UNFOLDING THE DYNAMICS OF CREATIVITY AND INNOVATION

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Perfect Information vs Random Investigation in the Jungle of Product Differentiation

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RESEARCH ARTICLE

Perfect Information vs Random Investigation: Safety Guidelines for a Consumer in the Jungle of Product Differentiation

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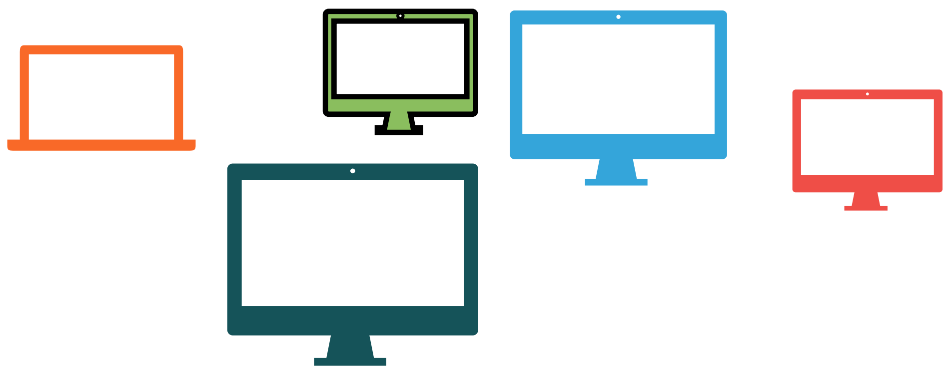
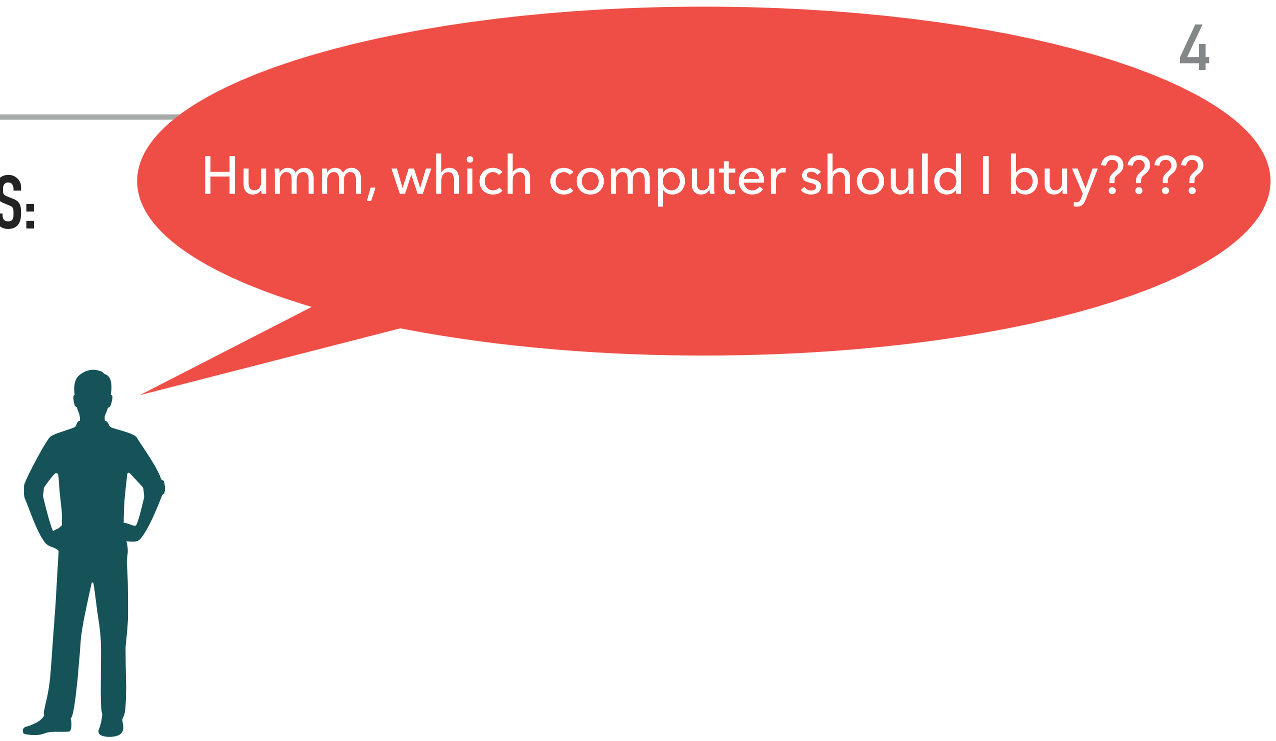
THE PROBLEM

WE STUDIED A CONSUMER'S INDIVIDUAL CHOICE PROCESS:





