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A Model of Human Mate Choice With Courtship that Predicts Population Patterns — *A Computational Evolutionary Psychology Approach*

Jorge Simão[1,2*] and Peter M. Todd[2]

[1] CENTRIA — Computer Science Department,

FCT — New University of Lisbon,

2825 – 114 Monte da Caparica, Portugal

jsimao@di.fct.unl.pt

Phone: +49 (30) 824 06 - 214

Fax: +49 (30) 824 06 - 394

[2] Center for Adaptive Behavior and Cognition,

Max Planck Institute for Human Development,

Lentzeallee 94 – 14195, Berlin, Germany

ptodd@mpib-berlin.mpg.de

Phone: +49 (30) 824 06 - 347

Fax: +49 (30) 824 06 - 394

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Introduction

Human mate choice, when you're immersed in it, seems like a long and complicated affair. Vast amounts of time and energy are spent thinking about who to attract, how to attract them, and how to keep them attracted once a relationship is underway. Yet, attempts to understand the processes of mate choice through formal models typically throw away most of its complexity, reducing everything to a simple sequence of decisions about whom to mate with. How realistic can such models be if the heart of the romantic process — courtship — has been removed?

Typical assumptions of models of mutual mate choice are that individuals search and encounter mates sequentially and that they make their mating decision in a single, *irreversible* act [6, 11, 8, 7, 5]. This conflicts with the fact that humans use extensive courtship periods to establish long-term sexual/romantic relationships, allowing individuals to engage in relationships in a tentative way — possibly switching to better alternatives if they become available in the future [3]. Many of these models also make the unrealistic assumption that complete and accurate information about partners and qualities is available to all individuals [2, 8, 7, 5]. Given that such information is often not available in the real world, it is not surprising that most of these models are of limited empirical validity.

We present an agent-based model of human mate choice based on evolutionary functional analysis. We assume that individuals build networks of acquaintances gradually, and we consider the strategic impact of courtship on mate choice decisions. We argue that individuals can make simple and efficient mating decisions by exploiting the specifics of the adaptive problem domain rather than attempting to perform complex optimizations, thus constituting an example of *ecological rationality* [10].

Computational Evolutionary Psychology — A New Approach

We introduce the *Computational Evolutionary Psychology* approach to the study of human social behavior and underlying psychological mechanisms — a marriage between evolutionary psychology, agent-based modeling, and bounded rationality [1, 9, 4]. This approach starts by identifying one or a set of related recurrent adaptive problems faced by ancestral humans, and then through a process of functional analysis and task-decomposition attempts to engineer possible domain-specific cognitive mechanisms that are able to solve these problems. Agent-based models are used to abstract the physical and social environment of the problem domain, and to experiment with different strategic decision rules and mechanisms that respect plausible psychological and informational constraints. This process can be iterated by continuous redesign of the decision-making mechanisms and redefinition of the hypothesized adaptive problem, until a suitable match with empirical data is obtained both at the individual level and at the population level. Methodologically speaking, we postulate and evaluate different hypotheses in the form of synthetic cognitive mechanisms as a tentative step to reverse-engineering the functional structure of the real mechanisms underlying the human mind. Espistemically, this provides the necessary scaffolding to build formal and unified theories of human social behaviour and cognition, breaking way from the fragmented landscape delivered by traditional approaches used in the social sciences. Here we present first steps using this approach applied to the study of human mate choice.

A Model Built Around Courtship (1)

To model the mate search process, we begin with a population of constant size $2*P$ with a fixed sex ratio of 50% (so P is the number of males or females). Individuals of both sexes have a one dimensional quality q, randomly generated from a normal distribution with mean μ and variance σ^2 ($0 < Q_{min} \leq q \leq Q_{max}$). When two individuals mate, they are removed from the population and replaced by two new individuals of random quality (one of each sex). Time is modeled as a sequence of discrete steps. Pairs of males and females meet at a certain stochastic rate: in each time step each individual has a probability Y of meeting a new individual of the opposite sex. Each individual maintains a list of the potential mates already met (the *alternatives list*).

Within the alternatives list, one member can have the "special status" of being the individual's current *date*. This happens when both individuals previously agreed to date and have not changed partners in the mean time (see below). It is also possible for an individual not to be dating anybody (i.e., in the beginning of its "life", or when it gets "dumped"). The length of time that two individuals are dating is regarded as the courtship or dating time c_t. If a pair of individuals remain dating for a period of K time steps (i.e., when $c_t > K$), they are deemed to mate and are removed from the population (and replaced). Every individual has a maximum lifetime of $L(> K)$ time steps. If individuals are unable to mate during that period they are removed from the population (they "die"). To replace the dead individual, a new one is created with the same sex.

