

## Research Paragraph

In the space below write **one paragraph** about the research you are doing. Please be sure to follow appropriate paragraph formatting.

Let me introduce my major. My major is channel coding, improves communication quality by adjusting complexity and performance. Since 2018, deep learning has been used in the communication field. In communication system's deep learning method, rather than a method only for communication system, the method of research in computer science (CS : a field of active research on methodology[technique]), which is conducting active research, is being transformed to suit the communication field. The communication system's challenge to solve with channel coding is to improve tradeoff for complexity and performance. Complexity and performance have Proportional relationship. Then, performance increases as complexity increases. And Channel coding can be applied not only to communication but also to hardware such as semiconductors, where complexity is important. Because if the hardware is too complex, it can't be done. Therefore, the direction of the study is that the performance should be as similar as possible to the algorithm representing the optimal value while lowering the complexity as possible. So goal of research is to reduce complexity by applying deep learning. Specially, I am interested in the LSTM technique among the methods, and I am interested in the method because it is a suitable method for long code messages.

① this → its, what?  
② explain why focus on

③ tradeoff

my → x technology

(CS) > communication

→ wireless network  
① spectrum  
② comm.

~ next class.

③ tradeoff → tradeoff tradeoff

④ the tradeoff

⑤ However  
⑥ tradeoff

## Research Paragraph

In the space below write **one paragraph** about the research you are doing. Please be sure to follow appropriate paragraph formatting.

~~Let me introduce my major. My major is~~ channel coding, improves communication quality by adjusting complexity and performance. Since 2018, deep learning has been used in the communication field. In communication system's deep learning method, rather than a method only for communication system, the method of research in computer science (CS : a field of active research on methodology [technique]), which is conducting active research, is being transformed to suit the communication field. The communication system's challenge to solve with channel coding is to improve tradeoff for complexity and performance. Complexity and performance have Proportional relationship. Then, performance increases as complexity increases. And Channel coding can be applied not only to communication but also to hardware such as semiconductors, where complexity is important. Because if the hardware is too complex, it can't be done. Therefore, the direction of the study is that the performance should be as similar as possible to the algorithm representing the optimal value while lowering the complexity as possible. So goal of research is to reduce complexity by applying deep learning. Specially, I am interested in the LSTM technique among the methods, and I am interested in the method because it is a suitable method for long code messages.

① this → it, 2/2 2/3

what?  
explain, why focus on



# Research Paragraph

About your research

## Instructions

1. Answer the following questions as notes
2. Use the notes to write one paragraph (5-10 sentences) about your laboratory and your research \*feel free to use your notes from the *Explaining your Research* document

## Paragraph Brainstorming Notes

Question		Notes
What is your research topic?		<ul style="list-style-type: none"> <li>● Channel coding with deep learning</li> </ul>
Why is this topic important?		<ul style="list-style-type: none"> <li>● By optimizing parameters through deep learning method, adjust tradeoff of complexity and performance.</li> </ul>
Describe your experimentation:	Key Problem(s) / Research Question(s)	<ul style="list-style-type: none"> <li>● What <b>deep learning techniques</b> (method) were used?</li> <li>● How much has performance improved?</li> <li>● How much has <b>complexity</b> changed?</li> <li>● How <b>many times</b> is the train in total?</li> <li>● What's the difference (improvement) from <b>previous study</b>?</li> </ul>
	Experimental Process: What experiments or tests do you perform to learn about or solve this problem?	<ul style="list-style-type: none"> <li>● Deep learning (used in computer science : SC is major part of deep learning, but communication system just use deep learning as Tools) should be adjusted to <b>become an appropriate deep learning model</b> in the field of communication.</li> <li>● Existing communication-related domain knowledge is required. (<b>domain knowledge</b>)</li> <li>● Set which parameters to train.</li> </ul>
How will this research be beneficial to the field of study? or How can it be applied outside of research? (i.e. commercial use or useful for everyday people)		<ul style="list-style-type: none"> <li>● In order to <b>be applied to hardware</b> (semiconductor), complexity must be low. So, improvement of complexity makes the method suitable for hardware.</li> </ul>

