Comparison of First In First Out with Shortest Job First in a Production Schedule Development: A Case of Backpack Production Scheduling Systems

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Abstract

The scheduling process is very closely discussed with job monitoring activities. First In First Out (FIFO) and Shortest Job First (SJF) is one method that is familiar used in scheduling a process. The execution process of these two methods looks very significant seen from various existing research sources, but these results are applied in the process of scheduling the Control Procession Unit (CPU). This study aims to determine the ideal method used related to increasing production efficiency, mainly in textile production. This study can be a reference for the use of scheduling methods with cases of long processing time and is done by taking samples taken using the FIFO and SJF methods. Once the sample data has been obtained, it is carried out using the time required. This will determine the method that either FIFO or SJF compilation is applied under certain conditions. The results obtained consist of the difference between ATT with a value of 62 % and an AWT of 68,6% which shows a considerable impact on the reduction of time when applied in the bag production sector. In this study, We propose further research to increase the estimated arrival time of the process in more complex cases.

Keyword
Scheduling process, FIFO, SJF, Comparison

1. Introduction

The existence of a scheduling algorithm aims to prevent deadlocks in a process that results in hampered execution of a program. However, the initial scheduling algorithm was created only for processing lines or in broad outline, the basic purpose of scheduling is to utilize CPU usage to facilitate the process of completion and response time, waiting and completion time, priority and system throughput(Sharma and Bansal 2015). Until now, many modern computer applications have been built as real-time distributed object systems(Kalogeraki, Melliar-Smith, and Moser 2000). This makes showing the development of architecture and hardware technology so that the case of scheduling algorithms that are classified more and more complex. Scheduling is an overall process of making a product on some specific machines and sorting is defined as making a product on one machine in a certain period (Irawan, Suhandi, and Arisandhy 2009). Scheduling work is important because it impacts on resource utilization, performance parameters, and is one of the most important activities of the process manager who decides to choose which in the ready queue to be assigned (Khan and Kakhani 2015) (Yeboah, Odabi, and Hiran 2015). In the manufacturing world, the purpose of scheduling is to minimize production time and costs (Masruroh 2011). In the research published in this journal, taking a sample of different test cases, taking samples, and processing into the real-time world with the bag production test cases is tested in this study. This research provides education and appropriate method selection techniques and must be applied in a production when viewed from the case of the process. Scheduling can be defined as a set of policies that govern the processing of processing tasks (Alworafi et al. 2017).

Seeing the reality in the field, technical production constraints certainly make the company owner feel the need for checking so scheduling is needed. Static algorithms like FIFO are often used to schedule periodic tasks with difficult deadlines(Kotecha and Shah 2008). However, when the request consists of several classes of work with different characteristics, customers usually want to be given preferential treatment for one or more classes of work at the expense of another so that a sort of priority scheduling strategy is applied(Mitrani and King 1981). Priority

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scheduling techniques are recommended to reduce hours of loss because there is no material supply(Manohar and Aappaiah 2017). In this study, trials were conducted using the First In First Out and Shortest Job First methods based on previous research references with different test cases (Alworafi et al. 2017) (Elnikety et al. 2004) (Siahaan 2016). The research of this method aims to find out how ideal it is related to increasing production efficiency. Efficiency in production as a comparison of output and input associated with achieving maximum output with several inputs, meaning that if the ratio of input-output is large, the efficiency is said to be higher (Aldida and Santosa 2013).

2. Methods

In scheduling, there are several important variables to determine the time usage of a process including Turn Around Time, Burst Time, Waiting Time, Process, Average Waiting Time, and Arrival Time. The procedure of implementing work on this scheduling takes into account the time of arrival of the work. Any work that comes first will be executed first, regardless of their service time (Gupta and Rakesh 2010). Turnaround Time or better known as the dirty time of a job, either the job has not been executed or is being executed until a job has been completed.

2.1 Assumptions on the Experiment

In this study, we set up 15 test data with four classifications of bag types including goodie bag, backpack, waist bag, and advanced bag. Available data will be converted and then tested into eight scheduling conditions using one to eight machines. The results of the calculation will be in the form of details waiting time, turnaround time, order number conversion, comparison of average waiting time, average waiting time, and average turnaround time.

