Joint inference of adaptive and demographic history from temporal population genomic data

Miguel Navascués, Vitor Antonio Pavinato, S. de Mita, J.-M. Marin

▶ **To cite this version:**

Miguel Navascués, Vitor Antonio Pavinato, S. de Mita, J.-M. Marin. Joint inference of adaptive and demographic history from temporal population genomic data. Approche Interdisciplinaire de l'Evolution Moléculaire, Nov 2019, Toulouse, France. hal-02790079

HAL Id: hal-02790079
https://hal.inrae.fr/hal-02790079v1

Submitted on 5 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

UPPSALA UNIVERSITET

Joint inference of adaptive and demographic history from temporal population genomic data

Miguel Navascués, Vitor A.C. Pavinato, Stéphane De Mita, Jean-Michel Marin

INRA, Université de Montpellier, Uppsala universitet
miguel.navascues@ebc.uu.se

7/10/2019

UPPSALA UNIVERSITET

Joint inference of adaptive and demographic history from temporal population genomic data

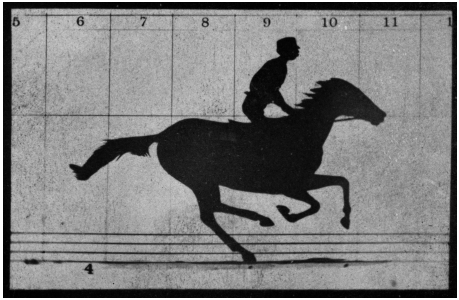
Miguel Navascués, Vitor A.C. Pavinato, Stéphane De Mita, Jean-Michel Marin

INRA, Université de Montpellier, Uppsala universitet
miguel.navascues@ebc.uu.se

7/10/2019

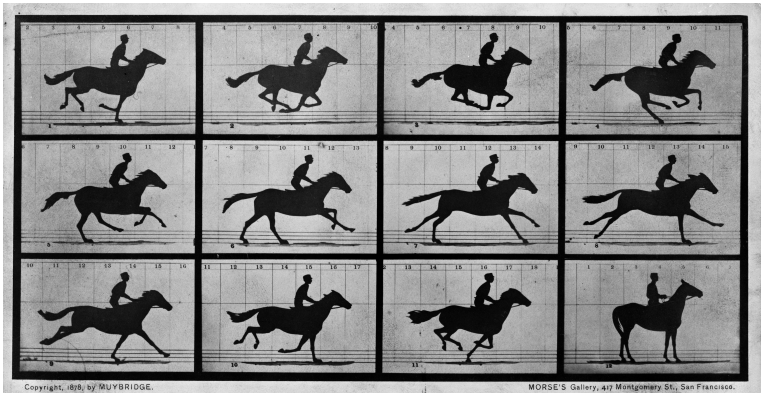
UPPSALA UNIVERSITET

Temporal genetic data for the study of evolution



UPPSALA UNIVERSITET

Temporal genetic data for the study of evolution



UPPSALA UNIVERSITET

Joint Inference of Demography and Selection

- Demographic inference assumes that effect of selection in genome-wide patterns of diversity can be ignored
- Selection inference focuses on detecting loci under selection (outliers)

UPPSALA UNIVERSITET

Joint Inference of Demography and Selection

- Demographic inference assumes that effect of selection in genome-wide patterns of diversity can be ignored
- Selection inference focuses on detecting loci under selection (outliers)

UPPSALA UNIVERSITET

Joint Inference of Demography and Selection

- Demographic inference assumes that effect of selection in genome-wide patterns of diversity can be ignored
- Selection inference focuses on detecting loci under selection (outliers)

UPPSALA UNIVERSITET

Model and approach

forward simulation + approximate Bayesian computation *via* random forest

equilibrium mutation-drift-selection

Haller & Messer (2019) doi:10.1093/molbev/msy228 (Software SLiM)

UPPSALA UNIVERSITET

Model and approach

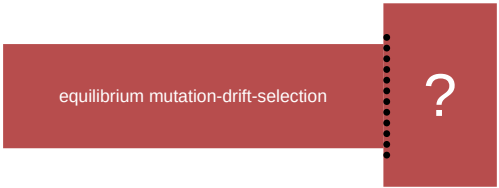
forward simulation + approximate Bayesian computation *via* random forest

Haller & Messer (2019) doi:10.1093/molbev/msy228 (Software SLiM)

UPPSALA UNIVERSITET

Model and approach

forward simulation + approximate Bayesian computation *via* random forest

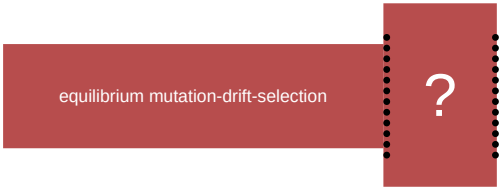


Haller & Messer (2019) doi:10.1093/molbev/msy228 (Software SLiM)

