Thank you for having an interest in my research.

My name is Sotaro Takiguchi.
I’ m a graduated student at Tokyo University of Agriculture and Technology.
I strongly wanted to present my research and get your feedback in Utah, but I cannot because of the recent situation. For making the most of virtual FNANO, I prepared **a poster with audio file** using Google Cloud Text-to-Speech.

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Nanopore decoding for solution of the Hamiltonian path problem in DNA computing

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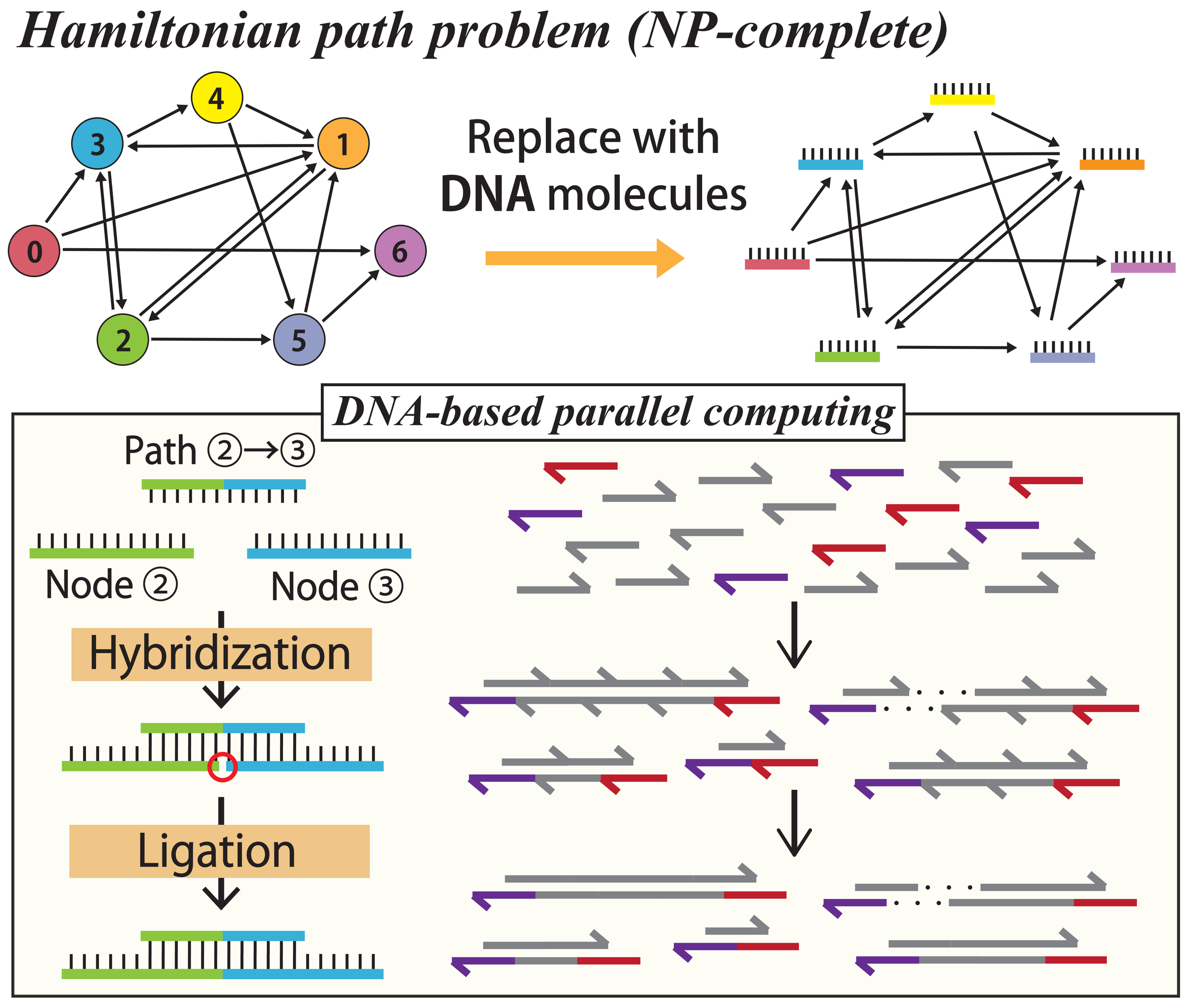
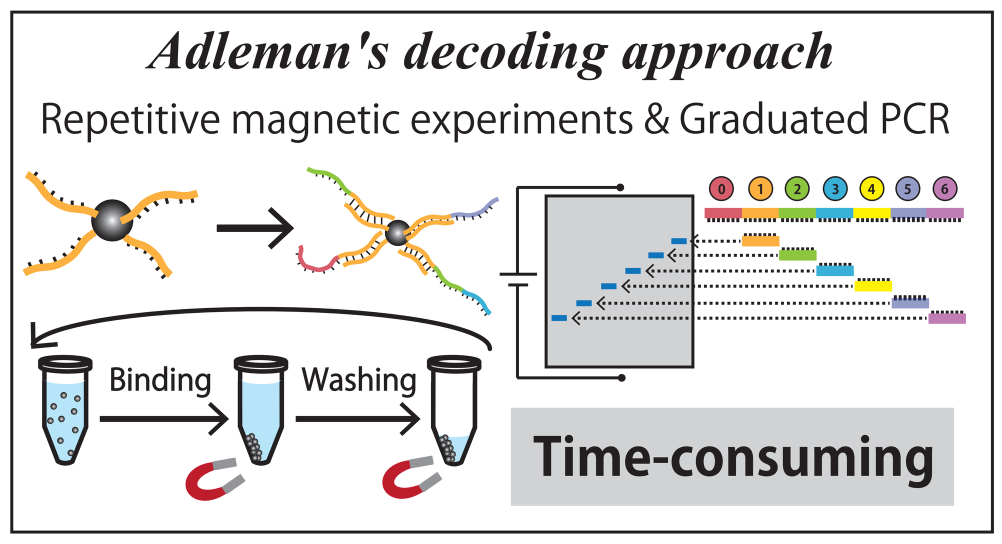
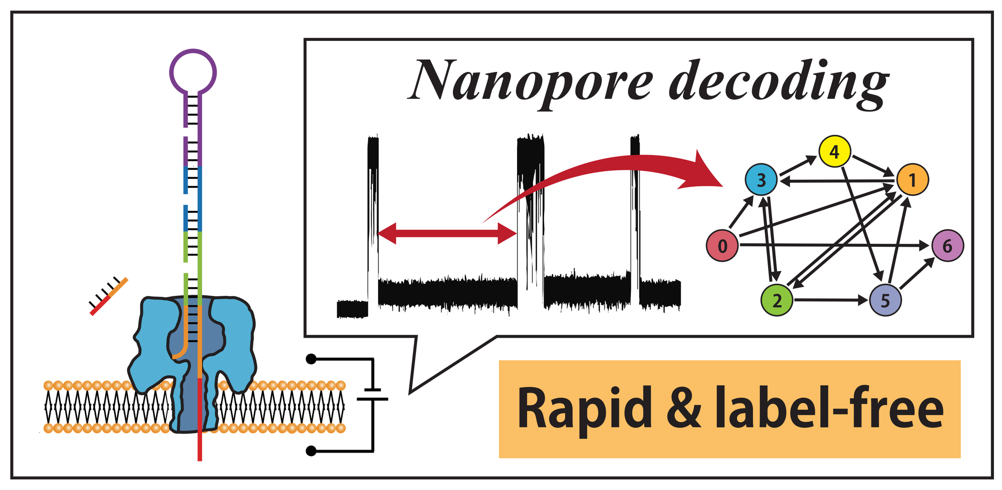
Introduction DNA computing has attracted attention as a tool for solving mathematical problems using molecules based on its massive parallelism. However, it is usually time-consuming to detect and decode the output information in the conventional system. We try to demonstrate rapid and label-free decoding of the output information in DNA-based parallel computation, a directed Hamiltonian path problem in this study, using nanopore technology.