A Model Built Around Courtship (2)

In each time step, individuals decide whether to continue to date the same partner or to try to date another individual that they know, that is, someone from their list of alternatives. To make this decision, several pieces of information are used: the quality of each alternative q_a (all alternatives are considered independently), the quality of the current date q_d, the current courtship time c_t, the age of the individual t, the age of each alternative t_a, and the age of the date t_d. If an individual is not dating someone else, q_d and c_t are set to 0. A binary output function S with these input variables is used to make courtship decisions, returning 1 iff a dating proposal is to be made.

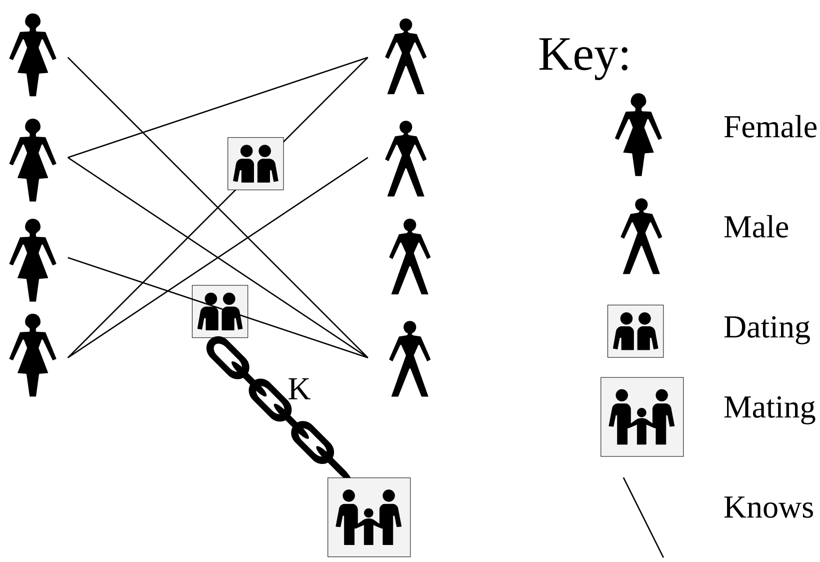

Figure 1: Model representation: Social networks and relationships.

Fitness and Strategic Decision Making

We assign mated individuals a fitness value, as follows:

$$F(q_d, t) = q_d^{Q_S} * (L - t)$$

In the above, q_d is the quality of the individual's partner, Q_S is a scaling factor that relates quality values to effective mating potential, and t is the individual's age at mating. Thus we reward a preference for high quality, and introduce a time pressure to motivate individuals to mate early (in addition to the limited life-time).

Given the above fitness function, agents can use the following reasonable (although not optimal) strategic decision rule for deciding whether to try to switch from the current date of quality q_d to another alternative of quality q_a (with this switch only happening if the alternative individual decides to switch from their current date as well):

$$\mathbf{S}(q_a, q_d, c_t, t, t_a, t_d) = \begin{cases} 1 & \textbf{if} \quad q_d = 0 \\ 0 & \textbf{if} \quad t + K > L \\ 0 & \textbf{if} \quad t_a + K > L \\ 1 & \textbf{if} \quad F(q_a, t + K) > F(q_d, t + K - c_t) \\ 0 & \textbf{otherwise} \end{cases}$$

Here, in the first condition, if the individual is not dating, he/she should begin dating; in the second and third, if there is not enough time left to carry out a full courtship period, then do not switch; fourth, if the expected fitness of mating with the alternative (calculated using the total required courtship time K) is greater than the expected fitness of mating with the current date (calculated using the remaining courtship time $K - c_t$), then switch; fifth, otherwise stay with the current date.

Simulation results (1)

We evaluated the performance of this model by seeing if it could produce realistic mating patterns matching those observed in human populations. Specifically, we looked for high rates of *assortative mating* (i.e., roughly equally attractive individuals mating with each other, as reflected by within-pair attractiveness correlations of around 0.6 in many human studies [6]), achieved with relatively little search, and with vast majority of individuals in the population being able to mate. We set the model parameters as show in table 1, and varied two of the parameters likely to have a wide range of values dependent on the specifics of different human population ecologies: the meeting rate Y and courtship time K. Each simulation run consisted of $10*L = 2000$ steps and the results shown correspond to averages across 5 runs.

Parameter	Description	Value(s)
P	population size/2	50
L	reproductive lifetime	200
μ, σ^2	quality distribution	$10, 4$
Q_{min}, Q_{max}	lower,upper bound	$0.01, 20$

Table 1: Parameter settings.

Figure 2 depicts the linear correlation between the qualities of individuals in mated pairs. Figure 3 shows the mean number of alternatives met before settling with the last date. And figure 4 show percentage of individuals in the population that are able to mate (all as a function of Y and K).

