Simplified mathematical method to compare the ordinary R&D teams and single experts

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Introduction

The human factor is very important if the high-level R&D skills are needed ("Intellectuals solve problems, geniuses prevent them." - Albert Einstein). Many people believe more in the power of teamwork than in "myths" of the lone genius [1]. However, if a project goal can be successfully achieved just by one high-skilled professional, it is not wise to delegate this duty to a group of low-skilled persons ("A great engineer is worth 100 average engineers." - Facebook CEO Mark Zuckerberg [2]). Generally, the dilemma "ordinary team or single expert" is of frequent interest for R&D organizations.

In this paper, an approximate mathematical approach has been developed to estimate the critical (minimum) size of an ordinary R&D team that can be more successful than a single expert. As a result, this method could help to resolve the "hire or not hire" issue.

Estimation of the "success" probabilities for single experts and ordinary team members.

One of my university professors used to say that everybody could win the Nobel Prize but it might take 20 years for the talents and 200 years for ordinary people. If the probability distribution is uniform (the chances are distributed equally in time), the probability of winning the Nobel Prize within 16 years is calculated as 16/20 = 0.80 for a talent and 16 / 200 = 0.08 for every "ordinary" person. Such a simplified view of the "success" probability quantifies both personal belief and logical rationality.

Assume that a single expert and each ordinary team member can make a breakthrough for the same time with the "success" probabilities P_{exp} and P_{team} (where $P_{exp} > P_{team}$). Their "failure" probabilities can be expressed as $F_{exp} = 1 - P_{exp}$ and $F_{team} = 1 - P_{team}$, respectively. Introduce three typical levels of the team expertise: A (advanced) with $P_{team} = 0.3$, B (middle) with $P_{team} = 0.2$, and C (basic) with $P_{team} = 0.1$.

The team level depends on both individual skills of each member and collaboration between the members. To simplify the simulation, let's neglect any interaction between the team members, but incorporate the benefits of team collaboration in the value P_{team} (for example, the "success" probability may be 0.15 and

0.20 for a single engineer and him as a team player, respectively). Hence, the whole team fails with the probability which is equal to the product of the individual "fail" probabilities: $F_{all} = (F_{team})^K$ [3] where K is the team size (the total number of the team members).

The critical size of an ordinary team to match a single expert

The team can overdo the high-level expert if $F_{all} < F_{exp}$, or

$$(1 - P_{team})^K < 1 - P_{exp} \; .$$

Taking natural logarithms of both parts of this inequality, obtain

$$K > J = \frac{\ln (1 - P_{exp})}{\ln (1 - P_{team})} . \tag{1}$$

Here, J is the critical (minimum) size of a team performing better than a high-level expert for the same task. The number J infinitely grows for $P_{exp} \to 1$ or $P_{team} \to 0$ but these two critical cases are rarely practical. Using Eq. (1), calculate and plot (Fig. 1) the critical number J for three levels of team expertise: advanced (A), middle (B), and basic (C).

The typical size of an engineering team

Let's estimate the average number of the most active members in typical engineering teams. Commonly, it is between 2 and 12, with the average of 7, which is the fictional team size in movies "The Magnificent Seven", "Seven Samurai", "Snow White and the Seven Dwarfs", "Seven brides for seven brothers", etc. The number 7 is also close to the average number of the field players in typical sports teams (Table 1). In Fig. 1, the intersections of the horizontal line matching K = 7 with the three curves signify the minimum "success" probabilities for the expert to perform better than the team: $P_{exp} \approx 0.9$, 0.8, and 0.5 in cases A, B, and C, respectively.

To hire or not hire a high-level expert

As seen from the plots in Fig. 1, the advanced team A may not need a full-time expert but such a specialist might be helpful on a short-time consulting basis. The basic-level team C is strongly recommended to hire a full-time expert. The middle-level team B could hire either a full-time expert or a part-time high-level consultant.

It should be noted that not every job hunter and team member can accurately estimate the inventive capacity (P_{exp} in terms of this paper) of a potential expert. A specialist with good knowledge of the subject should be invited to recommend the best candidate.