UPPSALA UNIVERSITET

Model and approach

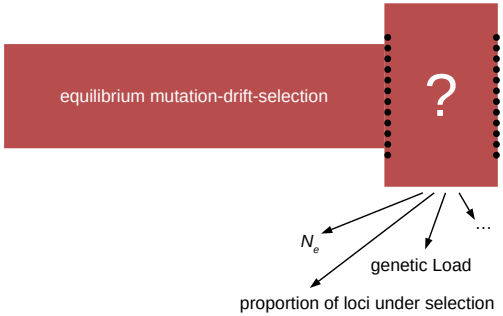
forward simulation + approximate Bayesian computation *via* random forest



Haller & Messer (2019) doi:10.1093/molbev/msy228 (Software SLiM)

Model and approach

forward simulation + approximate Bayesian computation *via* random forest



Haller & Messer (2019) doi:10.1093/molbev/msy228 (Software SLiM)

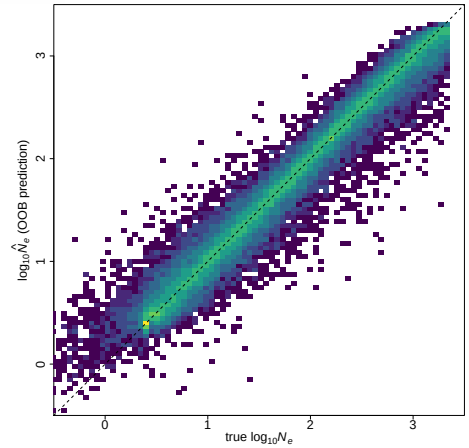
UPPSALA UNIVERSITET

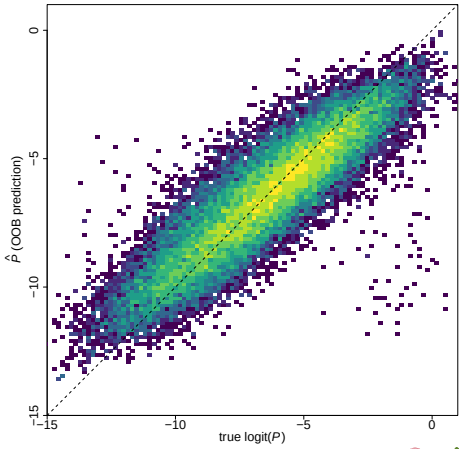
Demography and Selection

Does joint inference work?

UPPSALA UNIVERSITET

Demography and Selection





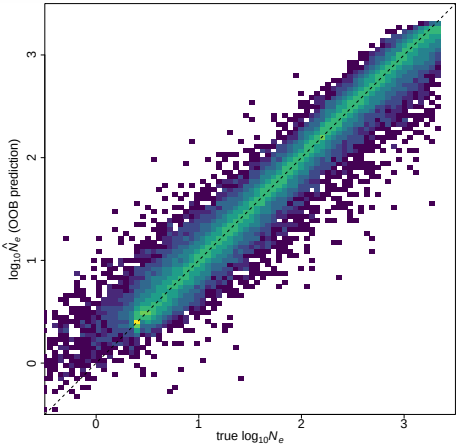
UPPSALA UNIVERSITET

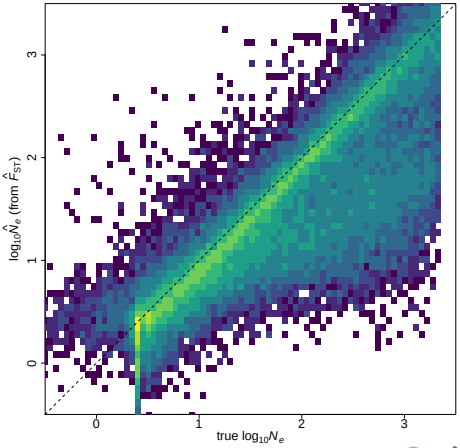
Genetic Drift ("demography")

Does inference of "demography" account for the action of selection?

UPPSALA UNIVERSITET

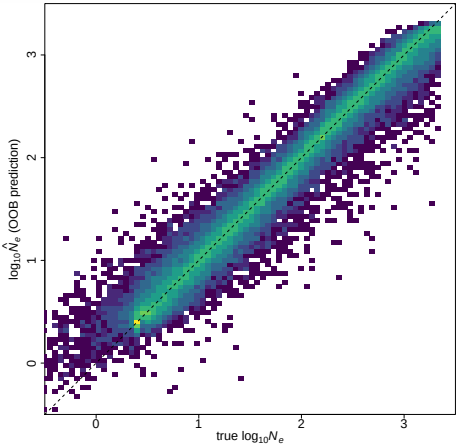
Genetic Drift ("demography")