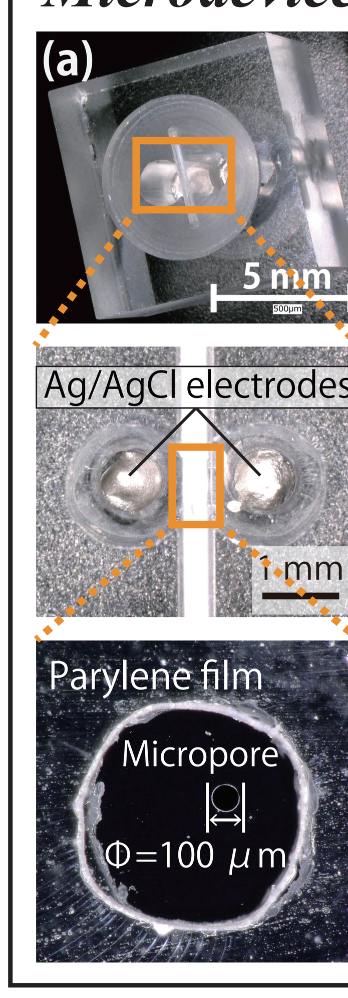
Research Concept

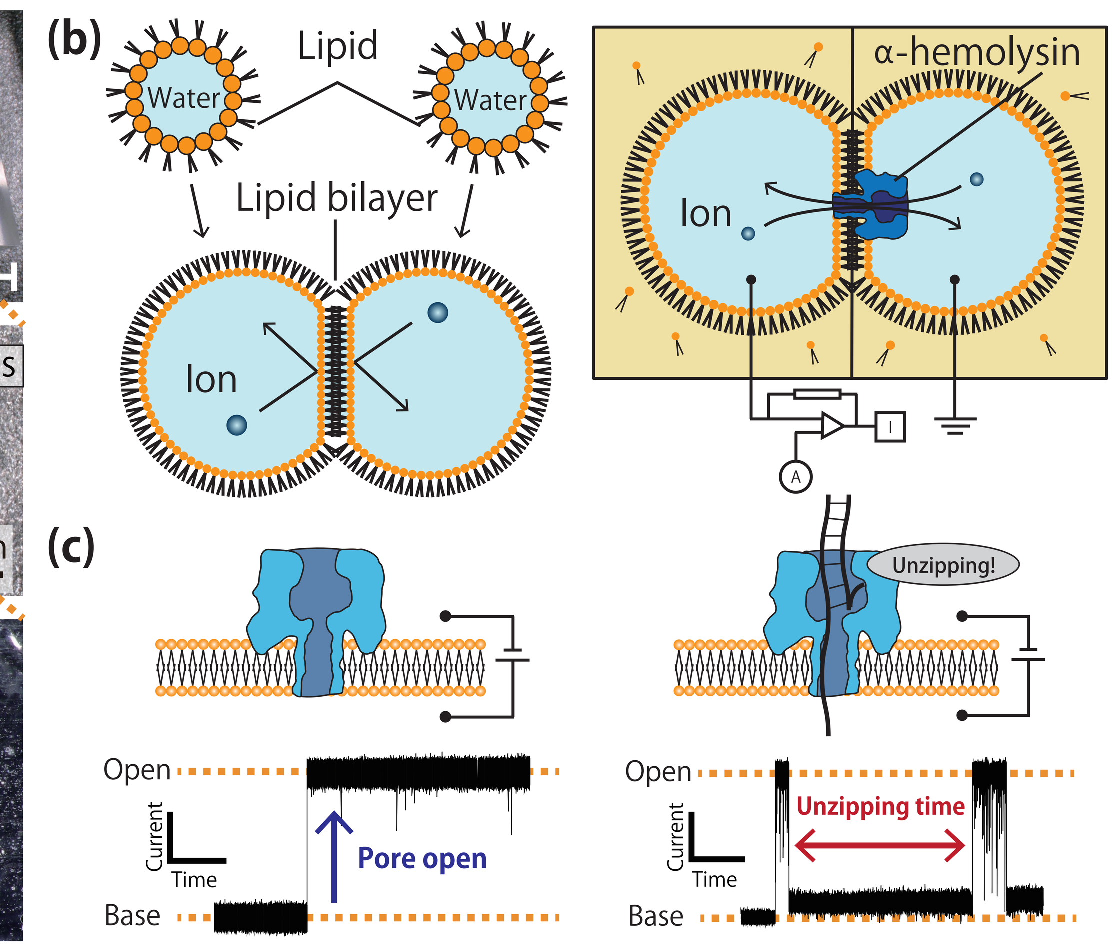






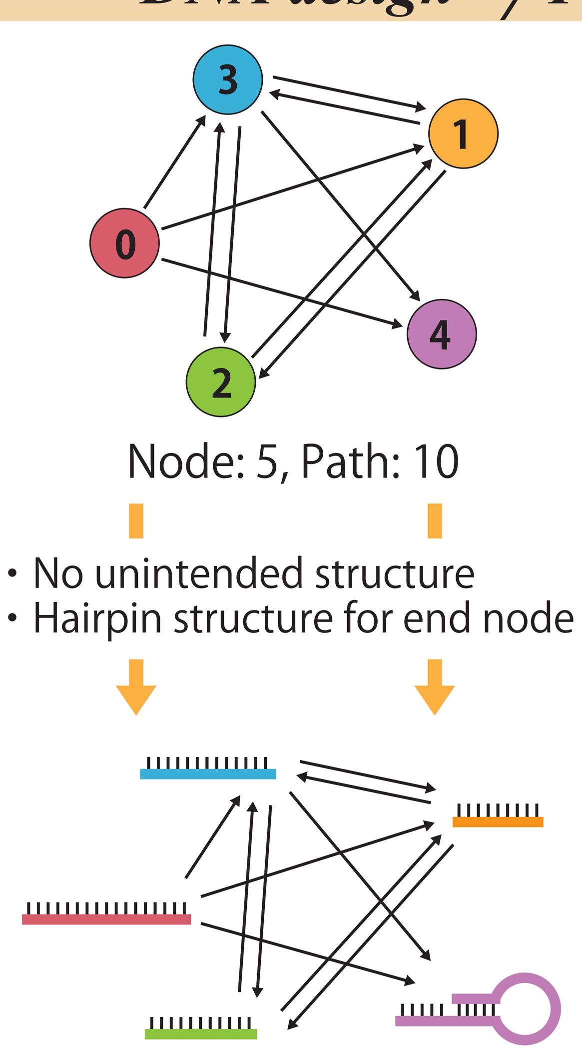
Material & Method