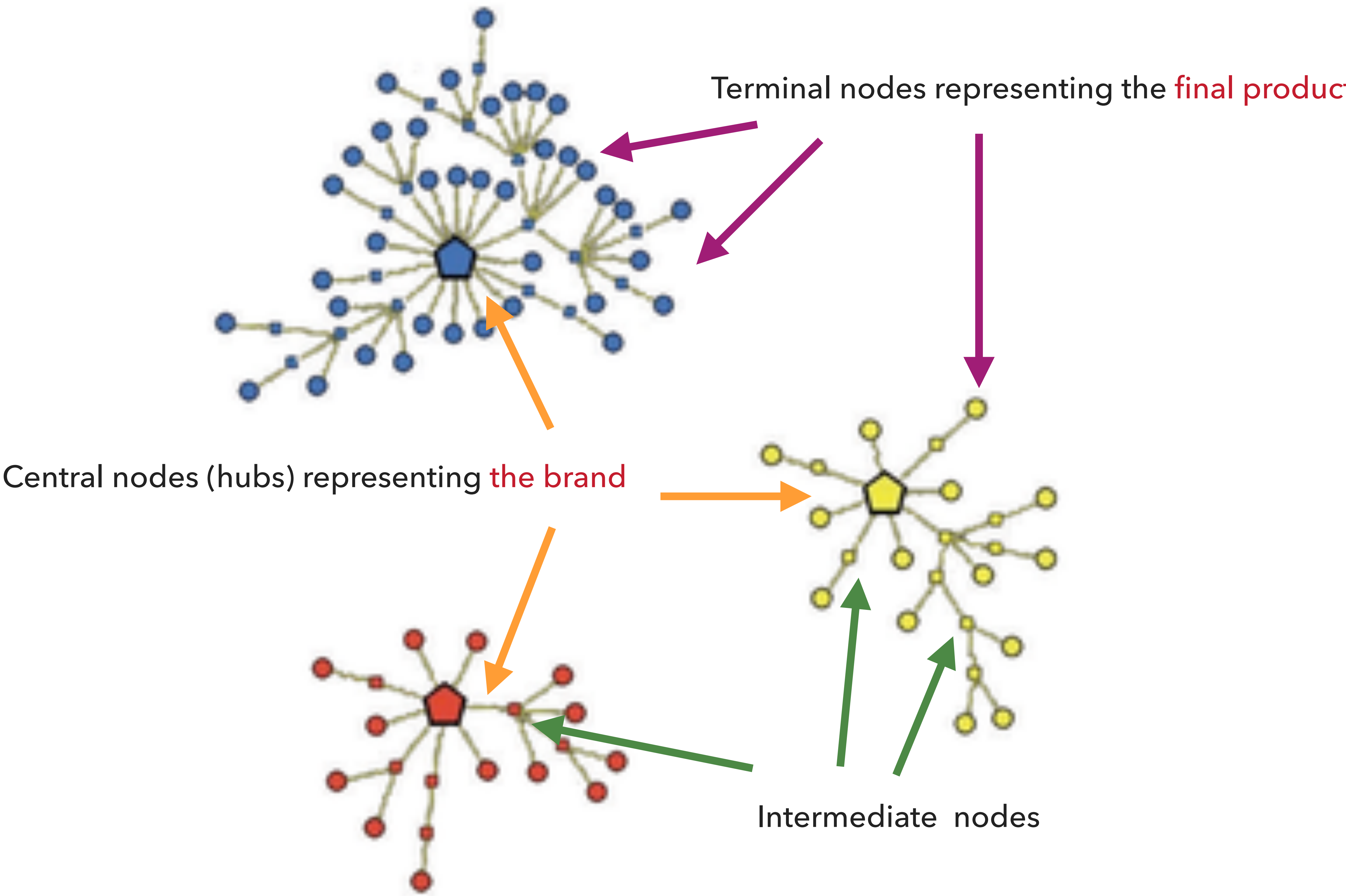
WE ANALYZED THE WAY IN WHICH A CONSUMER SELECTS A FINAL PRODUCT AMONG SEVERAL VERSIONS OF IT SUPPLIED BY DIFFERENT BRANDS AND HOW SHE MOVES IN THE MARKET TO OPTIMISE HER CHOICE.

THE DYNAMICS WE STUDIED IS SIMILAR TO THAT ONE OF A COMPANY SEARCHING FOR INNOVATIVE ABSTRACT RESEARCH STUDIES OR NEW PATENTS IN WHICH INVEST MONEY TO MAKE AN INNOVATIVE PRODUCT AND PROFIT.

THE SAME APPROACH COULD BE USED TO MODEL ALSO THE IMPORTANT PROCESS OF HOW TO TRANSFER NEW RESEARCH RESULTS OR IDEAS INTO THE INDUSTRY WORLD AND THEN TO FINAL CONSUMER PRODUCTS

THE MARKET

GRAPH REPRESENTATION OF A MARKET WITH THREE CLUSTERS



Example

A consumer decides to buy a final product represented by the 6-ntuple

< Apple; Macbook Air; 13”; i7   2: 2GHz; 8GB SDRAM; 512 GB >

Here the central node is the brand <Apple> , the terminal node is a laptop with some specified features, and the intermediate nodes are all restrictions of the 6-ntuple to the first i components.

Thus, each product can be identified with an n-tuple of features specified by the sequence of n–1 informative steps needed to reach it, starting from the central node (which represents its first feature).

The target could be also a vague ideal product not existing in the real market

Each market is viewed by a consumer through her peculiar perspective characterised by her parameters

Starting from a random point of this deformed market space, the consumer should try to reach her target, acquiring information, according to the parameters which characterise the consumer herself.

The target is a positioned somewhere in the market and it could also not coincide with an existing product.

THE CONSUMER

EACH CONSUMER/AGENT IS CHARACTERISED BY 3 PARAMETERS

Awareness (A_w): This is the capability of the consumer to discern the features of a product without being subject to the influence of the market: the higher her awareness, the less likely that she makes her choice according to the market's attraction field

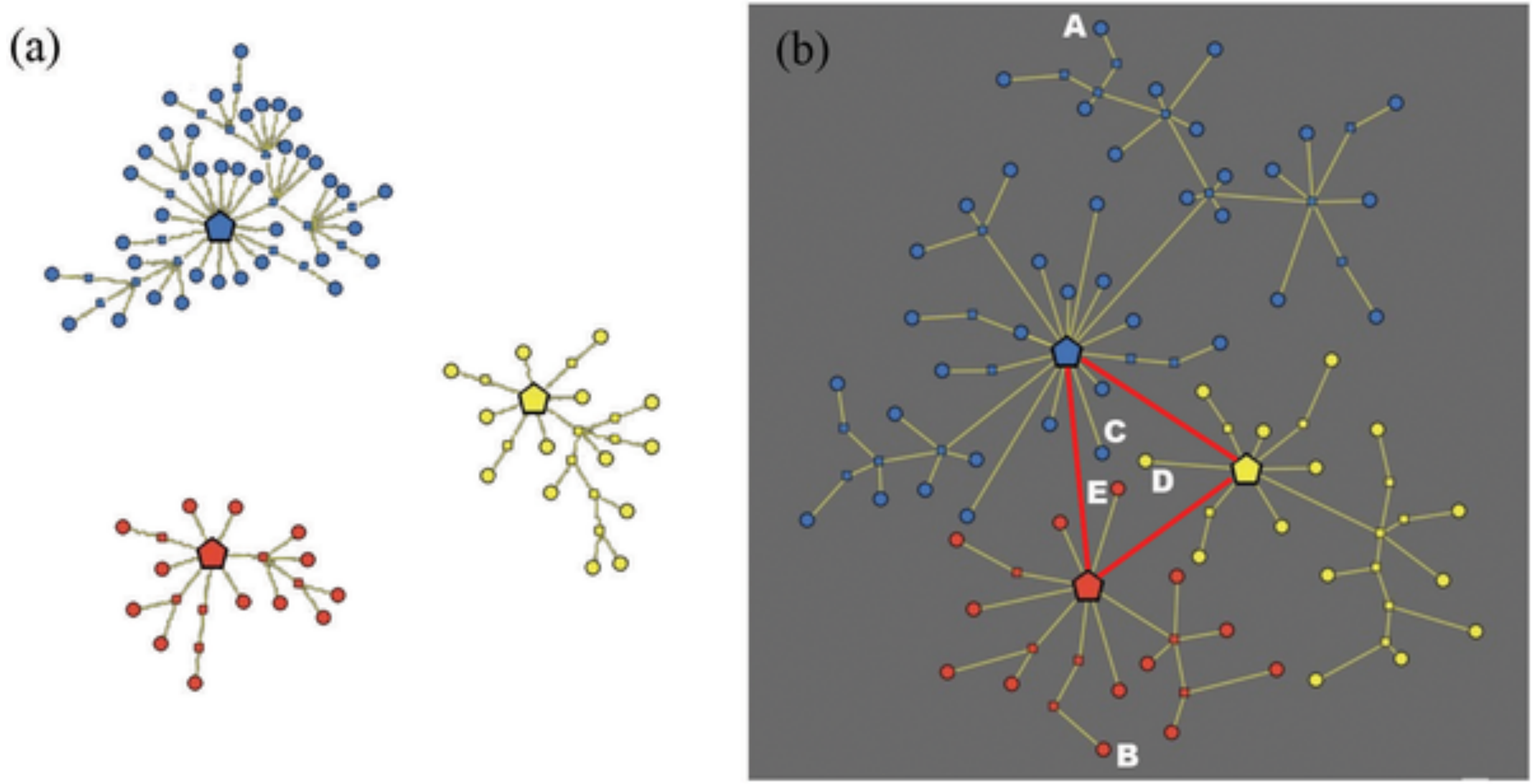
Knowledge (K_n): This parameter measures the perception of the existence of clusters (brands). Those clusters that are known to the consumer are labeled as active