2.2 Turnaround Time

In the case of turnaround time there are many possibilities, but what should be underlined is the rough time of a job, whether the work has interruptions at the beginning or end by any condition, the calculation is still carried out. In the calculation of turnaround time using the formula

Turnaround Time

$$\text{TATn} = \left(\sum_{i=1}^{n} BT\right) + WTn \qquad (1)$$

To calculate the average turnaround time, we use formula (2)

Average Turnaround Time

$$\text{ATAT} = \sum_{i=1}^{n} TAT \,/\, \text{n} \qquad (2)$$

2.3 Burst Time

Burst Time is the net time of a job that is being executed in a process, as seen in figure 1.

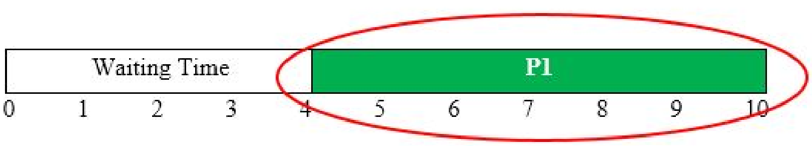

Figure 1. Burst Time

Separate burst time or work time of the process is very influential in the processes before and afterward. The Gantt chart circled above is an example of the net time of a job, as seen in figure 2.

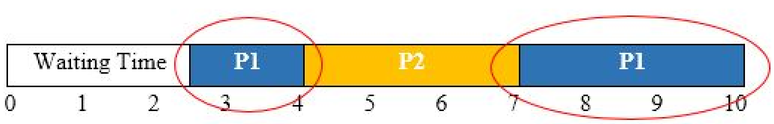

Figure 2. Separate burst time

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2.4 Waiting Time and Average Waiting Time

According to Rajput and Gupta, the waiting time in the queue and ready to use is the waiting time(Rajput and Gupta 2012). Waiting Time is a time outside the execution of a job. In the case of scheduling, waiting time can be in the form of free time on the job and time between the one process with another process outside the specified time of execution of the work. Examples of waiting times can be seen in Figures 3 and 4.

Waiting Time

$$WTn = \left(\sum_{i=1}^{n-1} BT\right) - ATn \qquad (3)$$

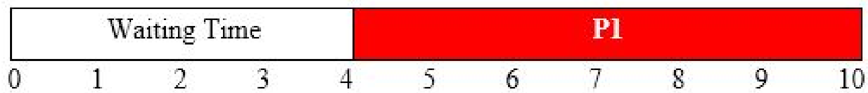

Figure 3. Waiting Time

Figure 4. Waiting Time between process

Average Waiting Time is the average waiting time of work sequences in a process. Average waiting time is a record of time that allows users to analyze the process of the results of a job whether ideal or experiencing starvation. Starvation can be interpreted as too much free time on a job that results in work delays. To calculate the average waiting time can be calculated using the formula (4) (Alworafi et al. 2017).

Average Waiting Time

$$AWT = \sum_{i=1}^{n} WT \,/\, n \qquad (4)$$

2.5 Criteria of Optimization Scheduling

Targeting scheduling based on these optimization criteria are:

a. Ensure that each process gets service from a fair machine production (sewing machine).
b. Keeping the processor busy so that the efficiency reaches the maximum. The meaning of being busy is that the processor is not idle, including the time spent executing user programs and operating systems.
c. Minimize response time.
d. Minimize turnaround time.
e. Avoid indefinite blocking or starvation: A process should not wait for an unbounded time before or while process service.
f. Maximizes the number of jobs processed at a time interval. The greater the throughput, the more work the system does(Parinduri and Hutagalung 2019).

To create optimal scheduling, this research requires sewing machine readiness with prime condition, and the process is assumed to work for 24 hours so there is no idle time.

