

## Exercise 6.2.1

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If we have a resource inequality  $[c \rightarrow c] \geq [cc]$ , it means that

- The noiseless classical bit channel can simulate the shared randomness
- The shared randomness cannot simulate the noiseless channel.

To illustrate the first statements above, we could consider the following procedure. Suppose that we have a protocol that consists of following steps,

- Step 1: Alice prepares a random classical bit with probability of getting 0 and 1 are both  $1/2$
- Step 2: Alice performs experiments and send her result to Bob through the classical noiseless channel. Then Bob also has a random classical bit with probability of getting 0 and 1 are both  $1/2$ ; Alice and Bob would get same result, so the probability of getting 00 and 11 are  $1/2$ , which shows they share randomness.

To illustrate the second statements above, we could consider a counter-example. If Alice prepares a random classical bit with probability of getting 0 and 1 are  $1/3$  and  $2/3$ , respectively, then she performs experiments and sends her result to Bob through the classical noiseless channel. Then Bob also has a random classical bit with probability of getting 0 and 1 are  $1/3$  and  $2/3$ , and the probability of getting 00 and 11 are  $1/3$  and  $2/3$ , respectively. However, a shared randomness can only produce the outcome of 00 and 11 with probability as  $1/2$ , so the shared randomness cannot simulate the noiseless classical channel.

Therefore, with analysis above, we conclude that we have the resource inequality  $[c \rightarrow c] \geq [cc]$ .