Discrimination ability (N_{lev}): This is the ability to discriminate among different products. The space is endowed with a satisfaction metric and is partitioned into N_{Lev} equivalence classes, called *indifference levels* and represented by concentric annuli centered at the target

All the nodes in an annulus are ex-ante equally preferred by the consumer, i.e., they display the same presumed utility

Starting from a random initial point the agent starts moving in the market according to these parameters trying to reach her target

GRAPH REPRESENTATION OF A MARKET WITH THREE CLUSTERS



the red edges represent the knowledge of the agent which has in this case a perfect information and knows that the hubs are connected

THE CONSUMER SATISFACTION

EACH CONSUMER/AGENT SHOULD TRY TO REACH HER IDEAL TARGET : AT THE END WE CALCULATE HER FINAL SATISFACTION DEFINED AS

$$\text{Sat}(P) := 1 - \frac{d(P, P^*)}{d_{\max}}$$

$$d(P,P^*) = ((x_P - x_{P^*})^2 + (y_P - y_{P^*})^2)^{1/2}$$

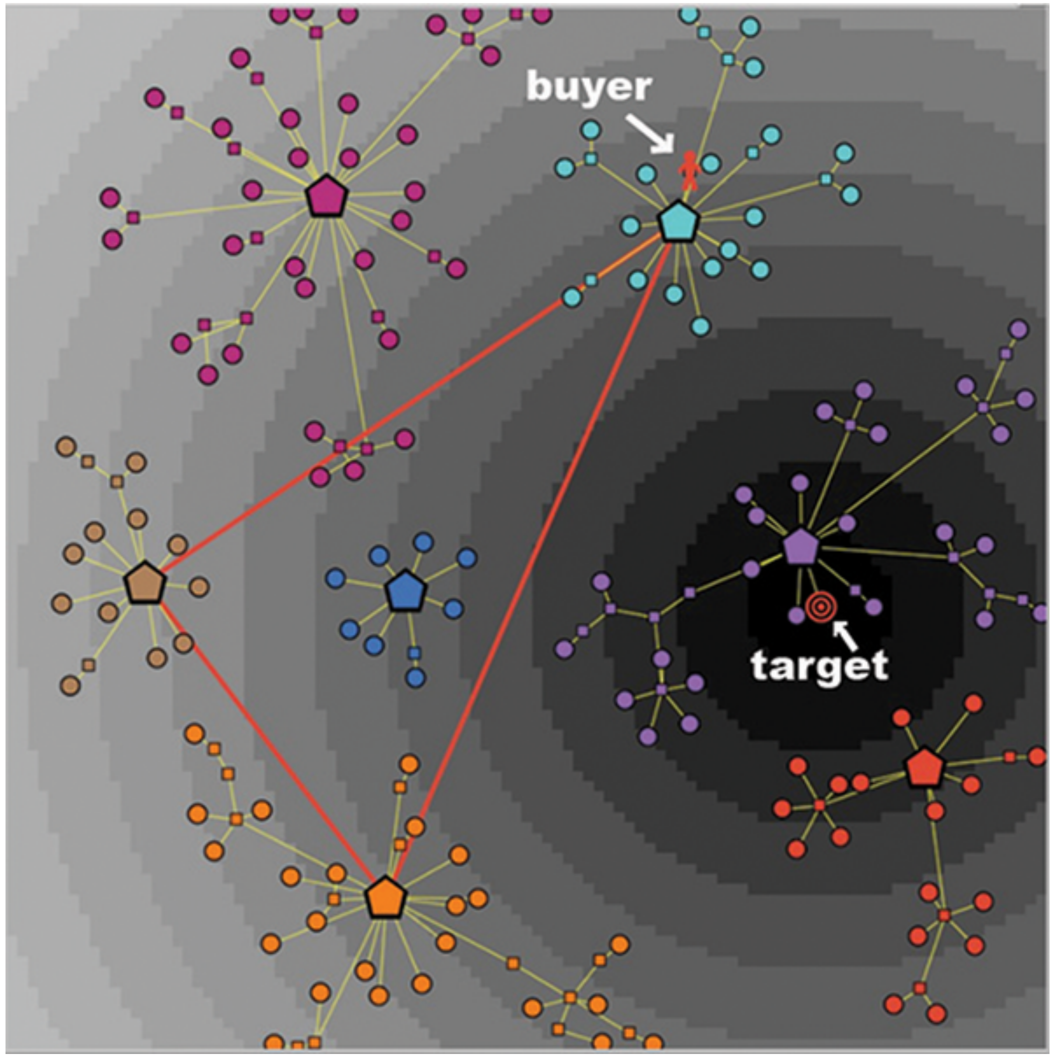
$$0 \leq \text{Sat}(P) < 1$$

where P^* is the position of the target

