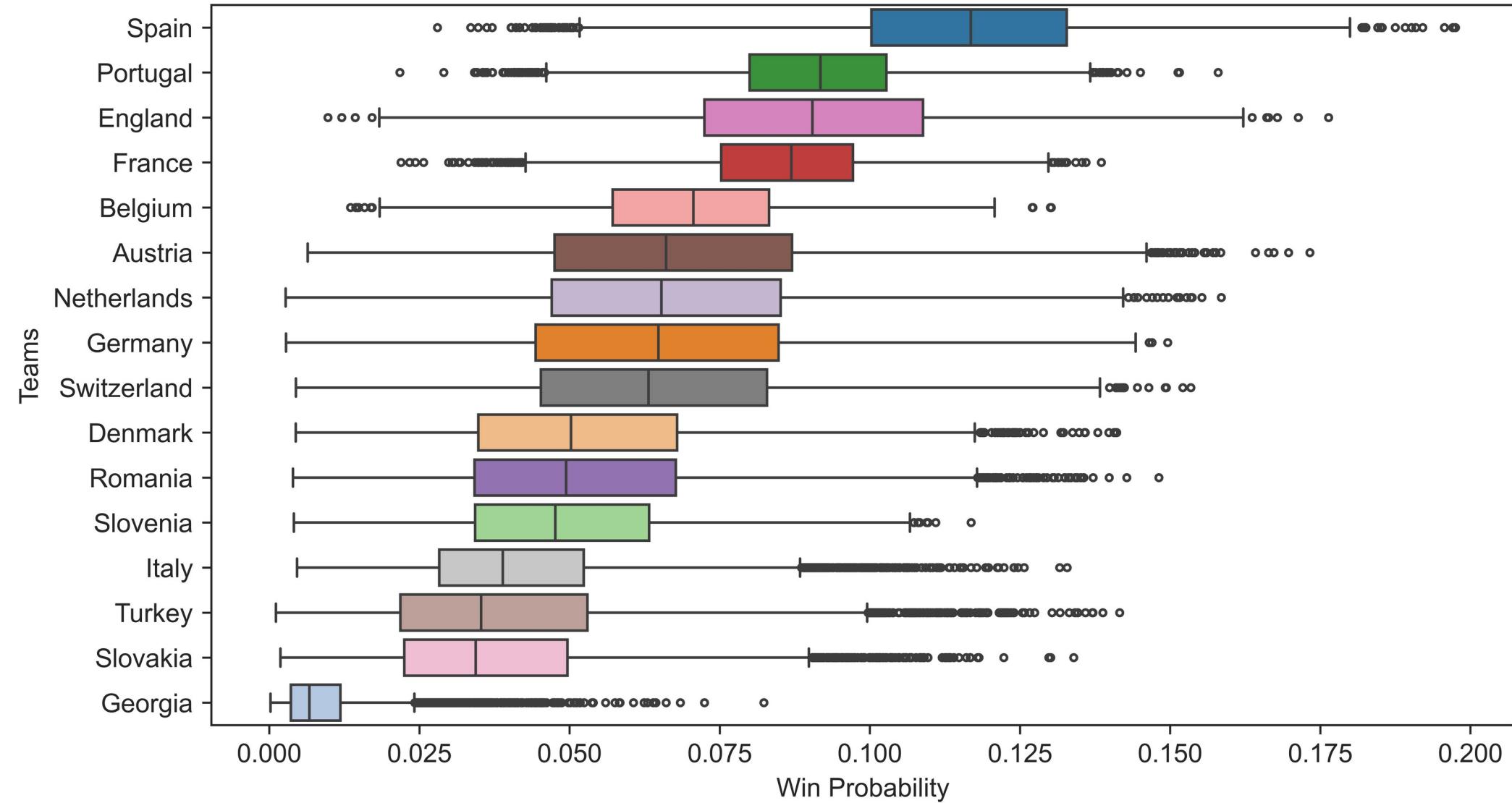
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[Ben Bettisworth](#) , [Alexander I. Jordan](#) & [Alexandros Stamatakis](#)