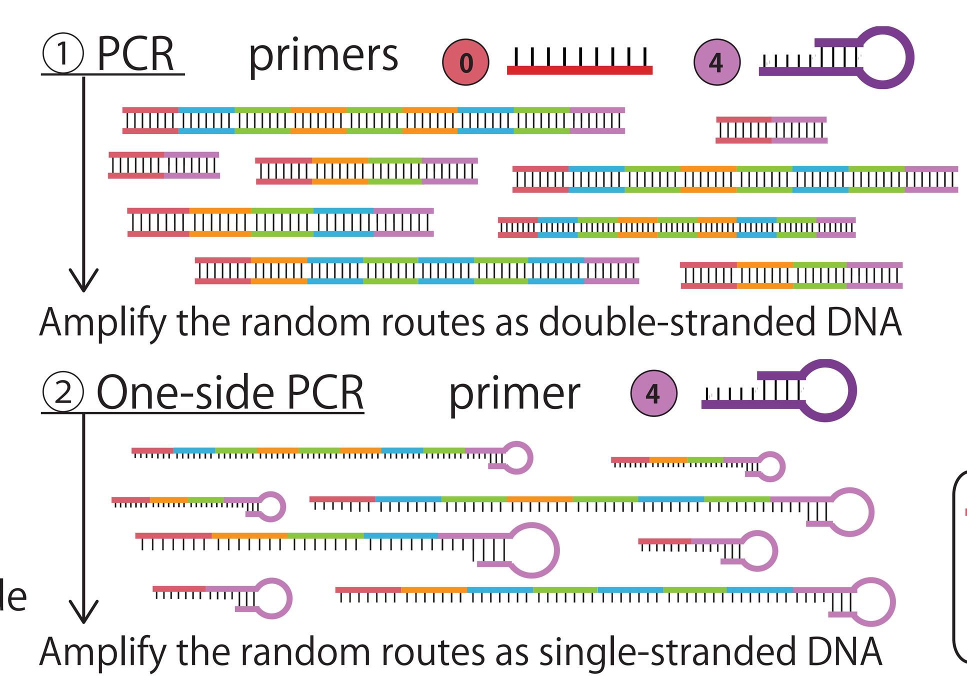


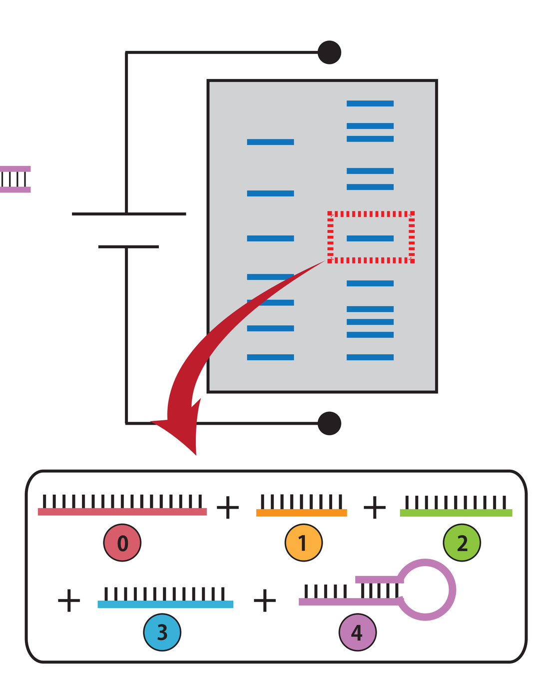


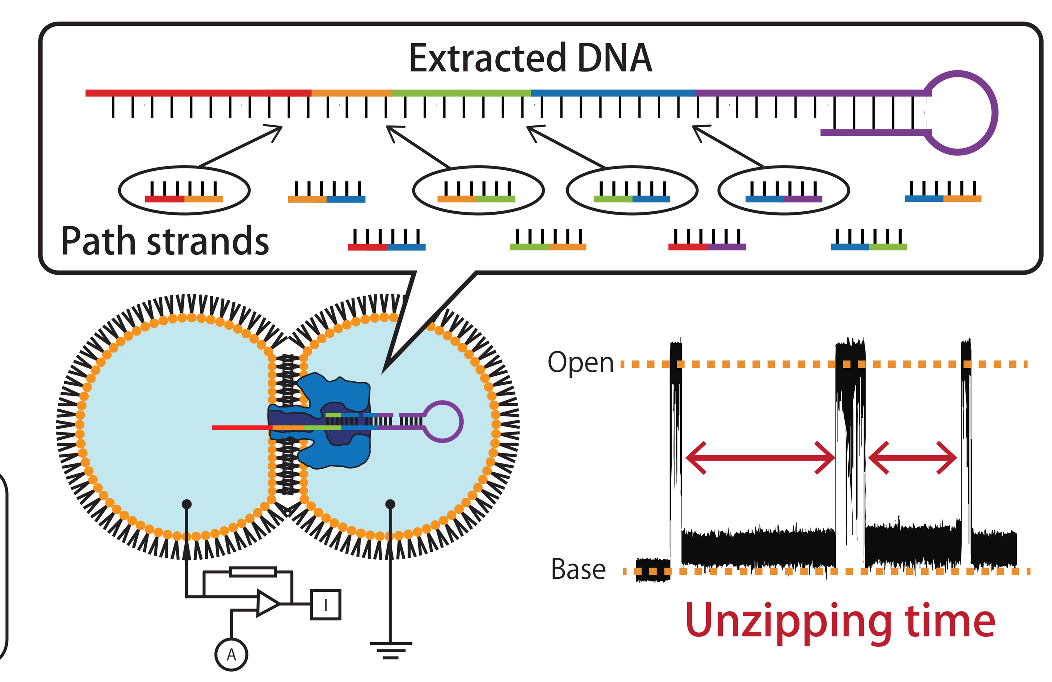
The strategy of nanopore decoding