and $d_{\max}$ is the maximal possible distance

THE MARKET

A MARKET WITH 7 CLUSTERS, AS VIEWED BY A CONSUMER WITH MODERATE KNOWLEDGE AND HIGH DISCRIMINATION POWER



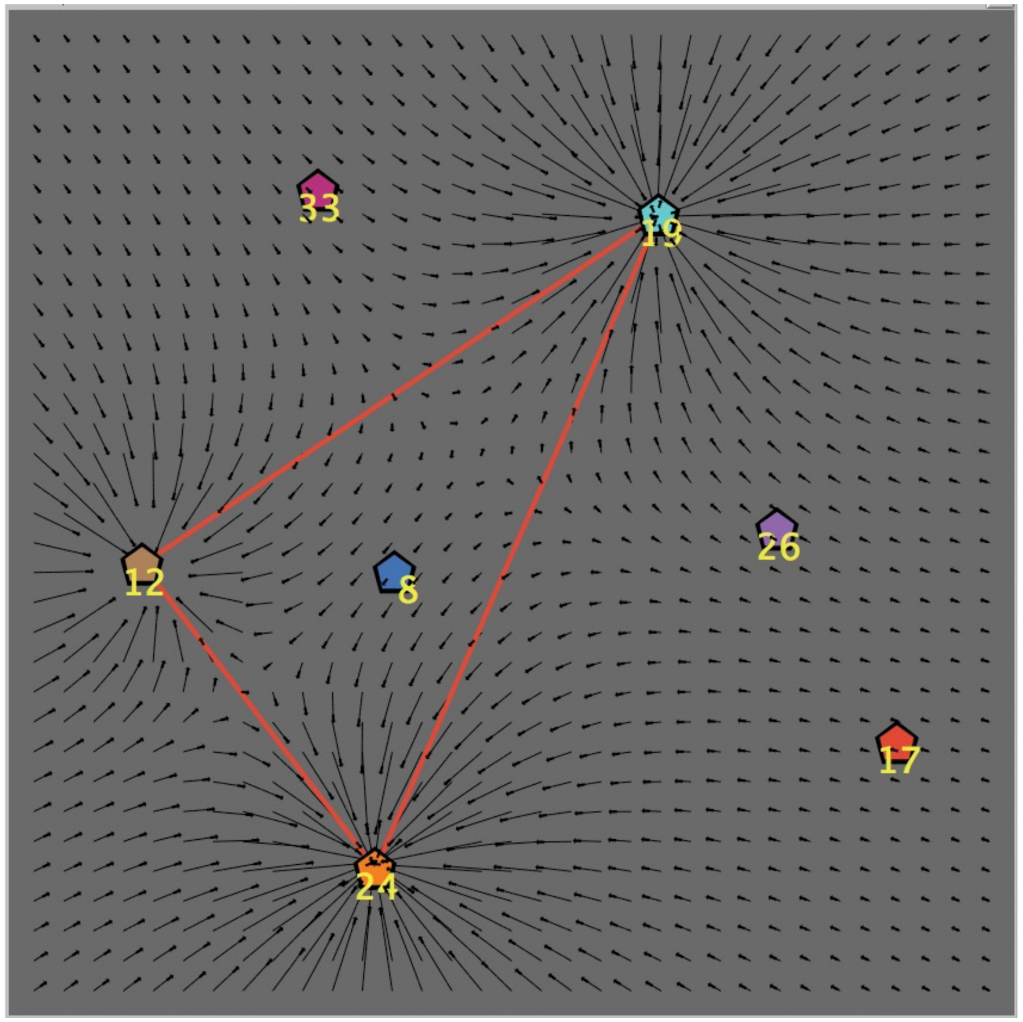
The consumer has a partial knowledge (Kn = 0.5) and a quite high number of indifference levels (N_{Lev} = 14), represented by annuli with different shades of gray.

The indifference areas are centered at the target, (located in this example on a node and denoted by concentric red circles).

THE MARKET-CONSUMER INTERACTION

HUBS HAVE AN ATTRACTION FIELD

The attraction field induced by three active hubs.



The label next to each hub represent its mass, which is equal to the number of products (leaves) of the corresponding cluster.

All intermediate and terminal nodes are not represented.

10 TYPES OF CONSUMERS CONSIDERED

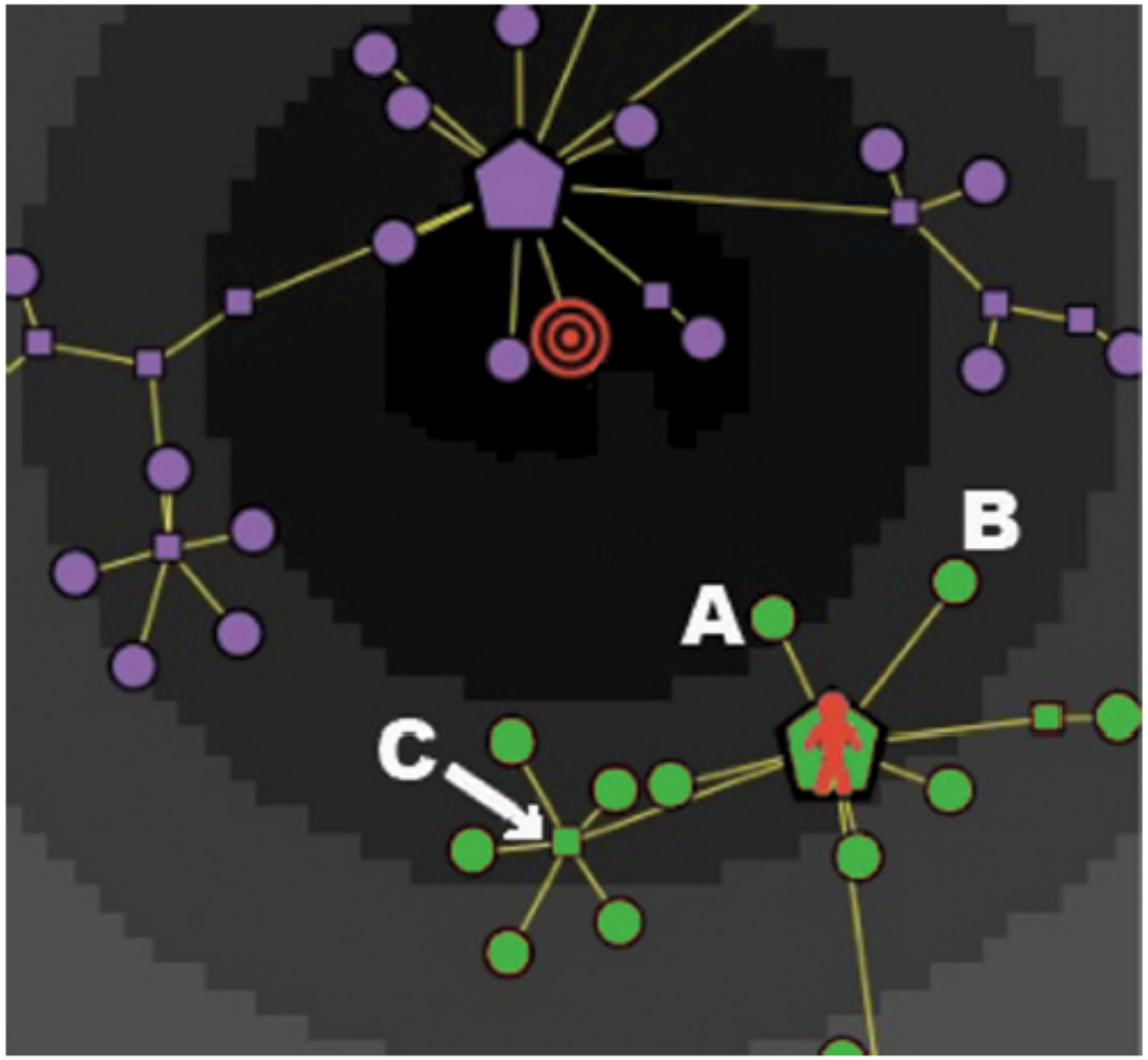
Table 1. Ten types of consumers characterized by different values of individual parameters. Only rather extreme values of knowledge (Kn), awareness (Aw) and discrimination ability (N_{Lev}) are used. The special type of random consumer also appears.