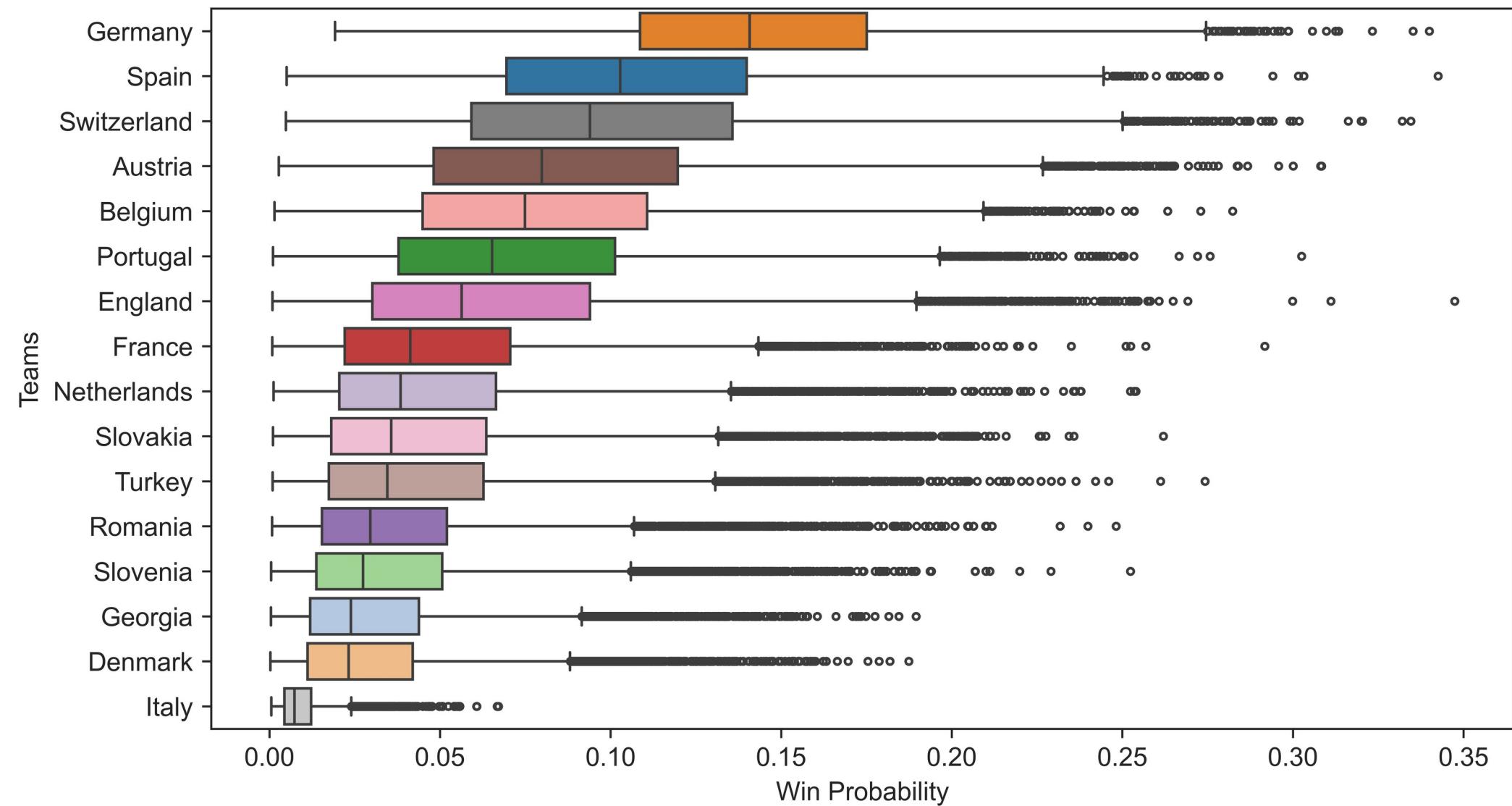
Quantify Impact of Alterations of pair-wise Win-Matrix



Qualifiers & Group Phase



Group Phase Only



Outline

- **Research Group Ecosystem**
- Administrative and Political Challenges
- Teaching & Research
- Dissemination Activities

Biodiversity Computing Group (BCG) ICS-FORTH



Computational Molecular Evolution Group (CME) HITS



Ancient DNA lab IMBB-FORTH



Research Group Ecosystem

- *Computational Molecular Evolution group* – Heidelberg Institute for Theoretical Studies
 - 5 PhD students (Germany, Greece) + 1 staff Scientist (Ukraine)
 - Numerous Bachelor and Master thesis (partially supervised by BCG members)
 - New type of CS students “*I want to do something with machine learning or data science*”
 - www.exelixis-lab.org
- *Biodiversity Computing Group* – Institute of Computer Science, Foundation for Research and Technology Hellas (Crete)
 - 3 PhD Students (Spain, Germany, Austria)
 - 3 PostDocs (Greece, Greek from France, US)
 - www.biocomp.gr
- *Ancient DNA lab* – Institute of Biology and Biotechnology, Foundation for Research and Technology Hellas (Crete)
 - Jointly managed with **Nikos Poulakakis and Pavlos Pavlidis**
 - 2 PostDocs + 1 lab technician + 1 archaeologist
 - <https://ancient-dna.gr/index.php/en/>

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Administrative Setup

- **HITS** – privately funded research institute (gemeinnützige GmbH)
- **KIT** – public university
- **FORTH** – public research center
- Consequences
 - Procedures, contracts, business processes differ among all 3 institutions
 - 3 different IT infrastructures (emails, VPNs, portals)
 - understand, read, edit documents (e.g. legal documents or press releases) in three languages now
 - invisible to FORTH/EU: HITS group leader meetings, annual reports (at HITS), professor portraits (at KIT), group evaluations etc.
 - different KIT and UoC teaching requirements and totally distinct PhD admission procedures
- Duplicate processes at private level
 - Tax declarations
 - Bank accounts
 - Insurances

Key Problem

- No single institution and funding agency sees the full complexity of systems and regulations we have to deal with
- Processes and regulations keep being extended and extended and extended

KPIs & Bean Counting

- 2000-2022: Scientific career without knowing what KPI stands for
- EU research funding (and Greek even more so): processes are over-specified → reduction of net research time
- DFG (German Science Foundation) does much better
- **Trust-based Funding !!!!**
- **πόθεν έσχες** declaration is ridiculous

Biodiversity Computing Group
6 out of 7 lab members from abroad – 5 nationalities