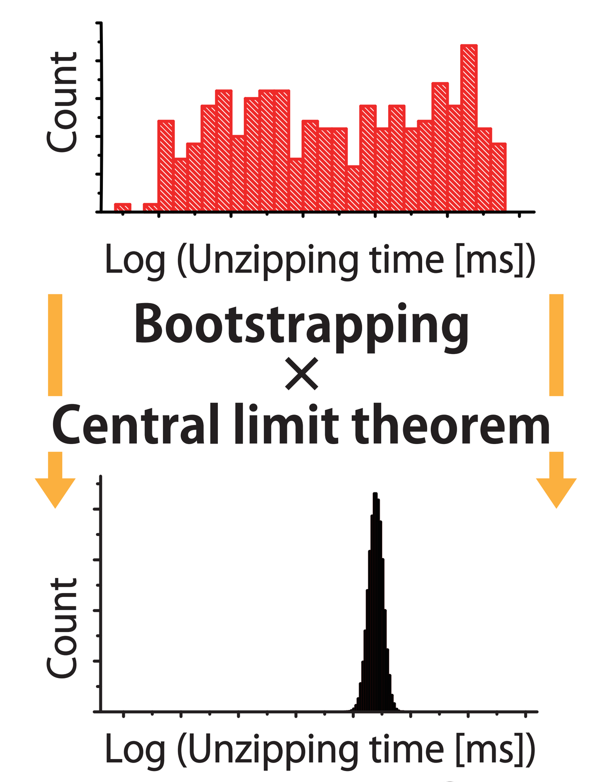
DNA design 〉 **PCR & one-side PCR (Step 1)** 〉 **Gel electrophoresis (Step 2)** 〉 **Nanopore measurement (Step 3)** 〉 **Data analysis**



