Adversarially Trained End-to-end Korean Singing Voice Synthesis System

Music & Audio Research Group, Seoul National University

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INTERSPEECH 2019

Best Student Paper Award Nomination

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Introduction : Singing Voice Synthesis

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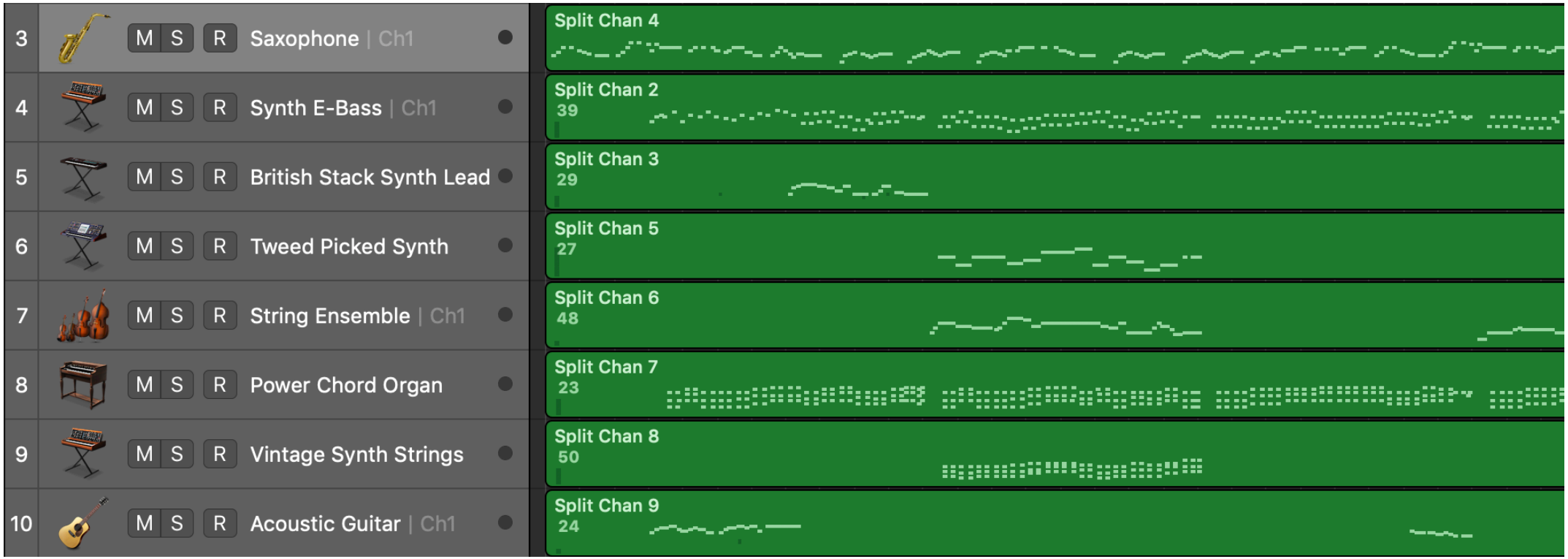
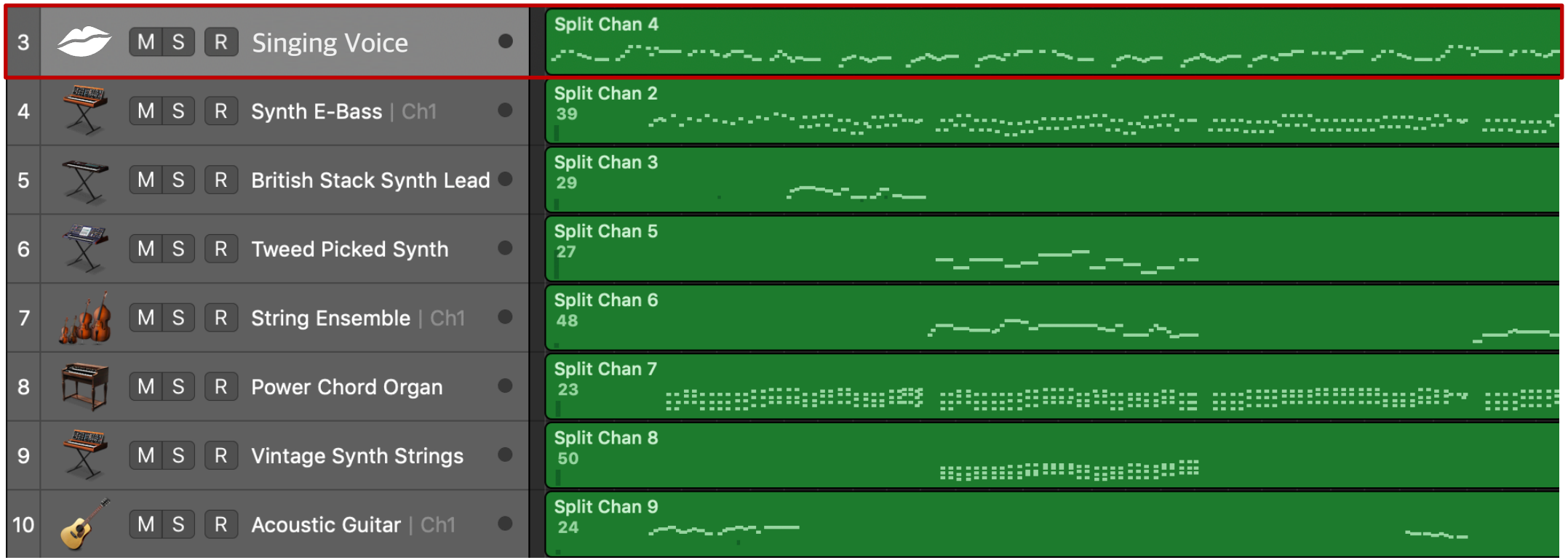