2.6 The FIFO Scheduling

FIFO is the simplest known discipline for scheduling flow in a network, it transmits packets in the order of their arrival(Sahni, Goyal, and Vin 1999). At the time the job arrives, the job will immediately be executed(Lee, Leu, and Chang 2011). While a process arrives at the same time, then their service is carried out through the sequence of work in the queue. Processes in the back queue must wait until all processes in front of them are finished. Every process that is in the ready status is entered into a queue (queue data structure) according to the time of arrival(Parinduri and Hutagalung 2019). FIFO is known to be inefficient for many workloads because many jobs waiting for execution can produce idle time(Hamscher et al. 2000). FIFO is often equated with First Come First Serve (FCFS). In our study, we did this process by collecting the classification of bag order data and sorting. FIFO are sorted according to the date of the most recent job order. In research studies that have been done by Anderson and Leontyev concluded that FIFO is a sensible scheduling option to consider for applications requiring a good average case delay and a somewhat higher maximum delay can be tolerated(Leontyev and Anderson 2007).

FIFO = (AT^1,…, AT^n) (5)

2.7 Priority Schedule Based on SJF

Priority Scheduling is a scheduling algorithm that prioritizes processes that have the highest priority. Each process has its priorities. The new incoming process has a higher priority than the current process, so the current process is stopped and the process will be transferred to the new incoming process. Scheduling based on preemptive priority specifies a run-time environment where tasks, with priority attributes, are sent in priority order. Priorities are static(Burns 1993).

In preemptive scheduling, it means that any work done on the processor can be interrupted by new jobs provided that there is a job with higher priority status, so that old work will be temporarily rested until the new work is completed or this job occupies high priority at a time based on certain rules enforced in scheduling(Kerlooza and Budiyantoro 2018).

SJF = (BTmin, …., BTmax) (6)

Because the average waiting time is less than other scheduling algorithms, the SJF is included in the optimal scheduling algorithm(Akhtar, Hamid, and Humayun 2015). In our study, we carried out this process by looking at the number of bag orders received. the fewer orders, the greater the chance of getting a queue at the beginning of time.

Research conducted by regarding the use of the first shortest job method can be concluded that reducing waiting time and reducing the effect of bottlenecks on bandwidth by 31.38% in case studies of cloud computing-based scheduling (Ru and Keung 2013).

3. Result and Discussion

The results of a study of 10 process data samples conducted by Khan and Kakhani showed differences in the waiting time and processing time difference of 15.7 seconds between the SJF and FIFO scheduling(Khan and Kakhani 2015). The research is applied to the process of scheduling a computer processor and only uses 10 sample data with burst time variables in each process and each priority has been determined. In this test, it was stated that the work process had the same arrival time (AT = 0) with a total of 15 jobs. For FIFO, data has been sorted by the time the bag order was received. Whereas the time management for SJF is done based on the large number of orders sorted by large and the least number of orders. Below can be seen the data input classification we used in this study in Table 1.

Table 1. Data Input Classification

No.	Type of Bag	Processing Time/ unit	Processing Time / Hour
1.	Waist Bag	10 Minute	6 unit/hour
2.	Rucksack	12 Minute	5 unit/hour
3.	Goodie Bag	5 Minute	12 unit/hour
4.	Advanced Rucksack	30 Minute	2 unit/hour

The data in table 1 is a bag work unit based on the type of bag using a standard sewing machine. Note the number of units worked and the working time only applies to one sewing machine. The data in table 2 is the number of bags ordered, the large number of bags made is likened to a process. The data is converted into units of time-based on table 1. The results of the data obtained from the conversion into units of time will be used as burst time data. Conversion time is adjusted to the number of bags compared to sewing machines assuming one or eight sewing machines are available. Below can be seen the data scheduling in bag production we used on this study in Table 2.

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Table 2. Scheduling Data

No.	Burst Time (Amount of Order)	Type Of Bag	Date of Entry	Order in FIFO	Order in SJF
1.	1000 Unit	Waist Bag	13 January 2020	1	8
2.	200 Unit	Waist Bag	4 March 2020	9	2
3.	300 Unit	Waist Bag	26 March 2020	11	6
4.	250 Unit	Rucksack	21 January 2020	2	5
5.	3000 Unit	Rucksack	3 March 2020	8	4
6.	10000 Unit	Goodie Bag	1 February 2020	3	15
7.	500 Unit	Goodie Bag	13 February 2020	6	7
8.	2000 Unit	Advanced Rucksack	6 February 2020	4	13
9.	200 Unit	Goodie Bag	23 February 2020	7	1
10.	1000 Unit	Advanced Rucksack	11 February 2020	5	9
11.	1000 Unit	Goodie Bag	5 April 2020	13	10
12.	1700 Unit	Goodie Bag	15 April 2020	14	12
13.	1200 Unit	Goodie Bag	1 May 2020	15	11
14.	250 Unit	Waist Bag	14 March 2020	10	5
15.	200 Unit	Rucksack	2 April 2020	12	3

The data contained in table 2 is then converted. The conversion is done based on the number of order orders into the specified time unit and sees the number of sewing machines used as conversion reference. Table of conversion results can be seen in table 3 below.

