Invasion Dynamics on Centrally-Organised Systems

Deception favours slow invasion

Kishore Dutta

Department of Physics, Handique Girls' College, Guwahati, India

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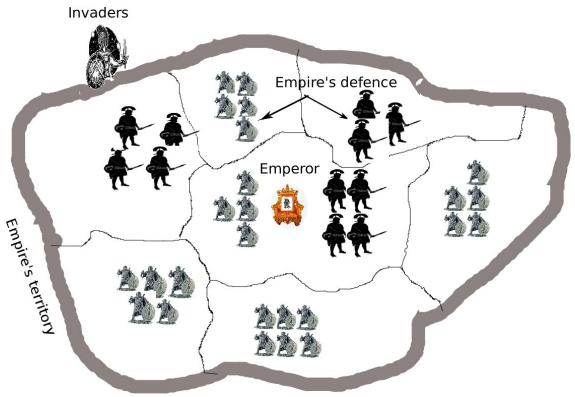
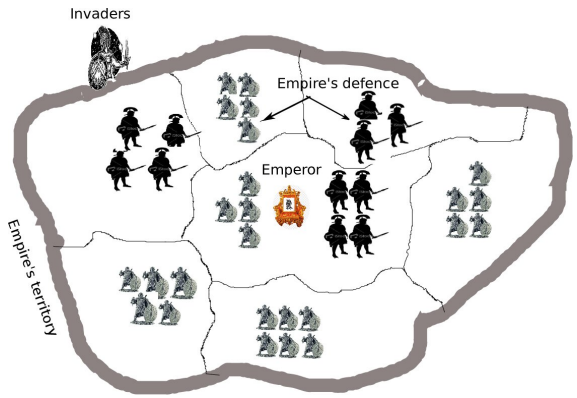
Some antique sociophysics questions



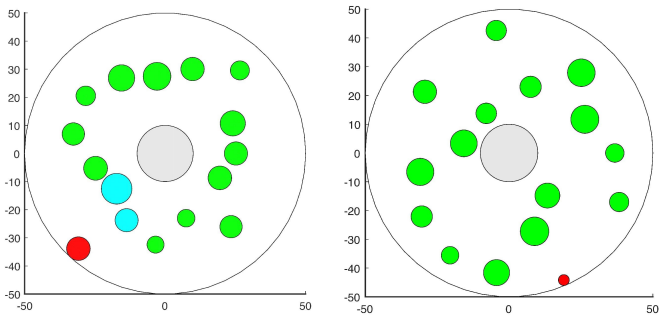
- How did the relatively weak invaders succeed in capturing a massive, centrally-organized system through the art of deceit?
- How can the consequences of deceptive invasion be understood and quantified in terms of the interplay between competition and cooperation?

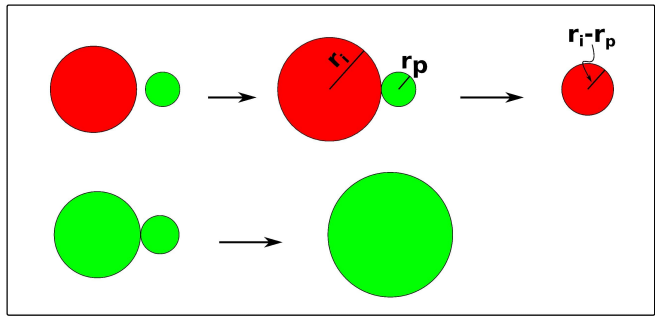
Overview



- **A prototype for deceptive invasion:** based on socio-political rules prescribed by pieces of historical evidence
- **Interplay of sociophysical processes:** expansion, integration, interaction and disintegration during the course of invasion
- **Competition and cooperation:** through internal conflict and warfare with the invaders
- **Optimal defensive structure:** maximal survival probability at minimal defence cost