Consumer	Kn	Aw	N_{Lev}
#1	0.5	0	4
#2	0.5	0	20
#3	0.5	1	4
#4	0.5	1	20
#5	0.5	*random*	–
#6	1	0	4
#7	1	0	20
#8	1	1	4
#9	1	1	20
#10	1	*random*	–

DYNAMICS OF THE MODEL

With probability $p = A_w$, **the consumer chooses one the first neighbors with highest degree among those with highest utility.**

The consumer moves according to a criterion of highest possible utility, and, in cases of ex-equo, she makes her choice according to the highest degree.



With probability $p = 1 - A_w$, the consumer select a first neighbor on the basis of the attraction field, without any consideration for the target. In this case, the selection depends on the position j of the consumer at time t, according to the following two subcases:

a) if at time t the consumer is on a central node (position A in the figure), then at time $t+1$ she will move to one of her k_j first neighbors with a probability proportional to the mass of each node;

b) if at time t the consumer is on an intermediate or a terminal node (position B in the figure), then at time $t+1$ she will move at random to one of her k_j first neighbors;

DYNAMICS OF THE MODEL

END OF THE JOURNEY

We put a constraint on the number of times that a consumer can visit a given node of her active subgraph:
this upper bound is reasonably set as equal to the degree of the node itself.

This limitation is in accordance to the (realistic) assumption that a **consumer should not travel along the same path more than once.** Therefore, after k visits, a node with degree k will be " switched-off" , and it will be no longer possible to cross it.

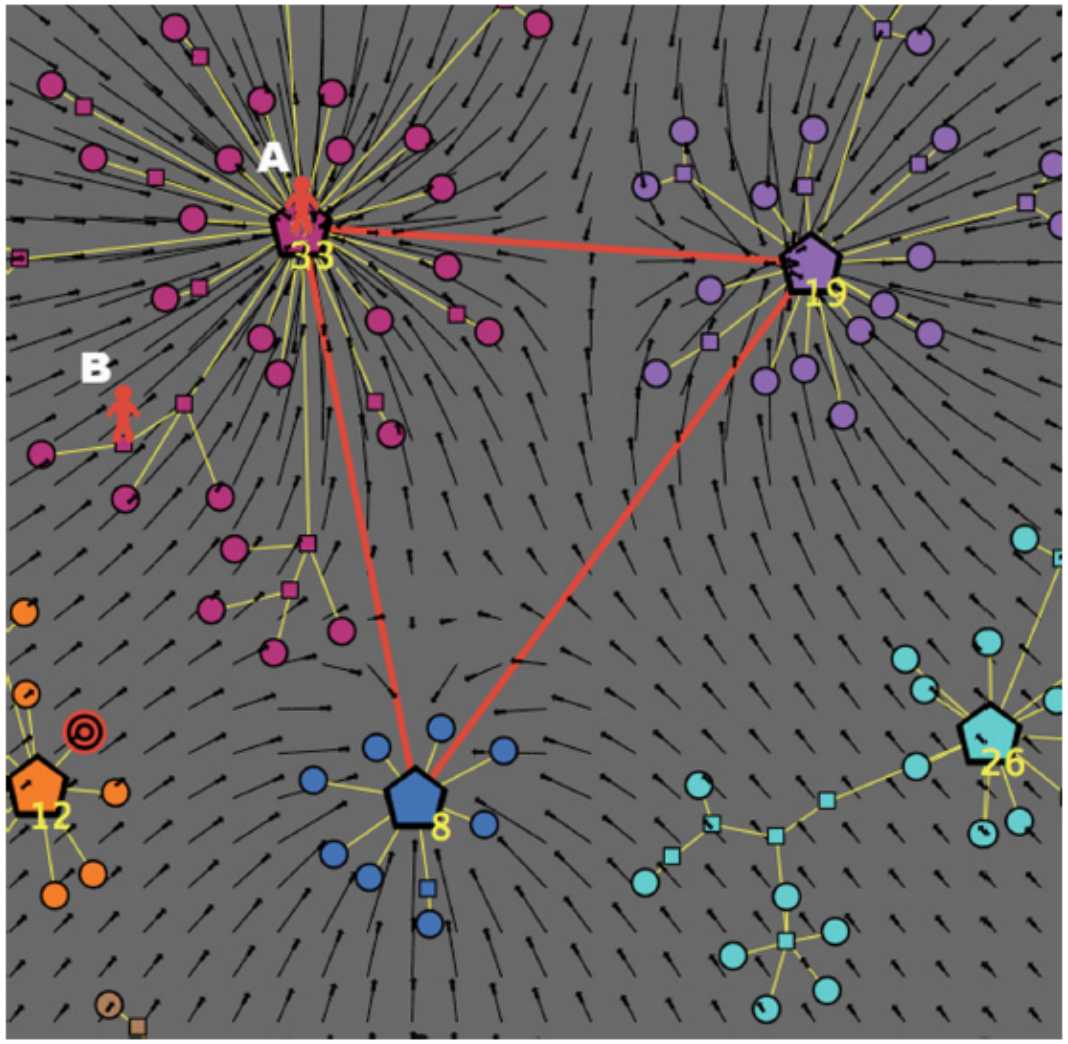


Fig 5. Dynamical rules determining the buyer's next move: the case of low awareness. The consumer is highly influenced by the attraction field induced by her active clusters, without consideration for the target.