Table 3. Data Conversion

No.	Amount of Order	Type Of Bag	Burst Time (Conversion result data by the number of sewing machines) / Hour							
			1Machine	2 Machine	3 Machine	4 Machine	5 Machine	6 Machine	7 Machine	8 Machine
1.	1000 Unit	Waist Bag	166.7	83.3	55.6	41.7	33.3	27.8	23.8	20.8
2.	200 Unit	Waist Bag	33.3	16.7	11.1	8.3	6.7	5.6	4.8	4.2
3.	300 Unit	Waist Bag	50	25	16.7	12.5	10	8.3	7.1	6.25
4.	250 Unit	Rucksack	41.7	20.8	13.9	10.4	8.3	6.9	5.9	5.2
5.	3000 Unit	Rucksack	50	25	16.7	12.5	10	8.3	7.1	6.25
6.	10000 Unit	Goodie Bag	600	300	200	150	120	100	85.7	75

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7.	500 Unit	Goodie Bag	41.7	20.8	13.9	10.4	8.3	6.9	5.9	5.2
8.	2000 Unit	Advanced Rucksack	1000	500	333.3	250	200	166.7	142.9	125
9.	200 Unit	Goodie Bag	16.7	8.3	5.6	4.2	3.3	2.8	2.4	2.1
10.	1000 Unit	Advanced Rucksack	500	250	166.7	125	100	83.3	71.4	62.5
11.	1000 Unit	Goodie Bag	83.3	41.7	27.8	20.8	16.7	13.9	11.9	10.4
12.	1700 Unit	Goodie Bag	141.7	70.8	47.2	35.4	28.3	23.6	20.2	17.7
13.	1200 Unit	Goodie Bag	100	50	33.3	25	20	16.7	14.3	12.5
14.	250 Unit	Waist Bag	41.7	20.8	13.9	10.4	8.3	6.9	5.9	5.2
15.	200 Unit	Rucksack	40	20	13.3	10	8	6.7	5.7	5

The data is processed into time which refers to the basic formula of each scheduling method. So that, we get a record of time in the form of waiting time process, burst time, turnaround time, and the data needed to be compared, namely the average waiting time and the average turnaround time. The results of calculations from the input variables table 1, table 2 and data conversion in table 3 can be seen in Figure 5 below.