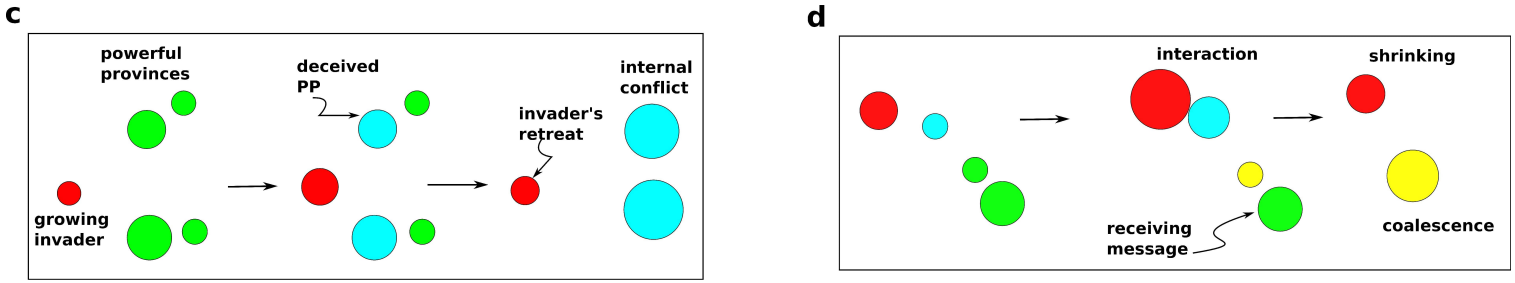
Sociophysical rules I





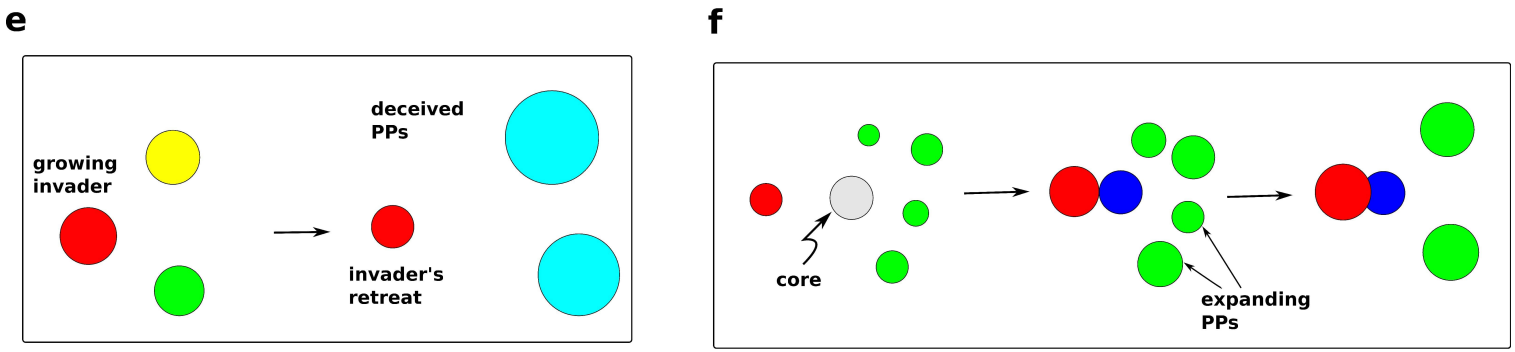
- **Powerful provinces (PPs):** green circular domains; **Central state or the emperor:** grey circular domain; **Troop of invaders:** red circular domain that expands and advances towards the emperor by triggering internal warfare.
- **Vicious war:** The smaller domain (radius, r_p) annihilates and the bigger one (radius, r_i) suffers the casualty and shrink in size by an amount $r_i - \varepsilon r_p$ with fairness parameter $0 \leqslant \varepsilon \leqslant 1$ [*Phys. Rev. E* **54**, 1274 (1996)].
- **Coalescence:** Two interacting PPs coalesce and acquire a new radius $r_a = r_i + r_j$.