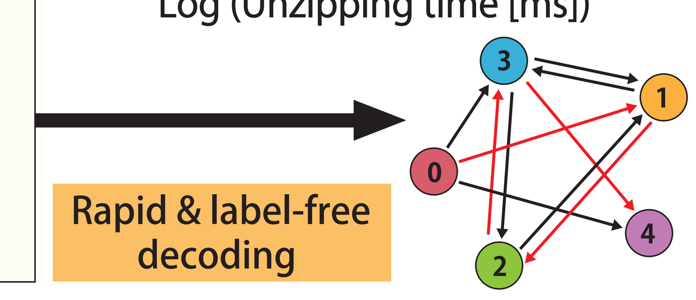






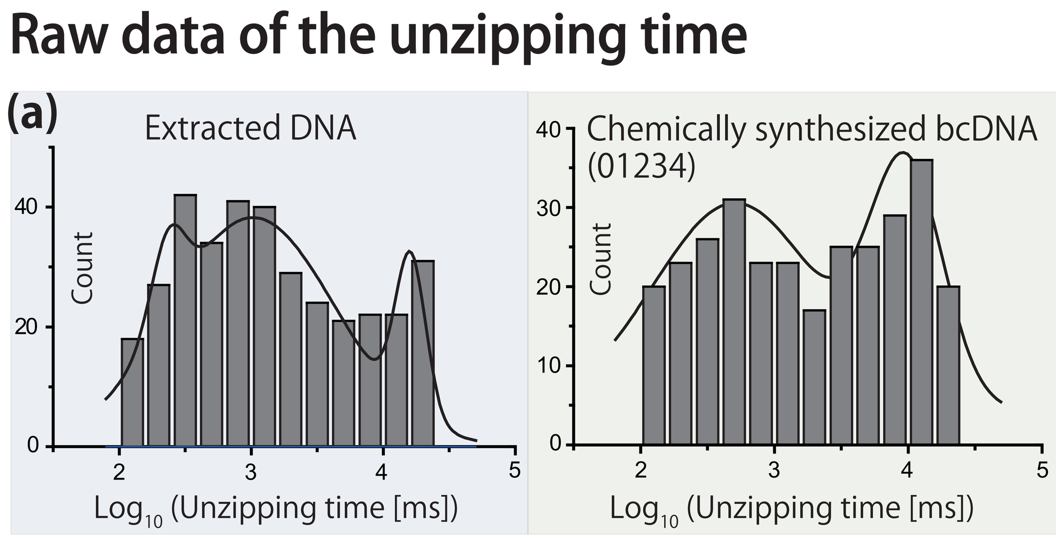


Step 1: Amplify the random paths generated by DNA computation as single-stranded DNA by PCR and one-side PCR.
Step 2: Separate the single-stranded random paths depending on its length by gel electrophoresis, and extract correct-length DNA encoding a route visiting all nodes only once, which is the correct answer.
Step 3: Each path strand hybridizes to the extracted DNA, and the duplex passes through an α-hemolysin (αHL), a pore-forming protein, nanopore with the path strands unzipping. Analyze the unzipping time to decode the information.



