

# It's Okay to Call Genetic Drift a "Force"

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- **The outline**
  - What is genetic drift?
  - What is the force interpretation?
  - *First problem*: The direction of drift
  - *Second problem*: Inertial states and deviations
- **The goal**: Both these problems are solvable – neither defeats the force interpretation of genetic drift.
- **What is genetic drift?**
  - Beatty (1992): Some form of random sampling or sampling error
  - Mendelian segregation, neutral variation, indiscriminate causes, the founder effect (possibly)
  - Figure 1: an example of a population undergoing random segregation (no mutation or selection)
- **The force interpretation**
  - Sober (1984): “Evolutionary biology has also developed a theory of *forces*. This describes the *possible causes* of evolution.”
  - Figure 2: A population situated on an adaptive landscape, undergoing two cancelling evolutionary forces
- **The first problem: Drift has no direction**
  - Matthen and Ariew (2002), Brandon (2006): Drift has no direction specifiable and predictable in advance
  - *Response*: Stephens (2004): Drift does have a direction, namely, *toward homozygosity*
    - Is homozygosity-space sufficiently well defined to support forces? (Filler, 2009)
    - Is this direction really what genetic drift *is about*?
  - *Response*: Filler (2009): Forces must have a mathematically *specific* magnitude and can *unify* a wide array of phenomena
    - But are these too *ad hoc* to suffice?
- **Response: Brownian motion**
  - We already recognize an example of a stochastic force – namely, Brownian motion

- *Possible objection:* Reject both Brownian motion and genetic drift
  - Why? We're not giving up complete predictability, nor are we giving up the ability to model these systems
  - Both Brandon and Matthen and Ariew already countenance stochastic forces
- Unclear what the motivation for rejecting both of these would be
- **The second problem: Inertial states and deviations**
  - Brandon (2006), McShea and Brandon (2010): Drift will be found in *any* evolutionary system. Therefore, drift should be considered part of the inertial state (the “first law”), not a force (the “second law”)
  - *Response:* Is drift more “constitutive” than Newtonian gravitation?
    - We can build test cases where we eliminate gravity, just as we can build test cases in which we eliminate genetic drift.
- **Conclusions**
  - *First problem:* Drift cannot be a force, because forces must have direction specifiable in advance
    - *Response:* We already countenance stochastic forces, such as Brownian motion
  - *Second problem:* Drift is a “first-law” inertial condition, not a “second-law” special force
    - *Response:* Drift is no more “constitutive” of evolutionary systems than gravitation is of Newtonian systems
  - The force metaphor lives to fight another day

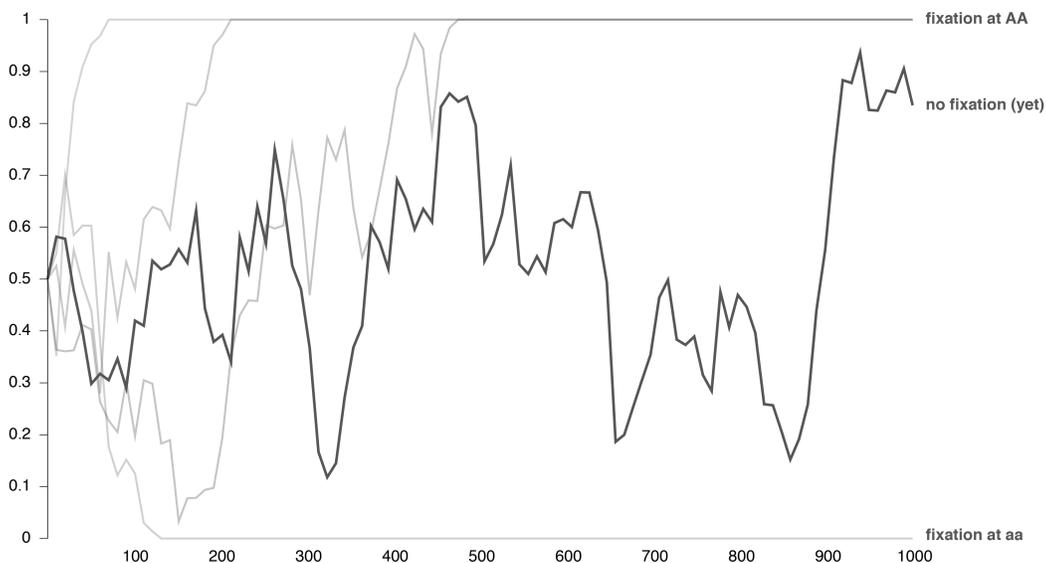


Figure 1: Five simulations of a heterozygous population ( $N = 100$ ) undergoing only genetic drift (no selection or mutation)