Sociophysical rules I



- **Deception:** If $r \leqslant r_d$, PPs (cyan in color) become the victim of invaders' deceit.
  The invaders retreat until the deceived PPs expand, engage in vicious wars among themselves as well as with the neighbouring smaller green PPs and suffer casualties.
- **Active PPs:** As soon as the expanding invaders interact with the surviving deceived PP, the deceived PP sends a message to its nearest PPs (yellow in color). The yellow PP expands and coalesces with its nearest green PPs for coordinated defensive maneuver.

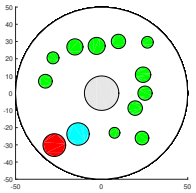
Sociophysical rules I

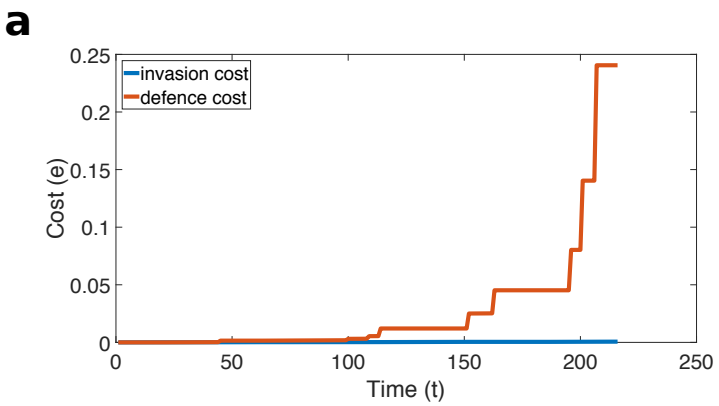


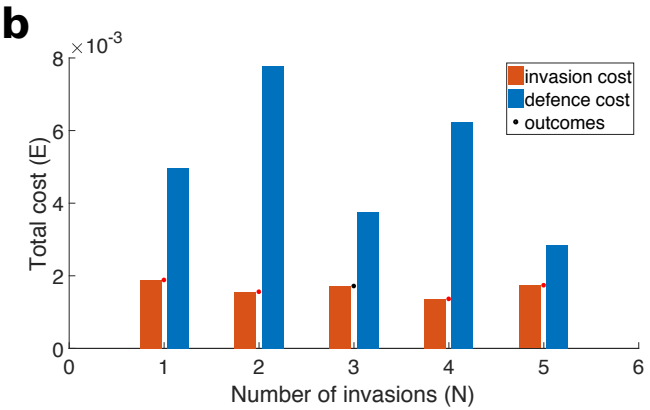
- **Strong deceit:** If deception is strong enough, the PP who receive the message can also be the victim of invaders deceit.
- **Coordinated manoeuvre:** As soon as the invaders attack the core (grey in color) of the empire, the emperor (turns blue in color) puts its remaining PPs on high alert to strengthen their coordination through coalescence.