Take Home Message

- Brain gain can be achieved
- When paying competitive salaries (80% of respective salaries in Germany)
 - Paying competitive salaries at a broader scale to foster brain gain and prevent brain drain is solely a matter of political willingness

Policy Paper with Melina

Substantially under-funded

Substanziell unterfinanziert

Probleme der griechischen Forschungslandschaft

| MELINA TAMIOLAKI | ALEXANDROS STAMATAKIS |

Das ERA (European Research Area) Chair-Programm der EU zielt, durch Gewinnung renommierter internationaler Forscherinnen und Forscher (sog. „ERA Chairs“), darauf ab, neue Forschungsrichtungen in ausgewählten europäischen Ländern aufzubauen. Dadurch soll dem Brain-Drain entgegengewirkt werden sowie institutionelle Reformen sollen angestoßen werden. Mit welchen Herausforderungen sieht sich das Hochschul- und Forschungssystem in Griechenland konfrontiert?

Griechenland ist beim ERA Chair-Programm seit 2022 antragsberechtigt und die ersten sieben ERA Chair-Projekte sind 2023 angelau-fen. Sie sollen zur Verbesserung des griechischen Hochschulsystems beitragen. Zu diesem Zweck fand im September 2023 auch das erste Treffen aller sieben griechischen ERA Chairs statt. Das griechische Hochschul- und Forschungssys-

tem hat aus unserer Sicht mit folgenden, miteinander zusammenhängenden Problemen zu kämpfen:

Bezahlung in der Wissenschaft international nicht konkurrenz- fähig

In Griechenland existieren neben den Assistant (stets mit Tenure Track), Associate und Full Professor-Positionen auch äquivalente und ähnlich dotierte verbeamtete Positionen an staatlichen Forschungszentren. Die Gehälter sind international nicht konkurrenzfähig. Derzeit erhält ein Full Professor ein Nettojahresgehalt von 24 000 Euro (während es vor der Finanzkrise im Jahr 2009, je nach Dienstalter, zwischen 31 000 und 40 000 waren). Die Lebenshaltungskosten entsprechen ca. 80 Prozent derer in Deutschland. Auch für akademische Managementpositionen (z.B. der Leitung von Naturkundemuseen o.ä.) sind keine Gehaltszuschläge vorgesehen. Aufgrund anhaltender Proteste seitens der Wissenschaftlerinnen und

(etwa 5 800 Zitate, h-Index von 27 laut Google Scholar) unterrichtet abends noch Lego-Robotik-Kurse für Grundschulkinder. Dieses Phänomen existiert bereits seit Jahrzehnten im griechischen Schulsystem bei den chronisch unterbezahlten Lehrern.

Der Gesetzgeber sieht vor, dass die o.g. Gehälter nur 50 Prozent der wöchentlichen Arbeitszeit (20 Stunden) abdecken und die verbleibenden 50 Prozent durch Fördermittel auf das Zweifache (je nach Institut sogar darüber hinaus) aufgestockt werden können. Daher stellt das Einwerben von EU-Fördermitteln und der damit einhergehenden Gehaltsaufstockung für viele Wissenschaftlerinnen und Wissenschaftler die einzige Möglichkeit dar, ihren Lebensunterhalt zu bestreiten. Die eigentlichen Forschungsinteressen sind zweitrangig, wichtiger ist es, über welches EU-Programm sich Mittel einwerben lassen. Ein Großteil der eingeworbenen Projektmittel wird infolgedessen dazu verwendet, die Gehälter der PIs aufzustocken, statt Doktoranden und PostDocs zu fördern. Insofern wird überproportional viel Zeit und kreative Energie dazu aufgewendet, Drittmittel einzuwerben, um zunächst den eigenen Lebensunterhalt zu sichern. Auf diese gravierenden Probleme können die ERA Chairs in Interviews mit der nationalen Presse sowie in Gesprä-

AUTOREN



Melina Tamiolaki ist Professorin für antike griechische Literatur an der Universität von Kreta und Koordinatorin des ERA Chair-Projekts „TALOS-Artificial Intelligence for Humanities and Social Sciences.“



Alexandros Stamatakis ist assoziierter

Objectives and Milestones

- Planned number of 10 exchanges (overall project) already achieved
Mainly between Heidelberg and Heraklion
US Fullbright fellowship Prof. Adam Leache U Washington at Seattle (6 months) in 2025
2 further potential long-term visitors
Lack of appropriate unbureaucratic funding

brain gain in the area of computational biodiversity research, **(O2.2) promote brain circulation within Europe, (O2.3) prevent brain drain at ICS-FORTH and Crete, and (O2.4) encourage appropriate institutional reforms at ICS-FORTH to attain a broader impact.**

Visionary Reforms

Gender Equality & Diversity

- Greece has the lowest gender equality index **in the entire EU**
- Policy proposal with Maria Klapa, Melina and many others
 - Establish Greek female professors program
 - Proposal text ready
 - Strengthen female representation in academic management bodies
 - Approved and obtained support from all research center and university Gender Equality Committees
 - Next step: talk with ministries
- Diversity
 - Embrace cultural and sexual diversity – currently not on the agenda

Realistic Reforms

- At ICS-FORTH
 - Improved documentation of internal processes
 - Definition of staff on- and off-boarding procedures
- HRS4R Human Resources Strategy for Researchers at FORTH
 - Initial struggle to make information available in Greek and English
 - How do we handle events in Greek only?