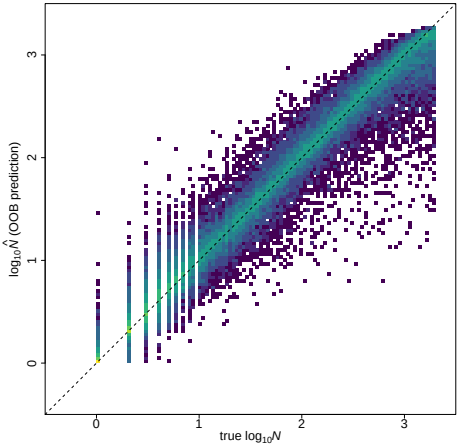




UPPSALA UNIVERSITET

Genetic Drift ("demography")





UPPSALA UNIVERSITET

Is there adaptive diversity? (Genetic Load)

UPPSALA UNIVERSITET

Is there adaptive diversity? (Genetic Load)

- This is **NOT** Mutation Load
- The presence of beneficial mutations creates Substitution Load, it shows that there is adaptive diversity
- $L = 0$: there is not genetic diversity to adapt to environmental pressures
- $L \approx 1$: there is a lot of selection (risk of depletion of diversity?)

UPPSALA UNIVERSITET

Is there adaptive diversity? (Genetic Load)

- This is **NOT** Mutation Load
- The presence of beneficial mutations creates Substitution Load, it shows that there is adaptive diversity
- $L = 0$: there is not genetic diversity to adapt to environmental pressures
- $L \approx 1$: there is a lot of selection (risk of depletion of diversity?)

UPPSALA UNIVERSITET

Is there adaptive diversity? (Genetic Load)

- This is **NOT** Mutation Load
- The presence of beneficial mutations creates Substitution Load, it shows that there is adaptive diversity
- $L = 0$: there is not genetic diversity to adapt to environmental pressures
- $L \approx 1$: there is a lot of selection (risk of depletion of diversity?)

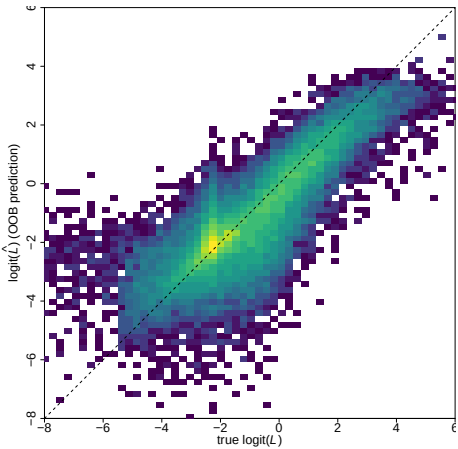
UPPSALA UNIVERSITET

Is there adaptive diversity? (Genetic Load)

- This is **NOT** Mutation Load
- The presence of beneficial mutations creates Substitution Load, it shows that there is adaptive diversity
- $L = 0$: there is not genetic diversity to adapt to environmental pressures
- $L \approx 1$: there is a lot of selection (risk of depletion of diversity?)

UPPSALA UNIVERSITET

Is there adaptive diversity? (Genetic Load)



UPPSALA UNIVERSITET

Is evolutionary rescue likely? ($\theta P_S = 4N_e\mu P_S$)

UPPSALA UNIVERSITET

Is evolutionary rescue likely? ($\theta P_S = 4N_e\mu P_S$)

- $\theta P_S > 1$: every generation new beneficial mutations arrive
- $\theta P_S < 1$: several generation of waiting time for an new beneficial mutation to arrive

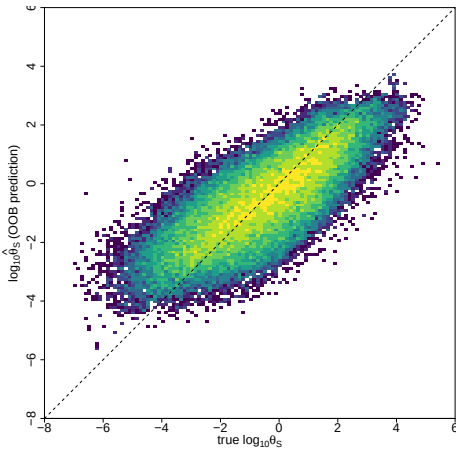
UPPSALA UNIVERSITET

Is evolutionary rescue likely? ($\theta P_S = 4N_e\mu P_S$)

- $\theta P_S > 1$: every generation new beneficial mutations arrive
- $\theta P_S < 1$: several generation of waiting time for an new beneficial mutation to arrive

UPPSALA UNIVERSITET

Is evolutionary rescue likely? ($\theta P_S = 4N_e\mu P_S$)