DYNAMICS OF THE MODEL

END OF THE JOURNEY

The consumer can terminate her journey (at time $t = t_{end}$) in two different ways:

(a). ***The consumer remains trapped in an informative cul-de-sac***. In this case, the consumer buys, among the products visited until t_{end}, the product P corresponding to the maximum relative satisfaction, and so Sat(P, t*)<1. The chosen product P is located at the relative minimum distance d from the target P*

(b). ***The consumer reaches her target and buys it***. This can happen only if the target coincides with an existing node that belongs to one of the active clusters. In this case, the algorithm terminates at the target P*, and the satisfaction of the consumer is given by Sat(P,t*)=1, with $t^* = t_{end}$.

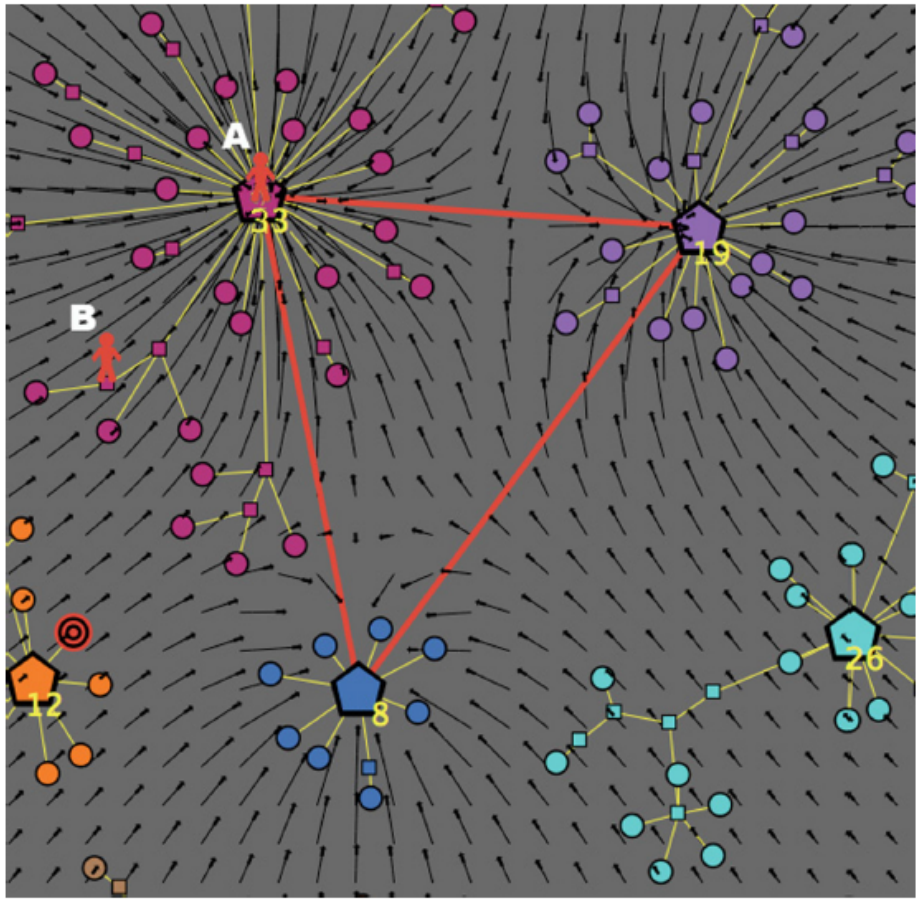


Fig 5. Dynamical rules determining the buyer's next move: the case of low awareness. The consumer is highly influenced by the attraction field induced by her active clusters, without consideration for the target.

FINAL CONSUMER MEASURES

AT THE END OF THE INFORMATIVE JOURNEY WE CALCULATE THE FOLLOWING QUANTITIES FOR EACH CONSUMER

FINAL UTILITY

$$U := \mathsf{Sat}(P, t^*)$$

TOTAL EFFICIENCY

$$H := \frac{t^*}{t_{\text{end}}}$$

$$t^* \in [0, t_{end}]$$

NUMERICAL RESULTS: target on product

25000 SIMULATIONS FOR EACH TYPE OF CONSUMER

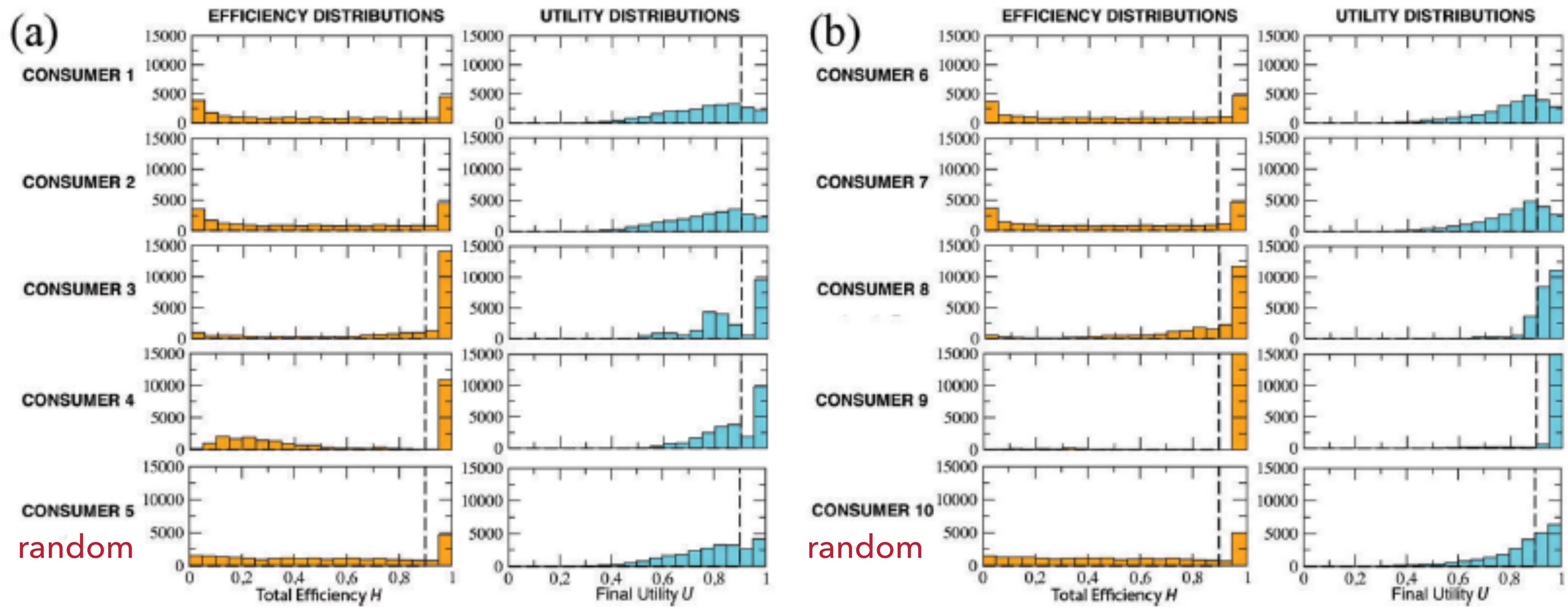


Fig 7. Market with "target on product". (a) Distributions for consumers 1 to 5 (Kn = 0.5). (b) Distributions for consumers 6 to 10 (Kn = 1.0). Distributions of efficiency and final utility calculated over $N = 25000$ simulation events for the 10 types of consumers shown in Table 1. Dashed lines indicate levels of efficiency and utility higher than 0.9.