Sustainability of BCG

- Permanent researcher position at end of year 3
- This is a **must** deliverable
- The idea is that the Greek state generates **new** positions (and does not just reallocate existing ones from retirements) to sustain the ERA chair groups
- Thus far, zero investment by the Greek state as far as I can judge
- In fact, ERA chairs have funded the chronically under-funded research centers via respective overheads
- 5 out of 7 ERA chairs at research centers under GSRI presumably face the same issue

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Training regional Talents

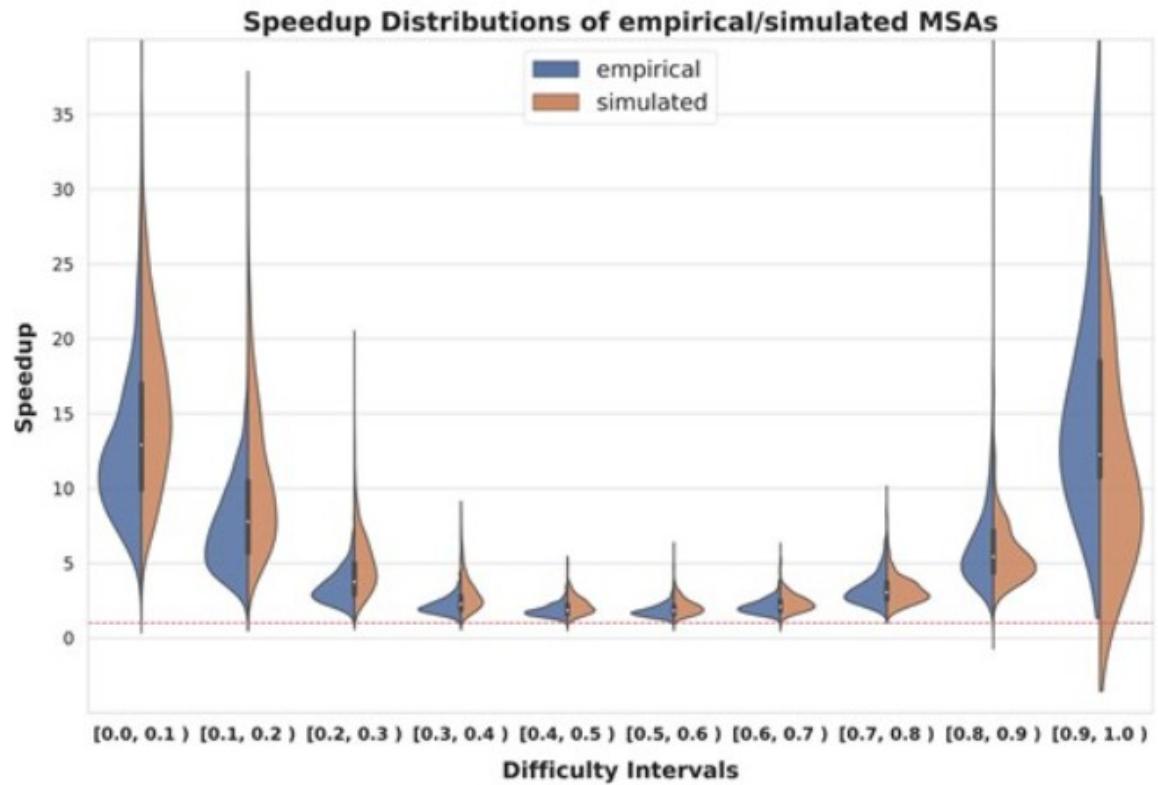
- Joint KIT-UoC course at CS Master's level “Introduction to Bioinformatics for Computer Scientists
 - Also attracted external guest hearers, e.g., a linguist from Turkey
- Summer Term Seminars
 - KIT: “Hot Topics in Bioinformatics”
 - UoC: “Reproducibility in Bioinformatics”
- Bioinformatics Master program at UoC
 - BCG PostDocs might teach some courses there
 - Discussion with director of program in summer 2024 planned

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Adaptive RAxML-NG

FIG. 7.



JOURNAL ARTICLE

Adaptive RAxML-NG: Accelerating Phylogenetic Inference under Maximum Likelihood using Dataset Difficulty