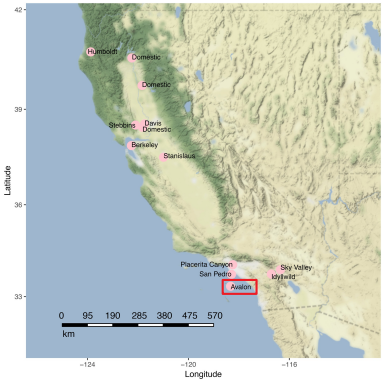
UPPSALA UNIVERSITET

Feral honey bee in California

Photo Andreas Trepte, photo-natur.net, CC-BY-SA

UPPSALA UNIVERSITET

Feral honey bee in California



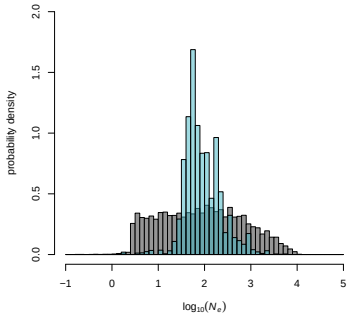
Cridland *et al.* (2018) GBE doi:10.1093/gbe/evy007

- Avalon, Catalina Island (Los Angeles)
- Samples from 1910 (2) & 2014 (5)
- Genome resequencing (236Mbp)
- 1 year = 1 generation

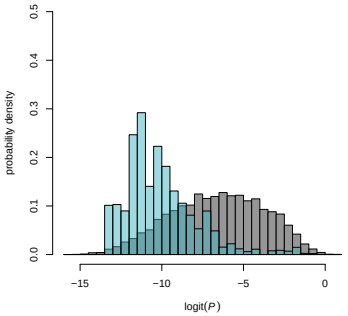
UPPSALA UNIVERSITET

Results bees

$\hat{N}_e = 90$
95%CI(23–887)



$\hat{P} = 4 \times 10^{-5}$
95%CI(10^{-6}–10^{-2})



UPPSALA UNIVERSITET

Conclusions & Perspectives

- Estimation of demography in the presence of pervasive selection
- Estimation of adaptive potential of populations
- Practical limitations: improve computational efficiency
- Model limitations:
  - Background selection
  - Adaptation from standing variation
  - Complex demography (migration/structure)
  - Hard selection

UPPSALA UNIVERSITET

Conclusions & Perspectives

- Estimation of demography in the presence of pervasive selection
- Estimation of adaptive potential of populations
- Practical limitations: improve computational efficiency
- Model limitations:
  - Background selection
  - Adaptation from standing variation
  - Complex demography (migration/structure)
  - Hard selection

UPPSALA UNIVERSITET

Conclusions & Perspectives

- Estimation of demography in the presence of pervasive selection
- Estimation of adaptive potential of populations
- Practical limitations: improve computational efficiency
- Model limitations:
  - Background selection
  - Adaptation from standing variation
  - Complex demography (migration/structure)
  - Hard selection

UPPSALA UNIVERSITET

Conclusions & Perspectives

- Estimation of demography in the presence of pervasive selection
- Estimation of adaptive potential of populations
- Practical limitations: improve computational efficiency
- Model limitations:
  - Background selection
  - Adaptation from standing variation
  - Complex demography (migration/structure)
  - Hard selection

UPPSALA UNIVERSITET

Conclusions & Perspectives

- Estimation of demography in the presence of pervasive selection
- Estimation of adaptive potential of populations
- Practical limitations: improve computational efficiency
- Model limitations:
  - Background selection
  - Adaptation from standing variation
  - Complex demography (migration/structure)
  - Hard selection

UPPSALA UNIVERSITET

Conclusions & Perspectives

- Estimation of demography in the presence of pervasive selection
- Estimation of adaptive potential of populations
- Practical limitations: improve computational efficiency
- Model limitations:
  - Background selection
  - Adaptation from standing variation
  - Complex demography (migration/structure)
  - Hard selection

UPPSALA UNIVERSITET

Conclusions & Perspectives

- Estimation of demography in the presence of pervasive selection
- Estimation of adaptive potential of populations
- Practical limitations: improve computational efficiency
- Model limitations:
  - Background selection
  - Adaptation from standing variation
  - Complex demography (migration/structure)
  - Hard selection

UPPSALA UNIVERSITET

Conclusions & Perspectives

- Estimation of demography in the presence of pervasive selection
- Estimation of adaptive potential of populations
- Practical limitations: improve computational efficiency
- Model limitations:
  - Background selection
  - Adaptation from standing variation
  - Complex demography (migration/structure)
  - Hard selection

UPPSALA UNIVERSITET

Thanks

InterLabex AGRO, CEMEB & NUMEV Postdoctoral Grant 2016

agropolis fondation
Supporting agricultural research for sustainable development

CeMEB

LabEx NUMEV

H2020 Marie Skłodowska-Curie Actions Individual Fellowships 2017