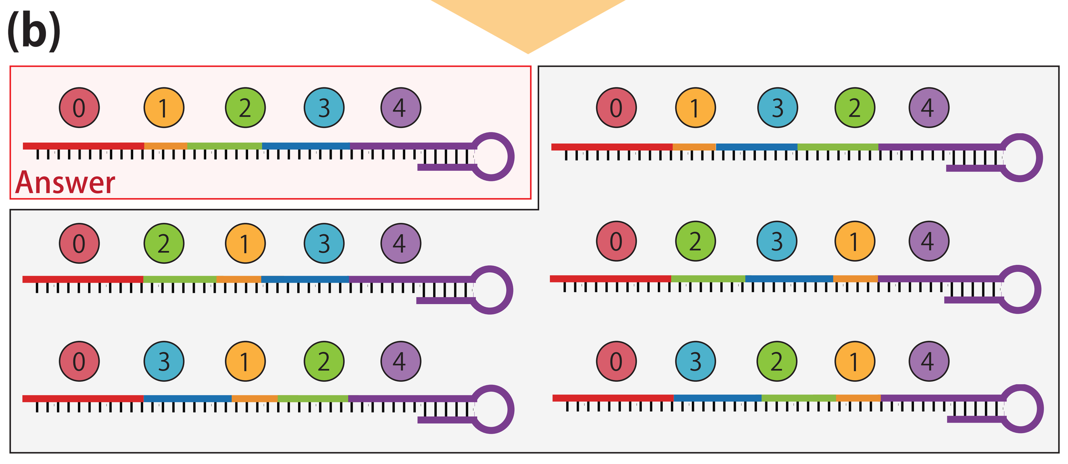
Result & discussion

Raw data of the unzipping time



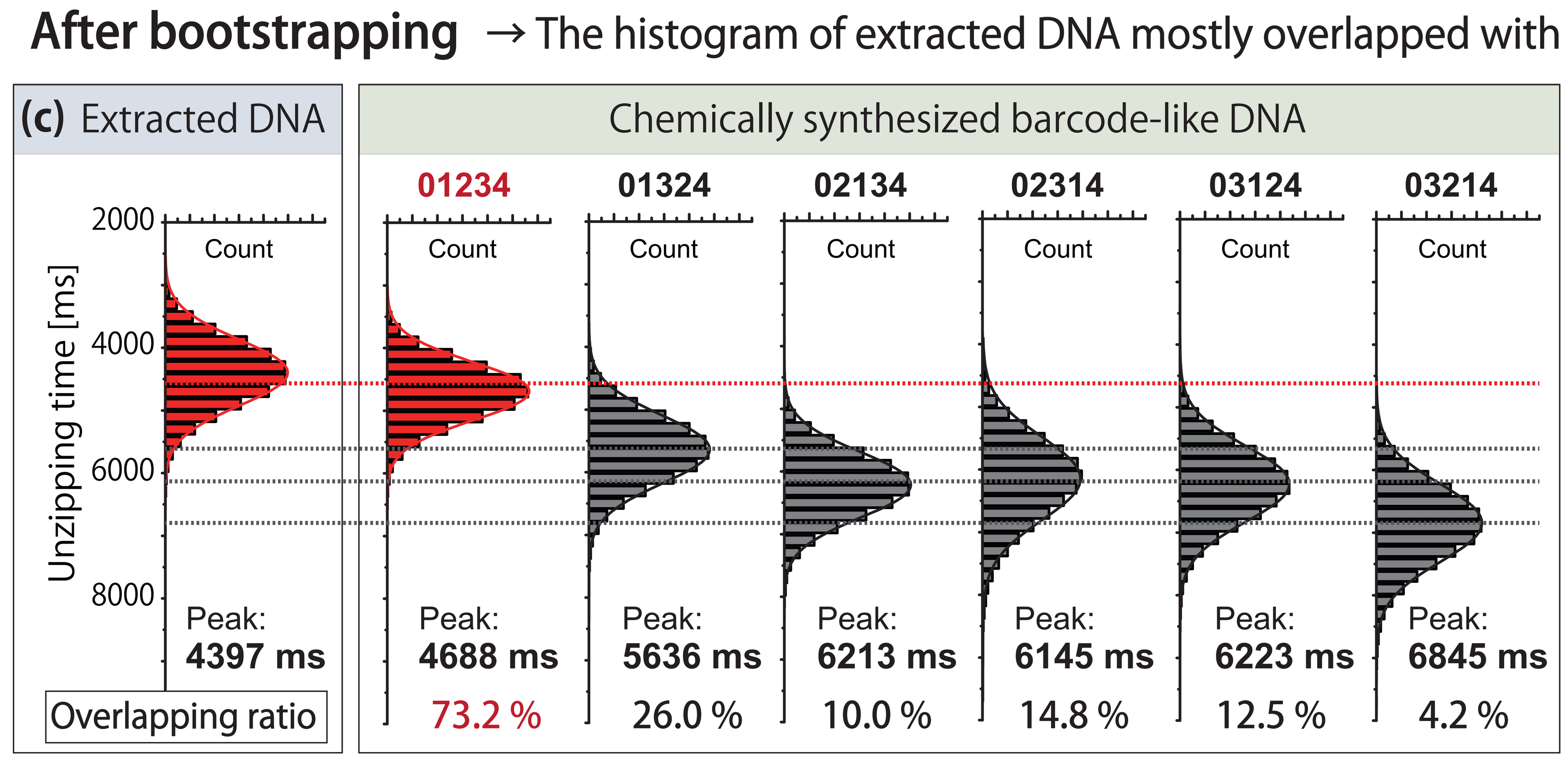
• No normality (p<0.05, Shapiro-Wilk test)
• No significant difference (p>0.05, Mann-Whitney U test)

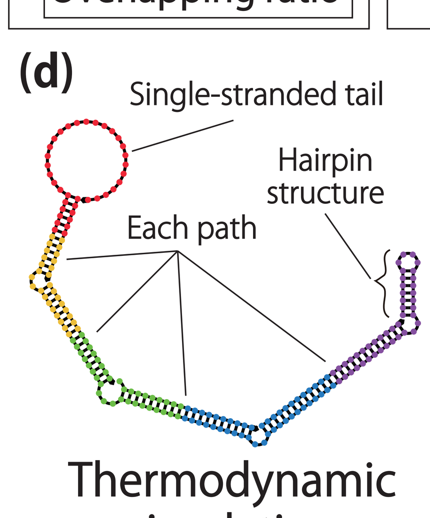