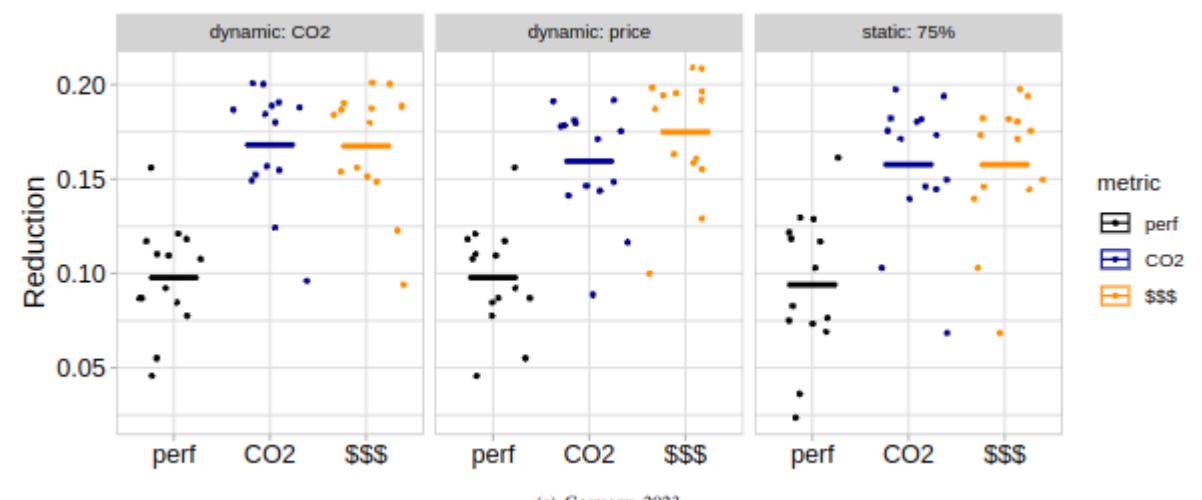
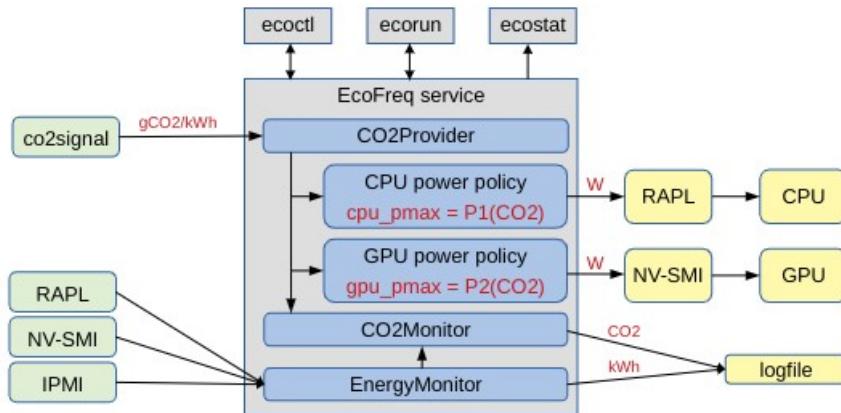
Anastasis Togousidis ✉, Oleksiy M Kozlov, Julia Haag, Dimitri Höhler,
Alexandros Stamatakis Author Notes

Work on Language Evolution

- With PhD student Luise in Heidelberg
 - Luise Häuser, Gerhard Jäger, Taraka Rama, Johann-Mattis List, Alexandros Stamatakis:
"Are Sounds Sound for Phylogenetic Reconstruction?"
Proceedings of SIGTYP2024 , **BEST PAPER AWARD**, Malta, March, 2024.
 - Luise Häuser, Gerhard Jäger, Alexandros Stamatakis:
"Computational Approaches for Integrating out Subjectivity in Cognate Synonym Selection",
Accepted for publication in Proceedings of SCiL 2024 at UC Irvine,
California, US, June 2024.
- Key challenge: insufficient data to apply complex models & machine learning methods

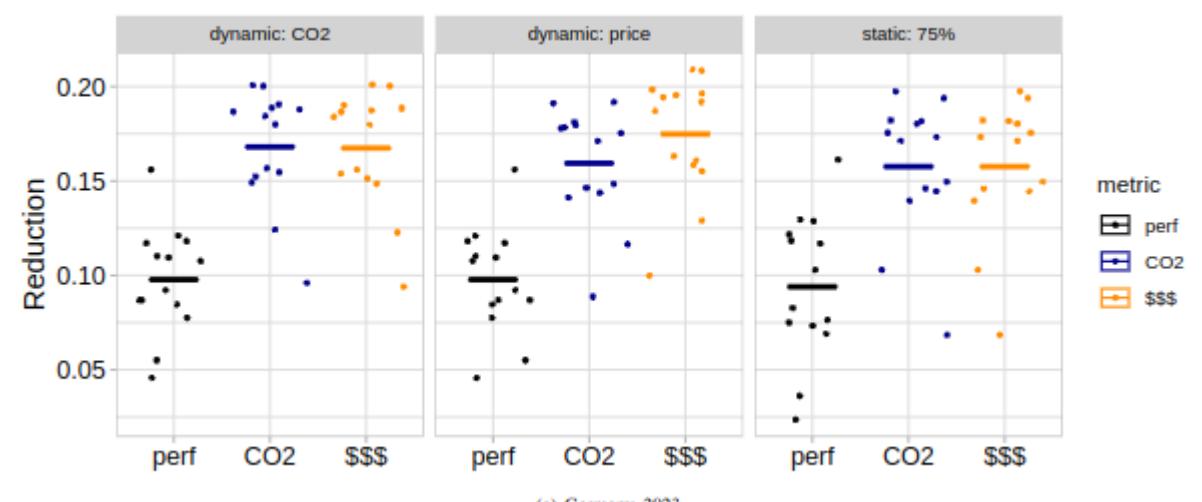
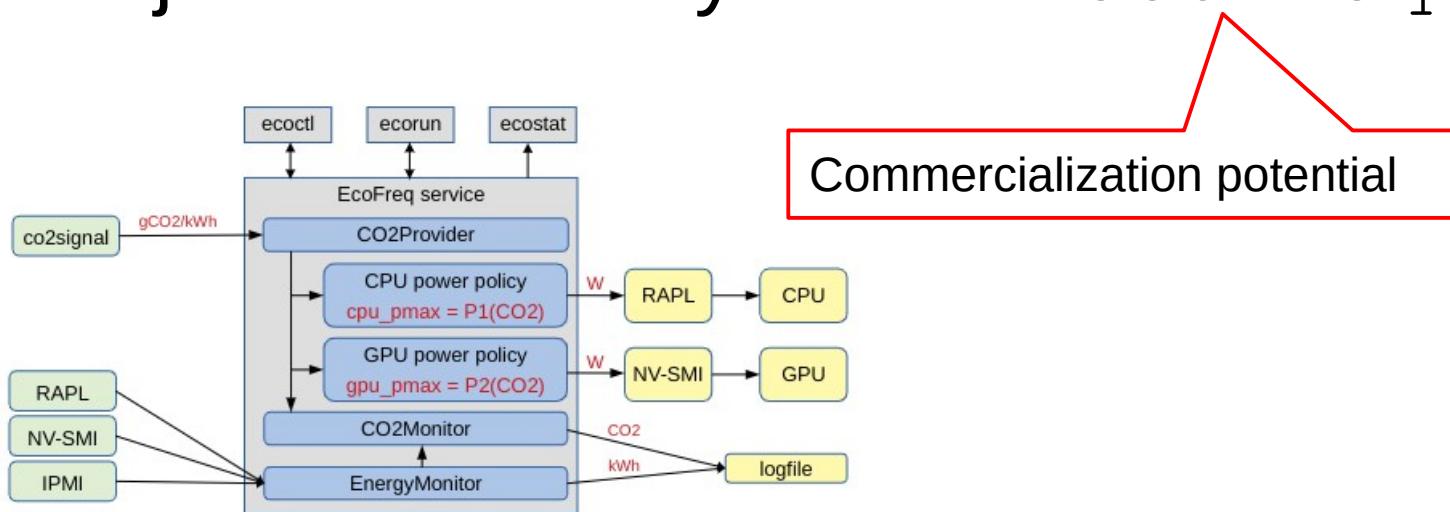
Energy Efficiency

