Agent-based model algorithm.

We first present the general algorithm for stochastic process of scientific discovery with replicator in the agent-based model and then discuss specific values used in the article.

1: Input: $\mathcal{M}, \Theta, S, R, \mathbb{P}(R_a), \mathbb{P}(M|R_a, M_G^{(t)}), M_G^{(0)}, M_T, \theta_T, n, t_{\text{max}}$

2: Set $t = 0$

3: while $t < t_{\text{max}}$ do

4: Simulate $R_a \sim \text{Categorical}(p_1, p_2, \cdots, p_A)$

5: Simulate $M_P^{(t)} \sim \mathbb{P}(M|R_a, M_G^{(t)})$

6: Simulate $D_i^{(t)} \sim M_T(\theta_T)$, for $i = 1, 2, \cdots, n$ independently of each other

7: Calculate

$$S(M_P^{(t)}) - S(M_G^{(t)}) = C + \sum_{i=1}^{n} \log \mathbb{P}(D_i^{(t)}|\hat{\theta}, M_P^{(t)}) - \sum_{i=1}^{n} \log \mathbb{P}(D_i^{(t)}|\hat{\theta}, M_G^{(t)})$$

where, $C = 2p \log(n)$ if SC, or $C = 2p$ if AIC, and $\hat{\theta}$ is the maximum likelihood estimate of $\theta$

8: if $S(M_P^{(t)}) < S(M_G^{(t)})$, then

9: Set $M_G^{(t+1)} = M_P^{(t)}$

10: else

11: Set $M_G^{(t+1)} = M_G^{(t)}$

12: end if

13: Set $t = t + 1$

14: end while

We choose $M_G^{(0)}$ randomly with equal probability from models in $\mathcal{M}$. $\Theta$ determines $\theta_{\text{min}}, \theta_{\text{max}}$ and $\theta_T$ is chosen uniformly randomly on this interval. The parameters of the categorical distribution used in step 4 is determined by the proportion of scientists in the population.