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P: is it fake
Q: is it liked
R: is it new

p: probability a story is fake
q: probability a story is liked
r: probability a story is new

	P	Q	R	Probability	Payoff
1	T	T	T	pqr	a
2	T	T	F	$pq(1-r)$	b
3	T	F	T	$p(1-q)r$	c
4	T	F	F	$p(1-q)(1-r)$	d
5	F	T	T	$(1-p)qr$	e
6	F	T	F	$(1-p)q(1-r)$	f
7	F	F	T	$(1-p)(1-q)r$	g
	F	F	F	$(1-p)(1-q)(1-r)$	h

ignore this case as it will not be propagated in social network

let us assume that 1% of all news items are fake news.

$$P(k \text{ events in interval}) = \frac{\lambda^k e^{-\lambda}}{k!} \qquad \frac{(rt)^k e^{-rt}}{k!} \qquad \lambda = rt$$

$\Downarrow$

λ: average number of events

$$\cancel{P(k \text{ in interval}, t) = \lambda^k e^{-\lambda t}}$$

Expected utility, $u(p, q, r)$

$$u(p,q,r) = pqr*a + pq(1-r)*b + p(1-q)r*c + p(1-q)(1-r)*d$$
$$+ (1-p)qr*e + (1-p)q(1-r)*f + (1-p)(1-q)r*g + (1-p)(1-q)(1-r)*h$$

$$E[q] = \frac{U+1}{U+D+2}$$

U: number of upvotes in a news
D: number of downvotes of a news

$$E(1-q] = \frac{D+1}{U+D+2}$$

$r = e^{-\lambda s}$ (probability that it is at least s seconds since last reload)

$P = \frac{\lambda^k e^{-\lambda}}{k!}$ (probability that fake news is at 1% of news item in an interval
k = 1% of element in interval)

set the utility
$h=0$
$g=0$
otherwise set $a,b,c,d,e,f. = 1$

$$u(p,q,r) = pqr + pq(1-r) + p(1-q)r + p(1-q)(1-r) + (1-p)qr + (1-p)q(1-r)$$
$$= p(qr + q(1-r) + (1-q)r + (1-q)(1-r)) + (1-p)(qr + q(1-r))$$
$$= p(qr + q(1-r) + (1-q)r + (1-q)(1-r)] + (1-p)q(\cancel{r} + 1 - \cancel{r})$$

$$\frac{\lambda^k e^{-\lambda}}{k!}\left(\frac{U+1}{U+D+2}e^{-\lambda s} + \frac{U+1}{U+D+2}(1-e^{-\lambda s}) + \frac{D+1}{U+D+2}e^{-\lambda s} + \frac{(D+1)(1-e^{-\lambda s})}{U+D+2}\right) + \left(1-\frac{\lambda^k e^{-\lambda}}{k!}\right)\left(\frac{U+1}{U+D+2}\right)$$

$$\Downarrow$$

$$\left(\frac{\cancel{Ue^{-\lambda s}} + \cancel{e^{-\lambda s}} + U - \cancel{Ue^{-\lambda s}} + 1 - \cancel{e^{-\lambda s}} + \cancel{De^{-\lambda s}} + \cancel{e^{-\lambda s}} + D - \cancel{De^{-\lambda s}} + 1 - \cancel{e^{-\lambda s}}}{U+D+2}\right.$$

$$\cancel{\left(\frac{U+D+1+1}{U+D+2}\right)} = \frac{\lambda^k e^{-\lambda}}{k!} + \left(1-\frac{\lambda^k e^{-\lambda}}{k!}\right)\left(\frac{U+1}{U+D+2}\right)$$

$$\frac{\lambda^k e^{-\lambda}}{k!} + \frac{u+1}{u+D+2} - \frac{\lambda^k e^{-\lambda}}{k!}\left(\frac{u+1}{u+D+2}\right)$$

$$\frac{\lambda^k e^{-\lambda}(u+D+2) + k!(u+1) - \lambda^k e^{-\lambda}(u+1)}{k!(u+D+2)}$$

$$\cancel{\lambda^k e^{-\lambda}(u}$$

$$\frac{\cancel{\lambda^k e^{-\lambda} U} + \lambda^k e^{-\lambda} D + 2\lambda^k e^{-\lambda} - \cancel{\lambda^k e^{-\lambda} U} - \lambda^k e^{-\lambda}}{k!(U+D+2)}$$

$$= \frac{\lambda^k e^{-\lambda} D + 2\lambda^k e^{-\lambda} - \lambda^k e^{-\lambda}}{k!(U+D+2)}$$

$$= \frac{\lambda^k e^{-\lambda} D + \lambda^k e^{-\lambda}}{k!(U+D+2)}$$

$$= \frac{\lambda^k e^{-\lambda}}{k!} \frac{(D+1)}{U+D+2}$$

(expected utility of a news)
considering the presence of fake news