- Project with Alexey at HITS ecofreq tool



Energy Efficiency

- Project with Alexey at HITS ecofreq tool



Forensics with aDNA lab



Forensic Science International: Genetics

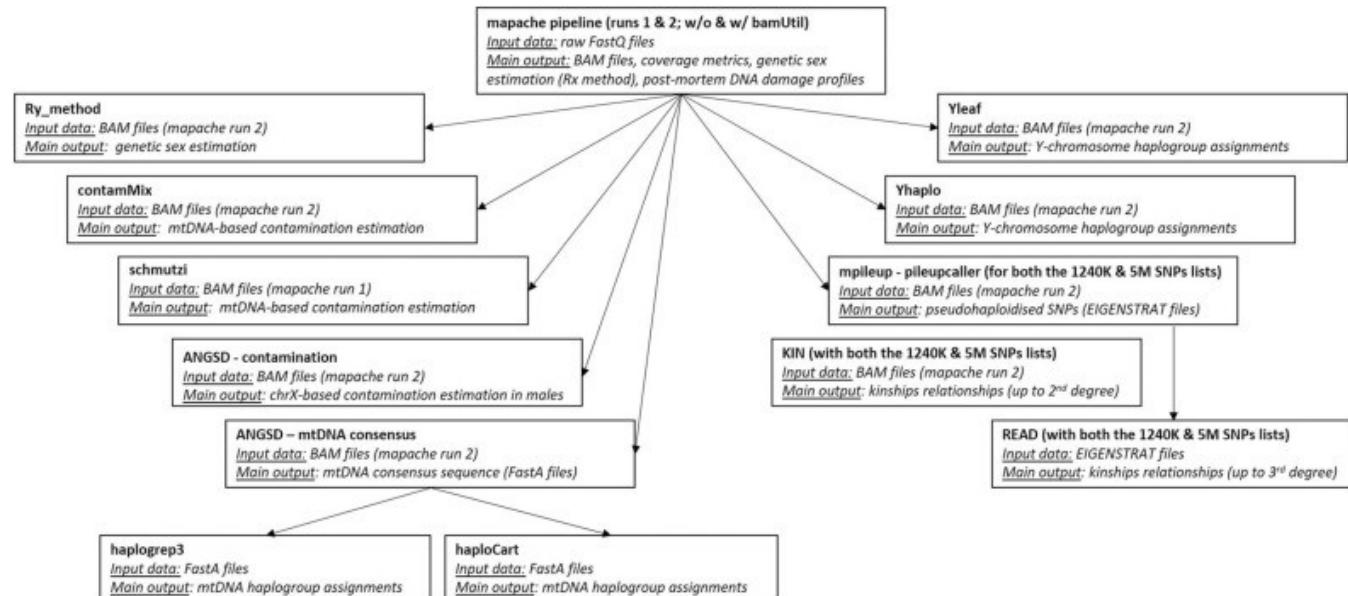
Volume 71, July 2024, 103060



Identification of the 18 World War II executed citizens of Adele, Rethymnon, Crete using an ancient DNA approach and low coverage genomes