**Major** : my major is channel coding with deep learning.

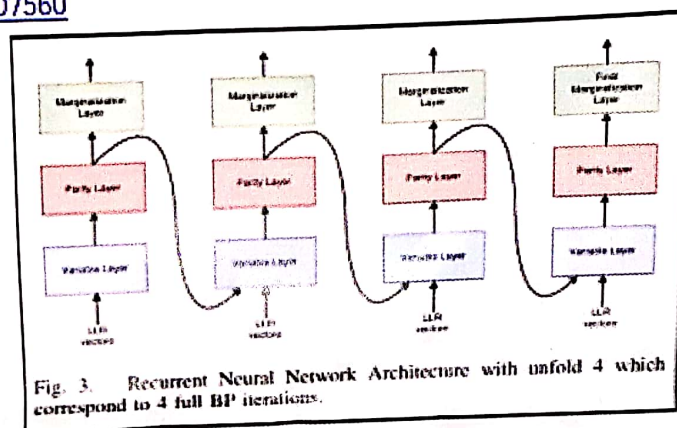
**research's goal(purpose)** : adjust complexity and performance(for HW equipment)  
The complexity must be low to be applied to hardware, but the performance must not be too poor.  
(tradeoff complexity & performance)

- recent research trend in my field is using deep learning for optimizing parameter. The reason why is that optimizing parameter is helpful for low complexity.

I think a master's degree, unlike a doctor, should write a graduation paper on application rather than theoretical content. Because I lack my major knowledge and experience.

## 1. RNN decoding of linear block codes

<https://arxiv.org/abs/1702.07560>



In this paper we introduce a recurrent neural network architecture for decoding linear block codes. Our method shows comparable bit error rate results compared to the feed-forward neural network with significantly less parameters.

(idea : RNN -> LSTM)

Eliya Nachmani, Elad Marciano, David Burshtein, Yair Be'ery

Eliya Nachmani is the most active researcher in my field, and I am thinking of ideas by referring to his's paper.



## 2. Deep learning methods for improved decoding of linear codes

<https://arxiv.org/pdf/1706.07043.pdf>

We also introduce a recurrent neural decoder architecture based on the method of successive relaxation. Another technique which can be used to improve the performance of belief propagation is the method of **successive relaxation** (or simply "relaxation"), as described in [23].

In relaxation, an exponentially weighted moving average is applied to combine the message sent in iteration  $t-1$  with the raw message computed in iteration  $t$  to yield a filtered message,  $m'_t$ :

$$m'_t = \gamma m'_{t-1} + (1-\gamma)m_t \quad (19)$$

where  $\gamma$  is the relaxation factor. As  $\gamma \rightarrow 0$ , the decoder becomes less relaxed, and as  $\gamma \rightarrow 1$ , the decoder becomes more relaxed. When  $\gamma = 0$ , the decoder reverts to being a normal, **non-relaxed decoder**.

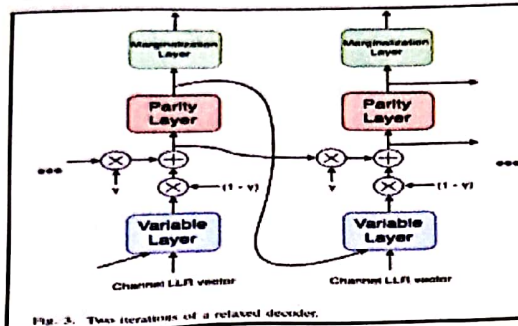


Fig. 3. Two iterations of a relaxed decoder.

- (1) SGD로  $\gamma$  값을 최적화한다고 하였지만, 그 값에 따른 성능 차이를 언급하고 있지 않다. 물론 brute force simulation을 통해서 보단 SGD로 최적화 후 BER 결과값을 출력했다고 하지만 그에 따른 성능 차이 비교.
- 2) 이것을 LSTM이나 CNN에 적용해보기)

The goal is to create new information by combining current and past information (using relaxation concept) properly and obtain the desired result value.