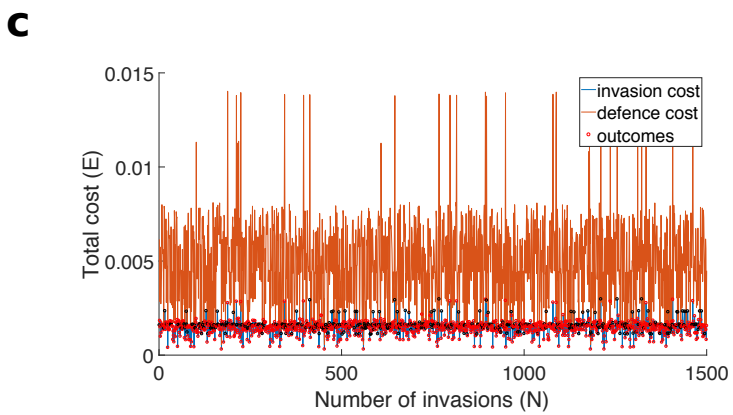
Visualisation & Results

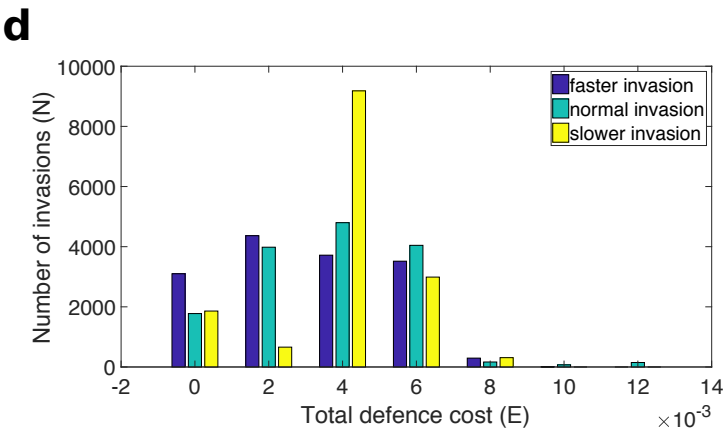
Click the figure on the right for visualisation