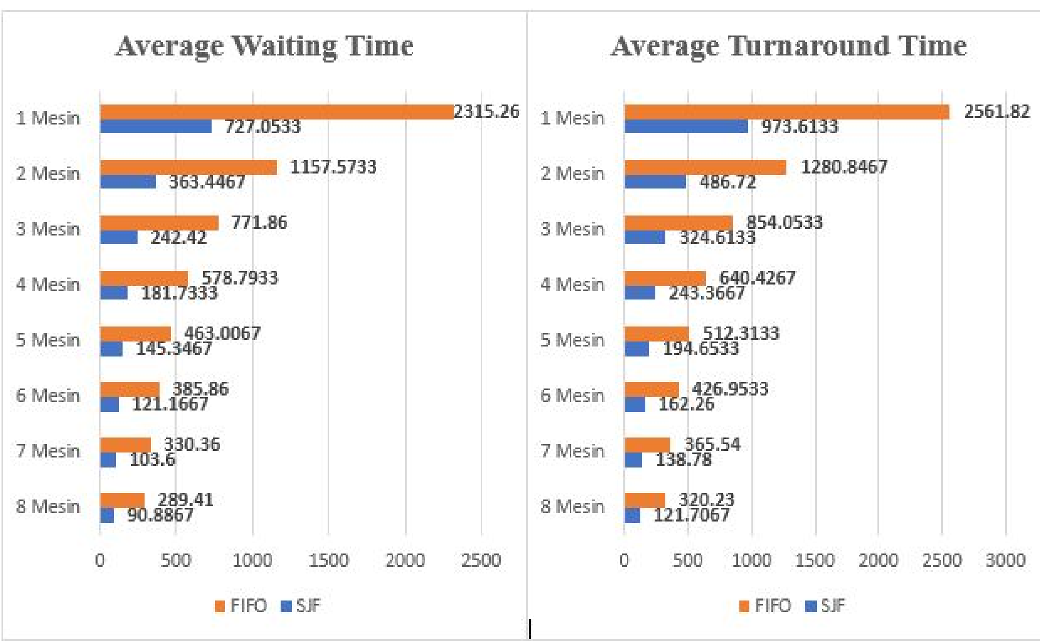

Figure 5. Result of AWT and ATT

The comparison of the average waiting time in Figure 5 shows a significant time difference in the process of using one and two machines using SJF and FIFO scheduling. Same as the results of the average waiting time of the test, the average turnaround time can be seen in the figure that shows a difference that is in the range of 60%. Result of the data obtained based on the calculation of the formula that has been expressed in subpoints methods. Comparison results and differences can be seen in Table 3 below.

Table 4. The Difference Between FIFO and SJF

Process/Type	The Different Between AWT and ATT	AWT (%)	ATT (%)
1 Machine	1588.2067 Hour	68.6 %	62 %
2 Machine	794.1267 Hour		
3 Machine	529.44 Hour		
4 Machine	397.06 Hour		
5 Machine	317.66 Hour		
6 Machine	264.6933 Hour		
7 Machine	226.76 Hour		
8 Machine	198.5233 Hour		

4. Conclusion

From the comparative research method between FIFO and SJF, it is found that the ideal time is compared to the number of machines. In this study, SJF scheduling is superior then FIFO with an AWT difference of 68.6% and an ATT difference of 62%. The results of this time difference have a significant impact on time cuts when applied in the industrial sector, especially in the realm of garment production which requires a significant amount of time and a large level of stock orders. It is recommended to take ¾ the machine with the fastest time record and the highest number of machines. SJF scheduling is considered good enough to be applied to conditions where there is a buildup of processes close together or even at the same time, but FIFO scheduling is the right choice if the arrival period of the process is long enough. Optimization of production depends on machine readiness and the number of processes performed. To get a more accurate time record, it is recommended to convert the time in the form of minutes and also increase the estimated arrival time of the process in more complex cases.

Reference

Akhtar, Muhammad, Bushra Hamid, and Mamoona Humayun. 2015. "An Optimized Shortest Job First Scheduling Algorithm for CPU Scheduling." *Journal of Applied Environmental and Biological Sciences* 5(12): 42–46.

Aldida, Bella, and Purbayu Budi Santosa. 2013. "Analysis of Production and Efficiency of Small and Medium Industries (Ikm) of Written Batik in Kotasemarang." *Diponegoro Journal of Economics* 2(1): 37–46.

Alworafi, Mokhtar A. et al. 2017. "An Improved SJF Scheduling Algorithm in Cloud Computing Environment." *2016 International Conference on Electrical, Electronics, Communication, Computer and Optimization Techniques, ICEECCOT 2016*: 208–12.

Burns, Alan. 1993. *Preemptive Priority Based Scheduling : An Appropriate Engineering Approach*.

Elnikety, Sameh, John Tracey, Erich Nahum, and Willy Zwaenepoel. 2004. "A Method for Transparent Admission Control and Request Scheduling in E-Commerce Web Sites." *Thirteenth International World Wide Web Conference Proceedings, WWW2004*: 276–86.

Gupta, Praveen K., and Nitin Rakesh. 2010. "Different Job Scheduling Methodologies for Web Application and Web Server in a Cloud Computing Environment." *Proceedings - 3rd International Conference on Emerging Trends in Engineering and Technology, ICETET 2010*: 569–72.

Hamscher, Volker, Uwe Schwiegelshohn, Achim Streit, and Ramin Yahyapour. 2000. "Evaluation of Job-Scheduling Strategies for Grid Computing." *IEEE/ACM International Workshop Bangalore, India*: 191–202.