NUMERICAL RESULTS: target on product

Table 2. Market with "target on product". Global quantities calculated over the $N = 25000$ simulation events for the 10 types of consumers described in Table 1. We report, in order, the following quantities: the percentage of events with final utility $U > 0.9$, the percentage of events with total efficiency $H > 0.9$, the social welfare W with its standard deviation $\sigma(W)$, and the average stopping time T with the corresponding standard deviation $\sigma(T)$.

Consumer	Kn	Aw	N_{Lev}	$H(\%)>0.9$	$U(\%)>0.9$	W	$\sigma(W)$	T	$\sigma(T)$
#1	0.5	0	4	21	19	0.76	0.16	46	24
#2	0.5	0	20	21	20	0.76	0.15	46	24
#3	0.5	1	4	61	41	0.86	0.13	25	18
#4	0.5	1	20	44	47	0.88	0.11	21	18
#5	0.5	*random*	–	22	27	0.79	0.15	43	24
#6	1	0	4	23	27	0.80	0.14	75	42
#7	1	0	20	23	27	0.80	0.14	76	42
#8	1	1	4	56	78	0.93	0.07	14	14
#9	1	1	20	93	94	0.97	0.07	7	5
#10	1	*random*	–	23	46	0.85	0.14	60	39

W is the mean value of the final utility distribution and $\sigma(W)$ is its variance

NUMERICAL RESULTS: target on product

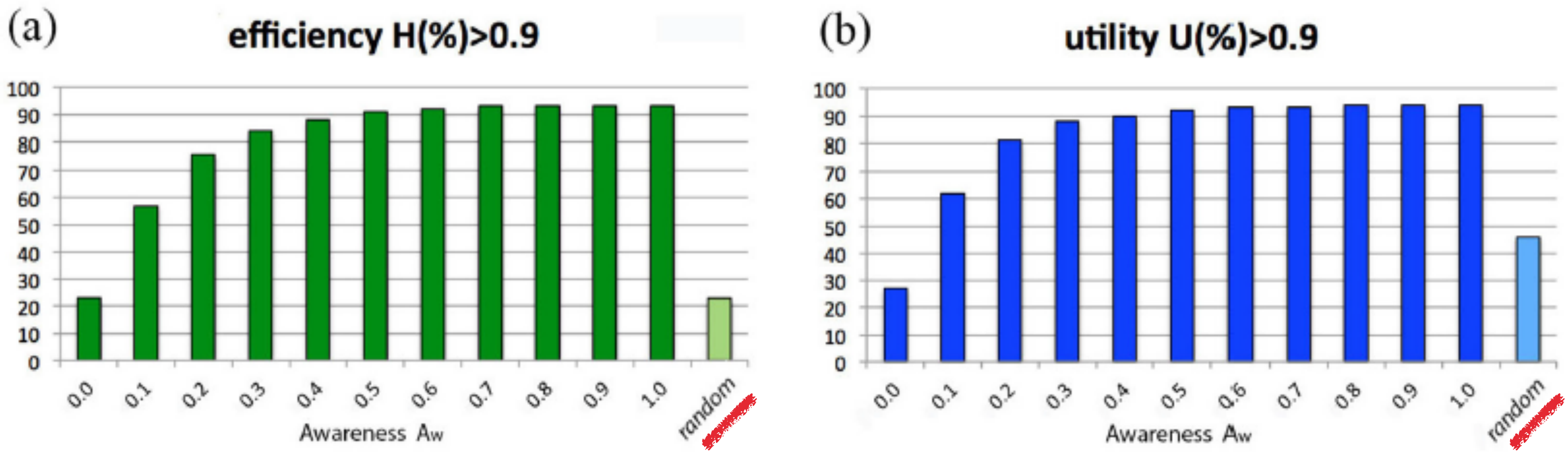


Fig 8. Market with "target on product". (a) Percentage of events with total efficiency $H(\%) > 0.9$. (b) Percentage of events with final utility $U(\%)>0.9$. Behavior of $H(\%)>0.9$ and $U(\%)>0.9$ as a function of Aw, for Kn = 1 and $N_{Lev} = 20$. The case of a random consumer is also considered.