Psonis Nikolaos^{a 1}, Vassou Despoina^{a 1}, Nafplioti Argyro^{a 2}, Tabakaki Eugenia^{a 2}, Pavlidis Pavlos^{b f}, Stamatakis Alexandros^{b c d}, Poulakakis Nikos^{a e f}

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Nature Paper on Bird Evolution

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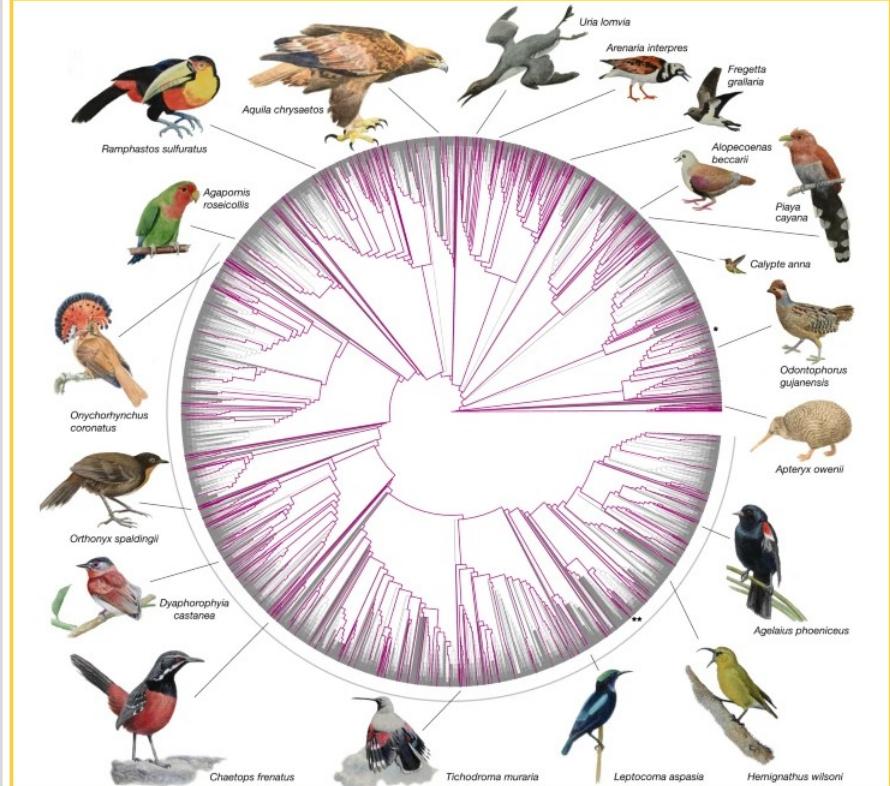
Article | [Open access](#) | Published: 01 April 2024

Complexity of avian evolution revealed by family-level genomes

[Josefin Stiller](#)✉, [Shaohong Feng](#), [Al-Aabid Chowdhury](#), [Iker Rivas-González](#), [David A. Duchêne](#), [Qi Fang](#), [Yuan Deng](#), [Alexey Kozlov](#), [Alexandros Stamatakis](#), [Santiago Claramunt](#), [Jacqueline M. T. Nguyen](#), [Simon Y. W. Ho](#), [Brant C. Faircloth](#), [Julia Haag](#), [Peter Houde](#), [Joel Cracraft](#), [Metin Balaban](#), [Uyen Mai](#), [Guangji Chen](#), [Rongsheng Gao](#), [Chengran Zhou](#), [Yulong Xie](#), [Zijian Huang](#), [Zhen Cao](#), ... [Guojie Zhang](#)✉

+ Show authors

Fig. 1: Newly sequenced genomes densely cover the bird tree of life.



The 10,135 bird species^{11,12} are shown on a draft phylogeny that synthesizes taxonomic and phylogenetic information³⁶ ([Supplementary Data](#)). In total, 363 species, covering 92.4% of all families, now have at least 1 genome assembly per sequenced family (purple branches). The grey arc marks the diverse Passeriformes radiation, with 6,063 species, of which 173 species have genome assemblies now. Chicken (*) and zebra finch (**) are marked for orientation. Paintings illustrate examples of sequenced species.

Ongoing Projects

- Extension of Difficulty Prediction
 - Master Theses at KIT
 - MSA (will be extended by **BCG member Lucia** in collaboration with Julia)
 - Phylogenetic placement (done – student also develop machine learning prediction of bootstraps) – preprint available – publication pending major revisions
- Malaise trap barcoding pipelines
 - **BCG members Giorgos and Noah** are working on this
 - Open source code for taxonomic assignment new tool already available on github
 - Two papers expected
 - Interaction with insect curator at the museum
 - Giorgos also supervises a Master Student at KIT



Ongoing Projects

- Uncertainty Quantification of PCA and MDS analyses used in pop gen & ancient DNA
 - Pandora Tool: Bootstrapping of SNPs – Julia works on this, code and preprint available, project started due to her visit in Crete
- BCG member Ben
 - Quantification of phylogenetic placement accuracy for ancient DNA data – to be submitted soon
 - Biogeography (ancestral range) data simulator – work in progress, open source code already available
 - Strain identification in virus datasets