Irawan, Daniel H, Victor Suhandi, and Vivi Arisandhy. 2009. "Proposed Production Scheduling Using the Ant Colony

System Algorithm (Case Study Cv. Bina Rubber Sumedang).” Maranatha University.

Kalogeraki, V., P. M. Melliar-Smith, and L. E. Moser. 2000. “Dynamic Scheduling for Soft Real-Time Distributed Object Systems.” *Proceedings - 3rd IEEE International Symposium on Object-Oriented Real-Time Distributed Computing, ISORC 2000*: 114–21.

Kerlooza, Yusrila Yeka, and Budiyantoro. 2018. “Clothing Production Scheduling Strategies for Quantum-Based and Preemptive Priority Scheduling Methods.” *Journal of Governance and Information Technology Framework* 4(2): 77–83.

Khan, Ms Rukhsar, and Gaurav Kakhani. 2015. “Analysis of Priority Scheduling Algorithm on the Basis of FCFS & SJF for Similar Priority Jobs.” *International Journal of Computer Science and Mobile Computing* 4(9): 324–31.

Kotecha, Ketan, and Apurva Shah. 2008. “Efficient Dynamic Scheduling Algorithms for Real-Time Multiprocessor Systems.” *International Conference on High Performance Computing, Networking and Communication Systems 2008, HPCNCS 2008* 9(3): 21–25.

Lee, Yun Han, Seiven Leu, and Ruay Shiung Chang. 2011. “Improving Job Scheduling Algorithms in a Grid Environment.” *Future Generation Computer Systems* 27(8): 991–98. http://dx.doi.org/10.1016/j.future.2011.05.014.

Leontyev, Hennadiy, and James H. Anderson. 2007. “Tardiness Bounds for FIFO Scheduling on Multiprocessors.” *Proceedings - Euromicro Conference on Real-Time Systems*: 71–80.

Manohar, H M, and S Aappaiah. 2017. “Stabilization of FIFO System and Inventory Management.” *International Research Journal of Engineering and Technology(IRJET)* 4(6): 5631–38.

Masruroh, Nisa. 2011. “Analysis of Production Scheduling Using the Ampbell Dudeck Smith, Palmer, and Dannenbring Method in Pt. Refractory Workshop Surabaya.” *Tekmapro* 1(1): 158–71.

Mitrani, I., and P. J.B. King. 1981. “Multiprocessor Systems with Preemptive Priorities.” *Performance Evaluation* 1(2): 118–25.

Parinduri, Ikhsan, and Siti Nurhabibah Hutagalung. 2019. “Processor Scheduling Techniques FIFO Non Preempetive SJF, Round Robin.” *Prosiding Seminar Nasional Riset Information Science /Proceedings of the National Seminar on Information Science Research (SENARIS)* (September): 864–71.

Rajput, Ishwari Singh, and Deepa Gupta. 2012. “A Priority Based Round Robin CPU Scheduling Algorithm for Real Time Systems.” *Journal of Advanced Engineering Technologies* 1(3): 1–11.

Ru, Jia, and Jacky Keung. 2013. “An Empirical Investigation on the Simulation of Priority and Shortest-Job-First Scheduling for Cloud-Based Software Systems.” *Proceedings of the Australian Software Engineering Conference, ASWEC*: 78–87.

Sahni, J, P Goyal, and H M Vin. 1999. “Scheduling CBR Flows: FIFO or Fair Queuing.” *Proceedings of 9th International Workshop on Network and Operating Systems Support for Digital Audio and Video*: 13–27.

Sharma, Mukesh K, and Kapil Kumar Bansal. 2015. “Fuzzy Analysis Of Shortest Job First.” *International Journal of Engineering Research & Management Technology* 2(June): 125–28.

Siahaan, Andysah Putra Utama. 2016. “Comparison Analysis of CPU Scheduling : FCFS, SJF and Round Robin.” *International Journal of Engineering Development and Research* 4(3): 124–31.

Yeboah, Dr.Thomas, Prof. Odabi I Odabi, and Kamal Kant Hiran. 2015. “An Integration of Round Robin with Shortest Job First Algorithm for Cloud Computing Environment.” *International Conference On Management, Comunication and Technology (ICMCT).* III(April): 1–5.

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Biography

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