## 3. Pruning Neural Belief Propagation Decoders

<https://arxiv.org/pdf/2001.07464.pdf>

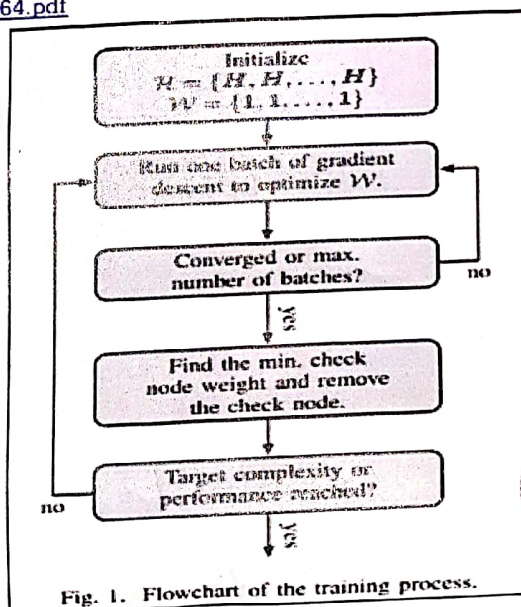


Fig. 1. Flowchart of the training process.

Considering the weights in the Tanner graph, the **magnitude of the weights** gives an indication of the importance of the edge in the decoding process. A magnitude close to **zero** indicate that the edge has **low importance**. By tying the weights for each CN, i.e., enforcing that the weights of all incoming edges to a single CN are equal, the weights can be interpreted as an **indication of the importance** of the CN in the decoding process.

CNs with connected low-weight edges do not play an important role in the decoding process and can be removed. We use this magnitude-based pruning approach to **reduce the complexity of the decoder by removing CNs** from the Tanner graph.

Valuation  
basis

(1. 가장 작은 weight를 가진 CNS 값을 모두 0으로 만드는 것 혹은 dependent한 row값을 0으로 설정하여, 제거하는 방법 -> weight 모두 제거 시 성능 감소가 있으니, weight를 training으로 모두 제거 말고 일부 제거하여, 성능향상과 복잡성 감소 이득

2. 보통 train 횟수와 test의 횟수를 동일하게 진행하는데, train 과정에서 얻은 최적의 결과값을 goal로 설정 후, 그에 90%, 95% 등 적정 수준 도달 시 test epoch stop.

3. Although recurrent neural network (RNN) [11] can process long code, some performance degradation appears since the neural network is unable to make the best use of the continuous inputs.  
long code에서 좋은 성능을 보일 수 있는 RNN이 지속적으로 input을 neural network에 입력할 수 없어, 성능 하락이 있으니, 만일 A라는 짧은 코드가 있다면, 이것을 protograph ldpc를 만들 때, copy & permutation을 하는 것처럼 입력 값을 적정 횟수만큼 cop & permutation으로 continuous input이 되도록 설정.)

[11] G. Kechriotis, E. Zervas, and E. S. Manolakos, "Using recurrent neural networks for adaptive communication channel equalization," IEEE transactions on Neural Networks, vol. 5, no. 2, pp. 267-278, 1994.



9/22.  
Terrarosa 5:10 ~ 5:20

## \* Article Annotation Practice

Which section of the paper  
is the best place to find that  
information? → section 2.

After skimming the article.

↳ What is the purpose or aim  
of this study?

adjust trade off performance and  
complexity.

## D2, Quick write.

↳ let me introduce my major.

explaining your research

↳ ① 기피원, ② 동생원

Graduate school  
원-반 여를

hw. self introduction  
exercise

↳ when is the best time and  
where is the best place for  
you to come up with  
creative ideas?

② 쓰기 4:30

## past simple

↳ 단순과거 시제 = something that has occurred and finished.

① I saw the movie yesterday.

「과거의 특정한 시점에 발생한 동작이 끝났다는 의미。」

② I went out with my friends last night.

↳ 과거의 특정한 시점에 일어난 일이라는 것을 명백히 한다.

↳ present tense : 현재시제  
(statement of fact or truth)

※ 동사를 원형 그대로 쓴다.

3인칭 단수 뒤에 오는 동사는 원형에

~s나 ~es가 붙고, 조동사 do는 does가 된다,

## present perfect (현재완료)

ex) I have seen the movie.

I have graduated from college. 「과거의 불분명한 시점에 발생한 행동이 현재까지 관련돼 있는 것」

↳ something that is either ongoing current research.