Conclusion

The simplified mathematical approach developed in this paper may help to compare the "success" probability of ordinary teams and single experts for the same tasks. Even though the special skills of a single expert are notably high, the team can overcome him if it is large enough. The critical (minimum) size of the team is estimated by Eq. (1).

Such an estimation is approximate but it may give a preliminary insight for the R&D engineering companies, in particular to resolve the frequent issue: to hire or not hire a high-level expert.

Literature

1. Keith Sawyer, "Group Genius: The Creative Power of Collaboration", Gildan Audio, 2008.
2. Jeff Stibel, "Why a Great Individual Is Better Than a Good Team", https://www.scribd.com/document/61607367/Why-a-Great-Individual-is-Better-Than-a-Good-Team
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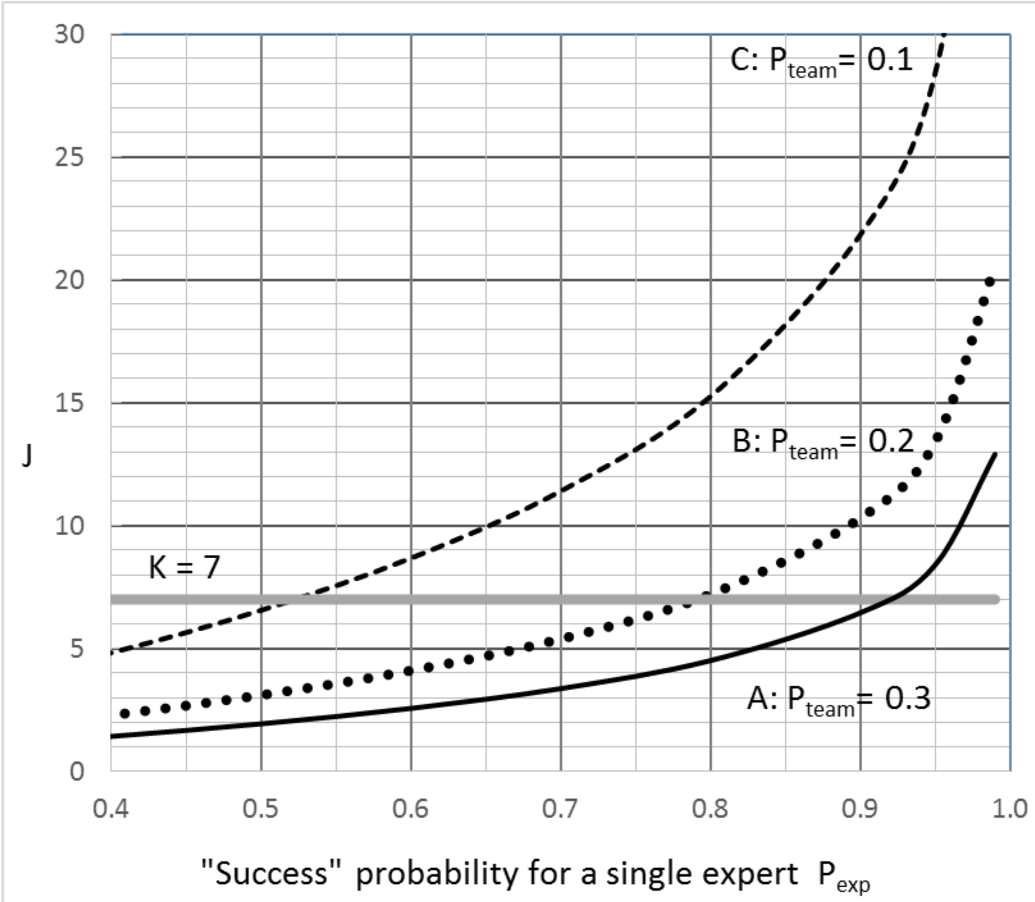

Fig. 1.
The critical number J for three levels of team expertise: A B, and C.
The bold horizontal line indicates the average number K = 7 of active team players.

Sports	The number of field players
Beach Voleyball	2
Basketball	5
Ice hockey	6
Volleyball	6
Water polo	7
Handball	7
Soccer	11
American football	11
MEAN	**6.9**

Table 1. The number of the field players for typical sports teams.