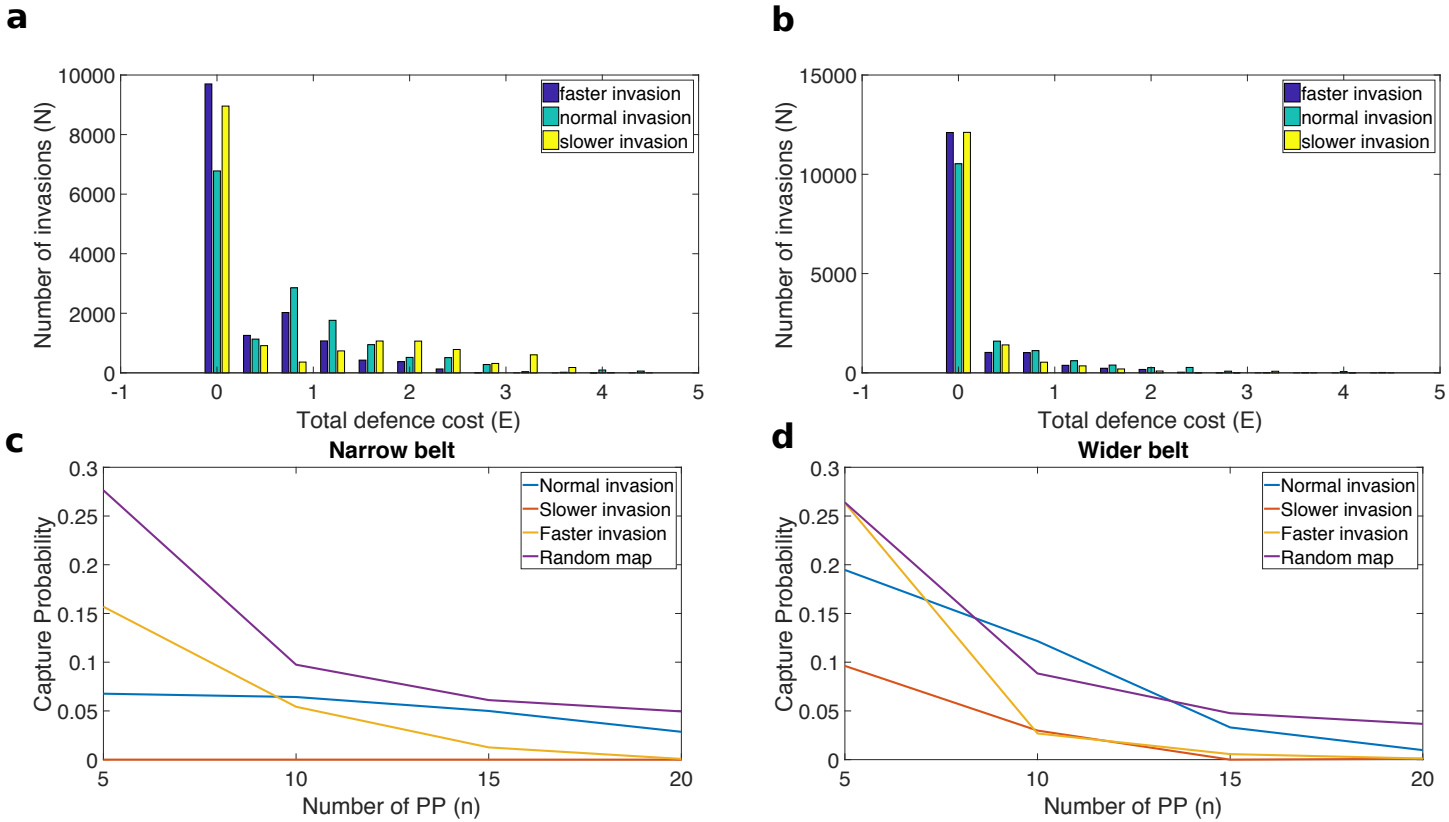








Results I

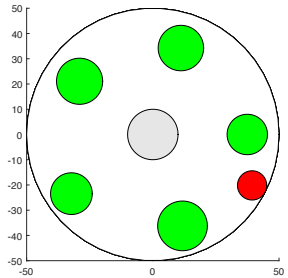


- **Narrow distribution of PPs:** Even a relatively weak empire with lesser PPs remains impregnable for slower invaders.

Results II

- **Wider distribution of PPs:** A small empire remains vulnerable even for slower invaders.

a



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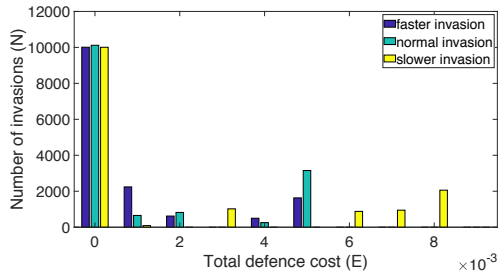

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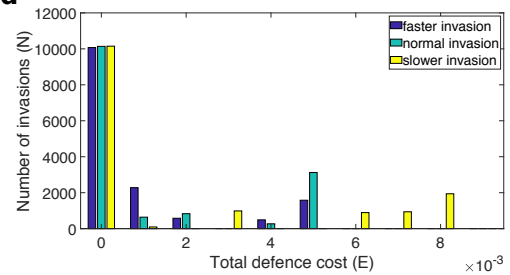

e

n	Invasion rates	P_c for idle PPs	P_c^a for strong deceit	P_c^a for weak deceit
5	normal	0.2274	0.2288	0.0068
5	slower	0.1909	0.1910	0
5	faster	0.0390	0.0386	0
10	normal	0.1062	0.1095	0.0216
10	slower	0.0033	0.0072	0.0004
10	faster	0.0140	0.0147	0

- **Optimal defense structure:** In most of the events ($N \approx 10000$), the empire appears as more resistible in destroying the invaders of any strength and does not allow to initiate the plan of deceit (zero defence costs).

Physical Interpretations: I

- Reducing the cost for the deceiver implies increasing the cost for the deceived, as envisaged in [*J. Strateg. Studies* **5**, 122 (1982)].
- A small empire can survive for a longer period if it fosters the art of deciphering any devious ploys instead of decentralizing the military power [Sun Tzu, *The Art of War*, OUP (1973)].
- Invaders' deception almost fails in empires with increasing number of widely distributed PPs. Such a huge empire must incur a very high defense expenditure in maintaining PPs [Daniel & Herbig, *Strategic Military Deception*, Pergamon, Oxford (1982)].
- Competition between the economy and the survivability demands an optimal defensive structure who can maintain a balance between these two important aspects for resilience.
- The intuitive picture of the "survival of the fastest" fails in such a competing dynamics, as observed in other cooperatively growing populations [*Phys. Rev. Lett.* **115**, 208104 (2015)].

Appreciation

Thanks for listening