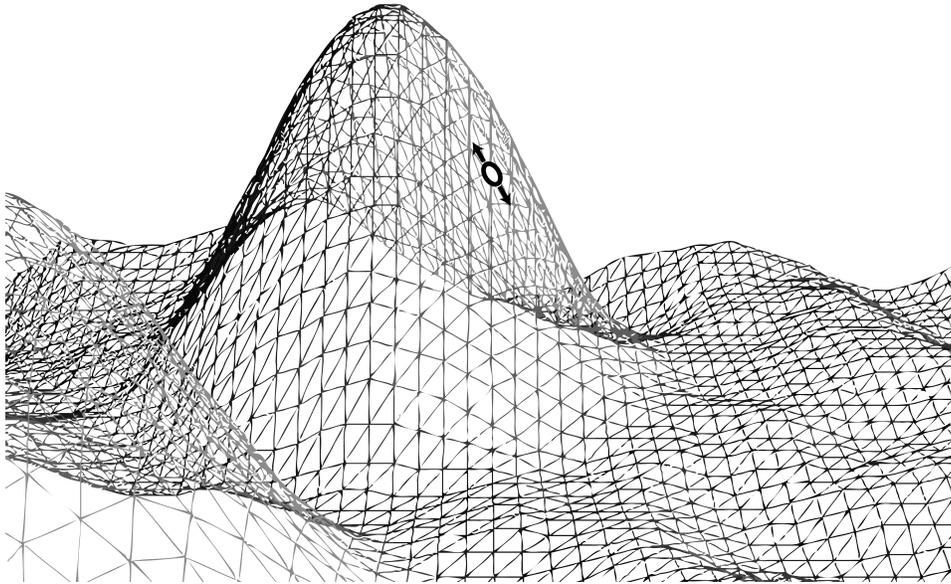


Figure 2: The force metaphor

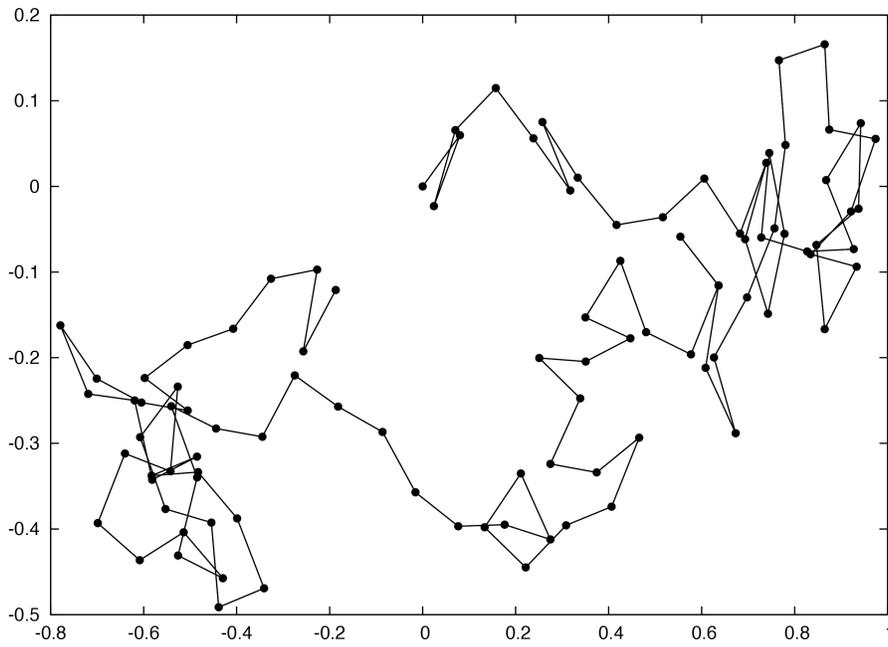


Figure 3: Simulation of a particle released at (0,0), undergoing Brownian motion