Simulation results (2)

The reasonably high correlation coefficients observed (mostly between .5 and .6) suggest that individuals are making good use of their mating potential even though they have no direct knowledge of their own mate value or the distribution of qualities in the population. This is also achieved by most individuals with rather little search: for example, with $K = 15$ and $Y = .2$, we obtained a correlation of qualities of .53, and observed that 87% of the individuals in the population were able to mate, even though they only met a small number of alternatives (6.9 before settling with the last date and 10.0 before mating), and only entered into 2.0 dates on average (including the very last one). This realistic combination of statistics was never obtained in previous models of human mate choice [6, 11].

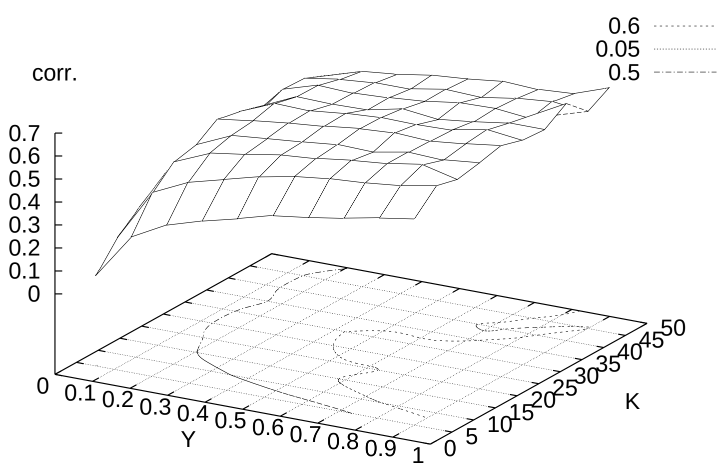

Figure 2: Mean correlation of qualities in mated pairs.

Simulation results (3)

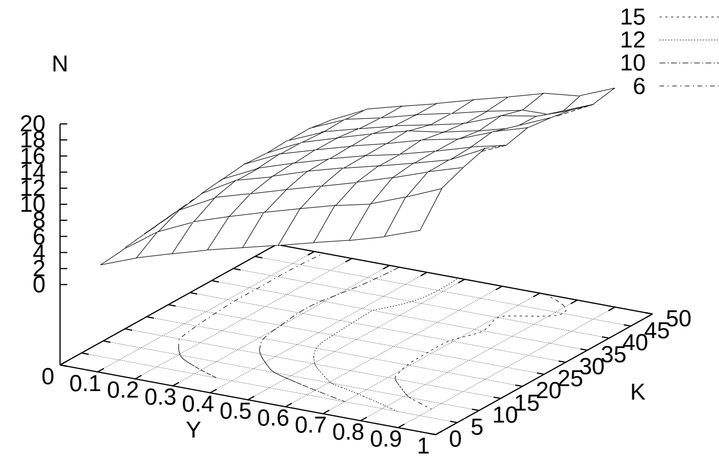

Figure 3: Mean number of alternatives seen before settling with the last date.

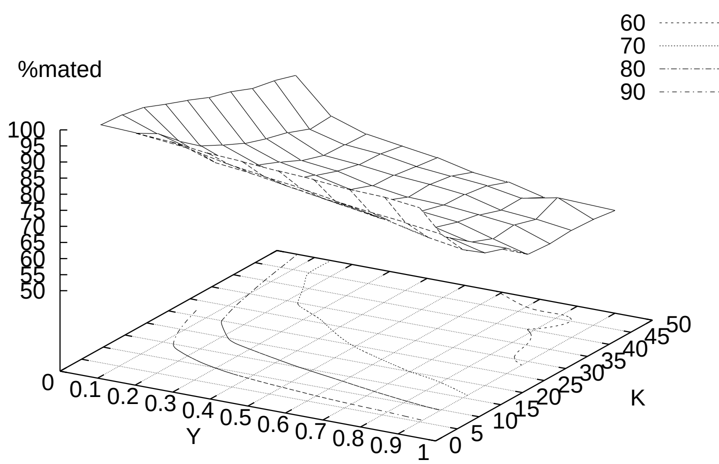

Figure 4: Percentage of individuals in the population that are able to mate.

Conclusions

We have briefly demonstrated how an agent-based model based on an evolutionary functional analysis can be used to gain insights into the processes underlying human sexual/romantic relationships. In particular, by building extended courtship processes into our model of the mating game, we have accounted for existing data in ways unattained by earlier models. We hope that our work will motivate researchers in the fields of artificial life and evolutionary psychology to begin courting each other to build explicit computational models of the mechanisms guiding human social behavior.

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