NUMERICAL RESULTS: target off product

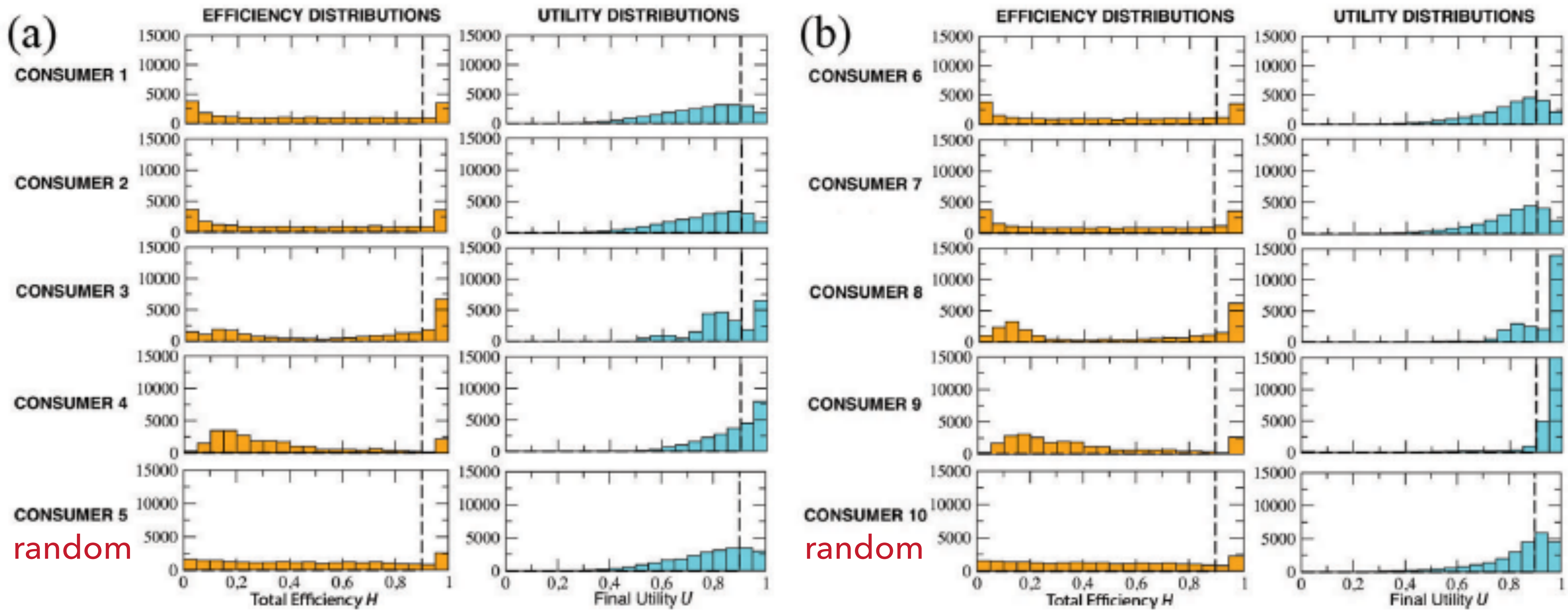


Fig 10. Market with "target off product". (a) Distributions for consumer types #1-5 (Kn = 0.5). (b) Distributions for consumer types #6-10 (Kn = 1). Distributions of efficiency and final utility calculated over $N = 25000$ simulation events for the 10 types of consumers. Dashed lines indicate levels of efficiency and utility higher than 0.9.

NUMERICAL RESULTS: target off product

Table 4. Market with "target off product". Global quantities are calculated over $N = 25000$ simulation events for the 10 types of consumers. We report, in order, the same quantities as in Table 2: the results are very similar.

Consumer	Kn	Aw	N_{Lev}	$H(\%)>0.9$	$U(\%)>0.9$	W	$\sigma(W)$	T	$\sigma(T)$
#1	0.5	0	4	18	19	0.75	0.16	49	25
#2	0.5	0	20	18	19	0.76	0.15	48	24
#3	0.5	1	4	34	33	0.84	0.12	35	15
#4	0.5	1	20	9	50	0.87	0.12	31	17
#5	0.5	*random*	–	14	26	0.78	0.15	46	25
#6	1	0	4	19	25	0.80	0.14	79	42
#7	1	0	20	19	25	0.80	0.14	79	42
#8	1	1	4	31	64	0.91	0.11	47	19
#9	1	1	20	11	89	0.94	0.10	33	19
#10	1	*random*	–	12	42	0.84	0.14	65	40

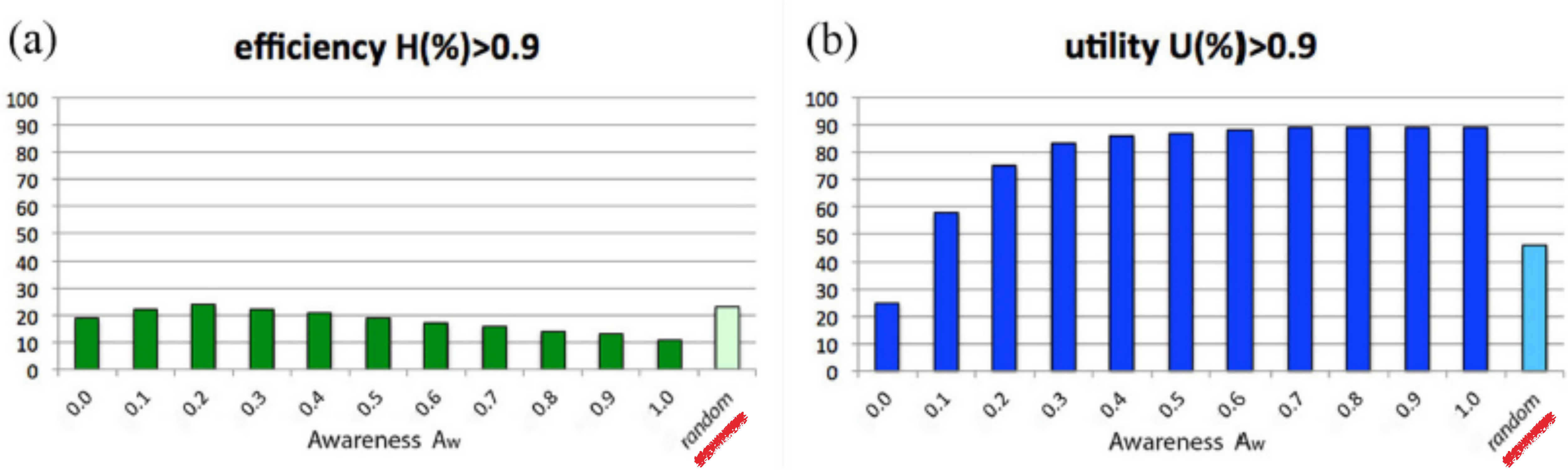


Fig 11. Market with "target off product". (a) Percentage of events with total efficiency $H(\%)>0.9$. (b) Percentage of events with final utility $U(\%)>0.9$. Behavior of $H(\%)>0.9$ and $U(\%)>0.9$ as a function of Aw, for consumers with Kn = 1 and $N_{Lev} = 20$. The case of a random consumer is also considered.

CONCLUSIONS

We have presented a graph-based model of consumer choice, which describes the cognitive journey that each consumer experiences in the process of searching information to buy a product.

Many of our results confirm what one would naturally expect: a perfect knowledge of the market structure paired with a high discrimination ability and a good individual awareness usually determines a very satisfactory choice.

ON THE OTHER HAND, A FEW RESULTS OF OUR SIMULATIONS LOOK RATHER SURPRISING !!

a) consumers provided with a minimal level of knowledge and information may unexpectedly reach very high levels of utility.

b) whenever consumers have a minimal level of knowledge and information, random decisions will make them better off: a consumer, who wants to avoid that social-economic forces – advertising, bandwagon effects, persuasive market power – may well defeat market attraction by employing a random search strategy.

Our analysis is restricted to a prototypical network configuration of the market. It would be interesting to test the robustness of our conclusions by considering also additional market configurations.

We are also aware that an empirical validation of the model, by means of real datasets, would give further support to the above conclusions.

This approach could be useful also to model the process of transferring innovative research results/ideas into the industry world and then to final consumer products

Many thanks !