High Performance Computing (Oct 15)

Question 1

When you submit a job, you can write the expected execution time of the job. Accurate estimation of the execution time is beneficial for both the user and the system. Write one benefit for users and also one benefit for the system.

Answer 1

For users' point of view, a benefit is that accurate estimation enables backfilling to schedule their job execution earlier, while ensuring the jobs to use the allocated computing resources to the end. For system's point of view, accurate estimation enables to keep the system busy by backfilling. Note that backfilling can schedule jobs for filling up idle timeslots only if the execution time is known in advance. Accurate estimation can maximize the resource utilization without failing the execution of backfilled jobs.

Suppose that the execution time of a job is underestimated (shorter than actual). Then, the job execution could potentially start earlier by backfilling if there is an available timeslot longer than the underestimated execution time. However, the job execution will be terminated because it does not finish within the allocated timeslot. Usually, terminated jobs will be resubmitted by users and executed again from the beginning. This is just wasteful for both users and systems. On the other hand, if the job execution time is overestimated, the job must wait until sufficiently long timeslots with enough computing resources are available, though the allocated computing resources would remain available until the end of job execution. If the execution finishing time is earlier than estimated, execution of subsequent jobs may or may not be moved earlier than the originally scheduled starting time, depending on the situation. Accordingly, only if the estimation is accurate, the job is properly scheduled for the earliest available timeslot, and also not terminated before the execution completion.

Question 2

On Slide 60, a mathematical model of the communication time per iteration is given. Derive the right-hand side term from the left-hand side one. Hint: it calculates the sum of a geometric sequence with the common ratio of 2 from 1 to log p.

Answer 2

$$\sum_{i=1}^{\log p}(\lambda + \frac{2^{i-1}n/p}{\beta}) = \lambda \log p + \frac{n(p-1)}{\beta p}$$

The left side is to sum up log p numbers. So the first term on the right side is obtained by simply multiplying λ by $\log p$. The second term is derived from the sum of a geometric progression with the common ratio of 2. Let a denote the common ratio. Then, the sum is given by $S = \sum_{i=1}^{N} a^i = \frac{1}{2}a(a^N - 1)(a - 1)$. For a=2 and N=log p, $S = 2^N - 1$=p-1.