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1 Introduction

The problem of *effectively* allocating finite resources has been known for centuries. Certainly, as long as there have been functional economies (even systems as simple as barter networks), producers have been pressured to utilize labour, capital, and raw materials in the most efficient manner possible. More generally, there exist an entire class of problems known as Assignment Problems.

In the most general case, the Assignment Problem boils down to "essentially [trying] to address the issue of getting the best from every [resource] allocation" [3, p. 8]. This could mean assigning workers of various skill levels to machines in a factory, scheduling specific types of products to be produced on assembly lines of varying capacity, reducing change-over and re-tooling costs during production, and many other problems. In this paper, we examine the problem of assigning a varied workload of tasks to a group of employees of varying skill levels in such a way that we minimize the elapsed time, commonly referred to as the MAKESPAN.

Our problem is important because it directly affects the throughput and, therefore, the profitability of the office we study. By finding an optimal assignment strategy that minimizes the amount of time it takes to complete a task, we can be sure that the office operates in an efficient, cost-effective, and sustainable manner over the long term.

1.1 Historical Context

While people have encountered Assignment Problems for at least several centuries, we lacked the tools to effectively tackle them, especially in the general sense, until fairly recently. Indeed, neither the Renaissance nor the Industrial Revolution produced the necessary confluence of applied and theoretical mathematics and advanced computational technology required to enable business owners to solve these types of problems unassisted.

By the mid-20th century, however, a number of critical breakthroughs would begin to bring powerful mathematical techniques to the masses. Alan Turing had worked to design high-performance code-breaking analog computers and had invented what we now call software while "attacking problems of calculability and Hilbert's Entsheidungsproblem"[4, p. 65]. John Von Neumann envisioned the architecture of the modern digital computer. Wassily Leontif had "opened the door to a new era in mathematical modeling"[2, p. 1], work for which he would be "awarded the 1973 Nobel Prize in Economic Science" [2, p. 1]. And a secret group colloquially referred to as "Blackett's Circus" had, while using science and mathematics to defeat the Nazis, created a new industry. They called it OPERATIONS RESEARCH.

Within the British Admiralty, and reporting directly to Winston Churchill, a scientist and Navy officer named Patrick Blackett led the "operations research group, ...a subdepartment of the navy's Scientific Research and Experiment Department." [1, p. 462] While developing technologies like RADAR and pioneering the application of science to military strategy, Blackett's team laid the foundation for the post-war surge in operations research work. Such work would eventually lead to minor business revolutions like lean manufacturing and its offshoot, agile software development. It was during these decades of rapid technological advancement that the mathematical modelling techniques used in this paper were refined. Fortunately for the authors, we now live in a time where complex matematical models can be effortlessly solved with any mediocre personal computer.

2 The Employee Scheduling Problem

In this paper, we examine an insurance office that handles two types of work: creating new policies, and preparing claims. The office has three employees of varying skill levels, who each take different lengths of time (on average) to complete a given task. Here we see the average time (in minutes) required for each employee to complete each task type

	New Policy	Claim
Employee 1	10	28
Employee 2	15	22
Employee 3	13	18

The company has compiled the timings above by empirical measurement. **TODO...finish this...**

2.1 Modelling Approach

References

[1] Stephen Budiansky. *Blackett's War: The Men Who Defeated the Nazi U-Boats and Brought Science to the Art of Warfare.* Knopf, Toronto, 2013.

[2] David C. Lay. *Linear Algebra and Its Applications.* Pearson Education, Indianapolis, 3rd edition, 2006.

[3] Pradeep Prabhakar Pai. *Operations Research: Principles and Practice.* Oxford University Press, New Delhi, 2012.

[4] Charles Petzold. *The Annotated Turing.* Wiley Publishing, Indianapolis, 2008.