Check the accuracy of nanopore decoding...



Chemically synthesized barcode-like DNA
(same-length/different route)

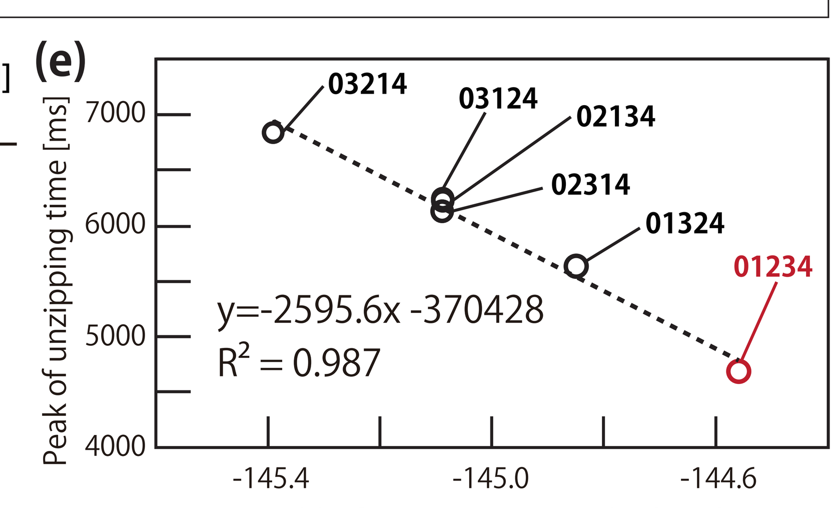
After bootstrapping → The histogram of extracted DNA mostly overlapped with that of the answer (01234).