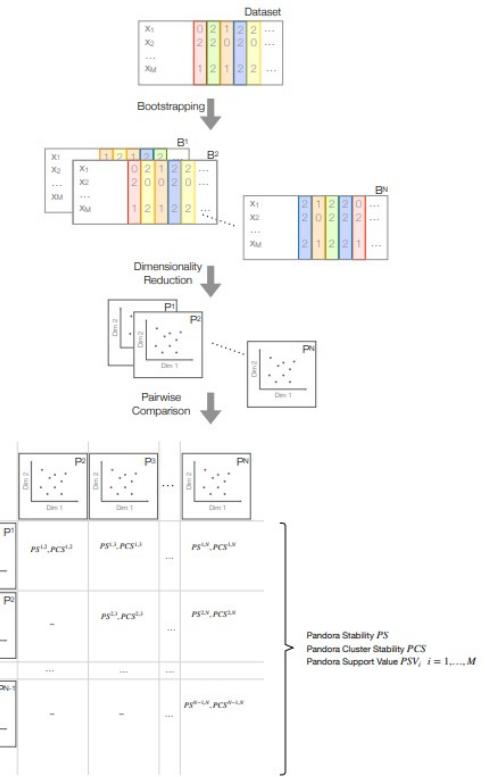
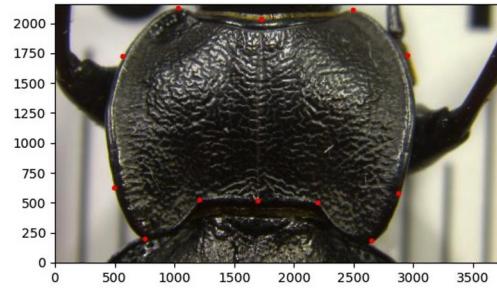


Figure 1: Schematic overview of the bootstrap-based stability analyses for genotype data, as implemented in our Pandora tool.

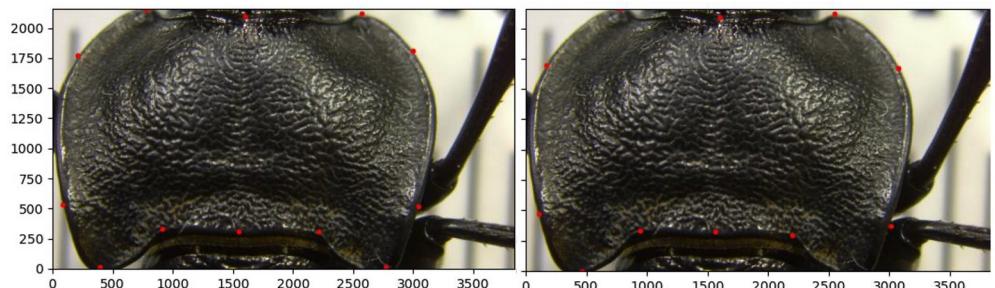
New Projects



Manual Landmarks



Predicted Landmarks



- Multiple Sequence Alignment Difficulty
- Collaboration with Natural History Museum PhD student (I am on his committee) to automate morphometric annotation of beetles
 - Further analogous collaboration planned

New Projects



- Cretan PanGenome project
 - 100 Cretan genomes
 - National funding with ancient DNA lab
- Data analysis with ancient DNA lab
- Development of a Pan-Genome data simulator

New Projects



- Phylogenetic difficulty Distribution over the tree of life using EvoNaps database from Franziska's Master thesis
- Collaboration on phylogenetic bacillus genome analysis with Panos Sarris at IMBB-FORTH (new collaboration)

New Projects



- Work on gene tree – species tree reconciliation methods
 - Transfer Highways

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Legend2024 participants



Legend2025

- Together with the co-organizers we decided to turn this into a regular annual event with Crete and FORTH as its starting point
 - Legend2025 shall take place in France
 - Legend2026 in the US

Computational Molecular Evolution Summer Schools

- 2023 – successfully organized in Crete
- 2024 – successfully organized in the UK
- 2025 – EMBO funding obtained for Crete

Communication Activities

- Schools
 - Three primary School visits – “The Aegean Archipelago – a living laboratory of evolutionary biology” completed (planned to be achieved at end of project)
 - Material on Air Traffic Control (unplanned) – material available on-line
- General
 - Museum Stand
 - Darwinian Monday Talk
 - 2 outreach talks in Listaros (as organizer)
 - Talk by **BCG member Giorgos** on insect biodiversity scheduled for July 7, 2024



Press Releases & Newspaper Articles

- Nature paper on bird evolution
 - HITS and FORTH press releases
 - Dedicated article by **Vasiliki Michopoulou** including policy aspects and the broader context of our work in Heidelberg and Heraklion
 - Dedicated interview on local Cretan news portal with Katerina Mylona (including policy aspects, the ERA chair program, and the organization of the Legend2024 conference)
 - Two local TV interviews in Crete
 - Focus on policy issues
 - Focus on contribution of Bioinformatics to bird evolution paper

Press Releases & Newspaper Articles

- Identification of World War II victims in Adele village, Crete with the ancient DNA lab
 - FORTH press release
 - Dedicated article by **Vasiliki Mochopoulou** (again)
 - Numerous TV, radio and newspaper reports
 - Interviews by Nektarios and Nikos
 - We don't have all the data yet
 - Nikos mentioned the importance of properly exploiting the national sample wealth at every opportunity

Thank you for your attention



Listaros village, Crete