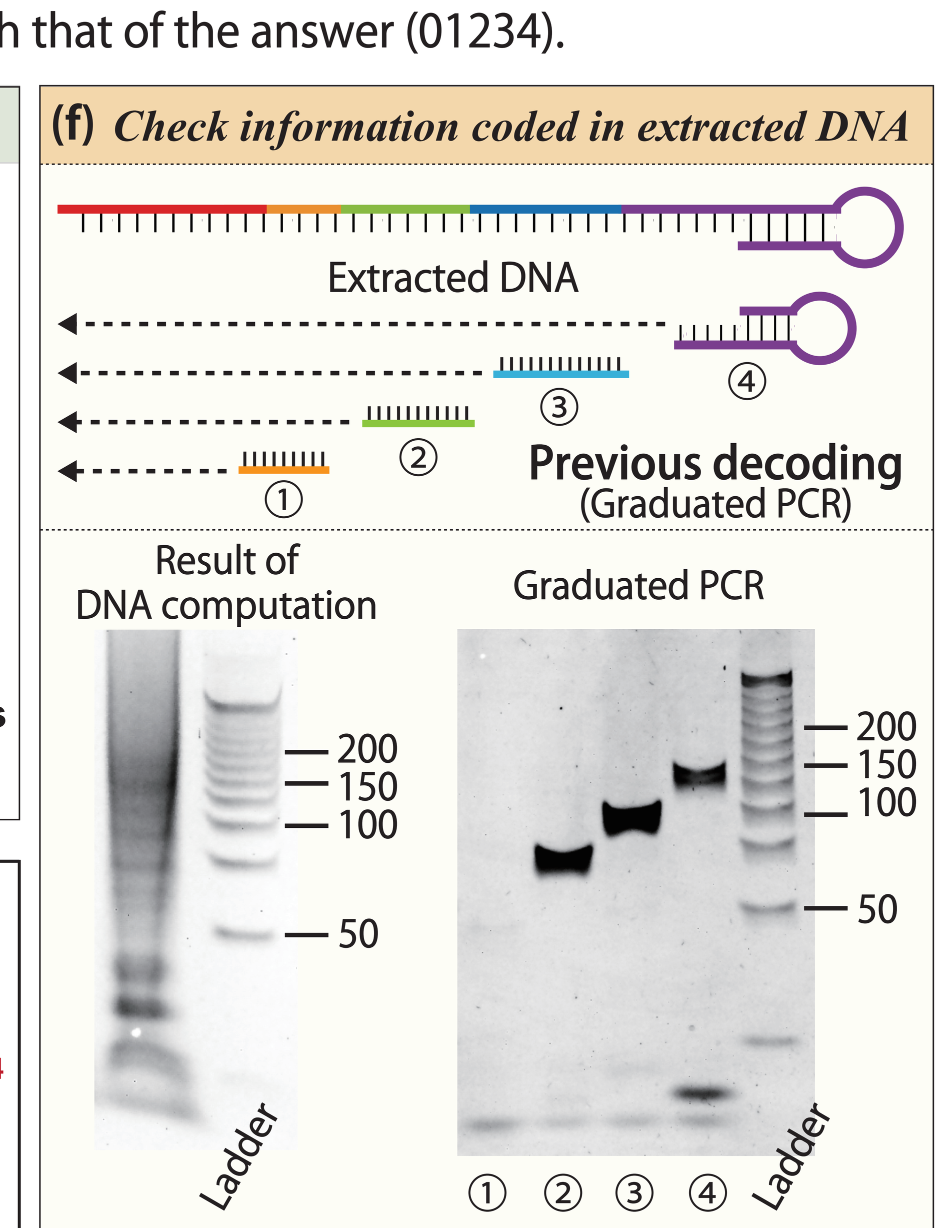




Thermodynamic simulation

Free energy (ΔG) [kcal/mol] (NUPACK simulations)	
01234	-144.56
01324	-144.85
02134	-145.09
02314	-145.09
03124	-145.09
03214	-145.39





Designed DNA could perform parallel computation.
The extracted DNA coded the Hamiltonian path.

Conclusion

We succeeded to perform DNA-based parallel computation using designed DNA and to demonstrate nanopore decoding with a small graph encoding a directed Hamiltonian path problem. Our data suggested that nanopore technology can be applied to DNA-based parallel computation as a decoding method. We believe that the concept of nanopore decoding can also be applied to the detection of biomarkers.

References

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