Introduction : Singing Voice Synthesis



Introduction : Singing Voice Synthesis






Proposed System Overview

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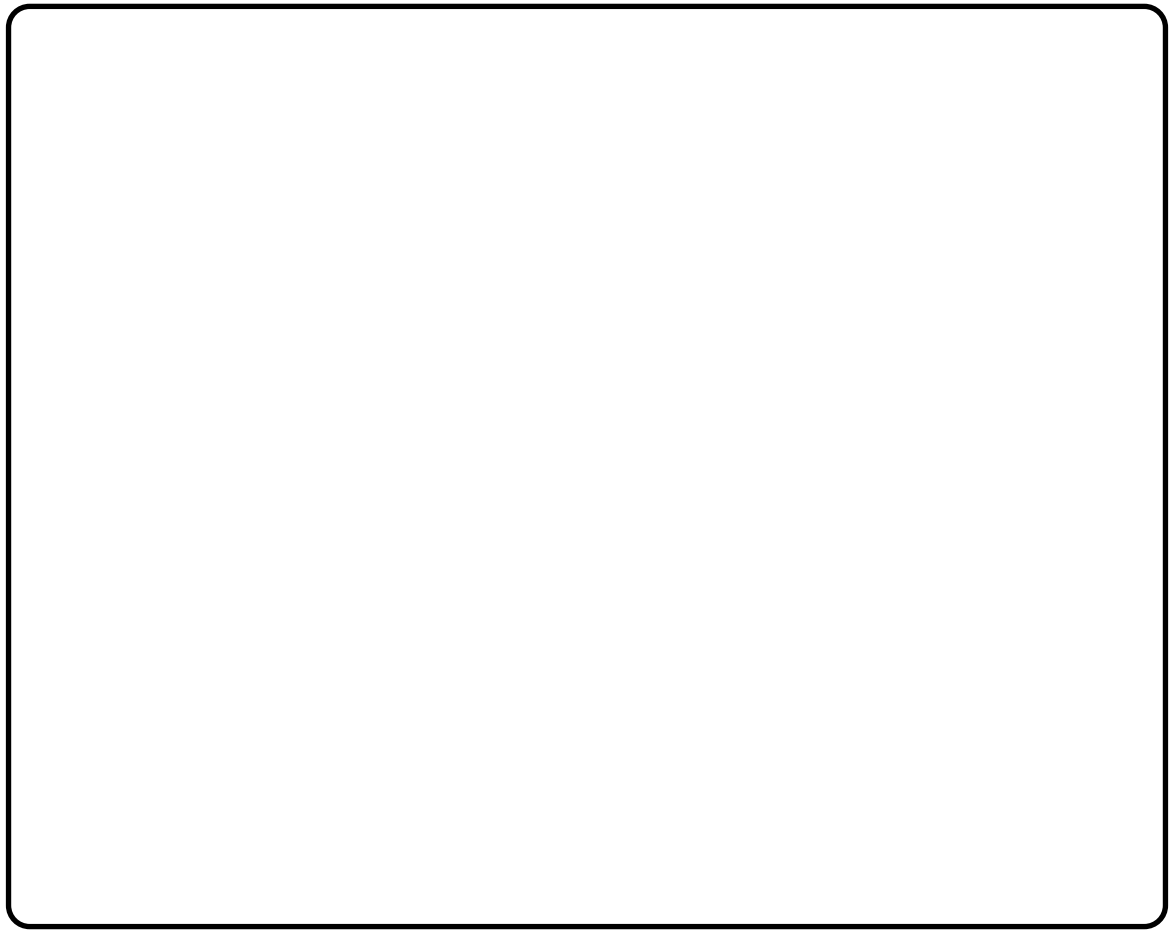

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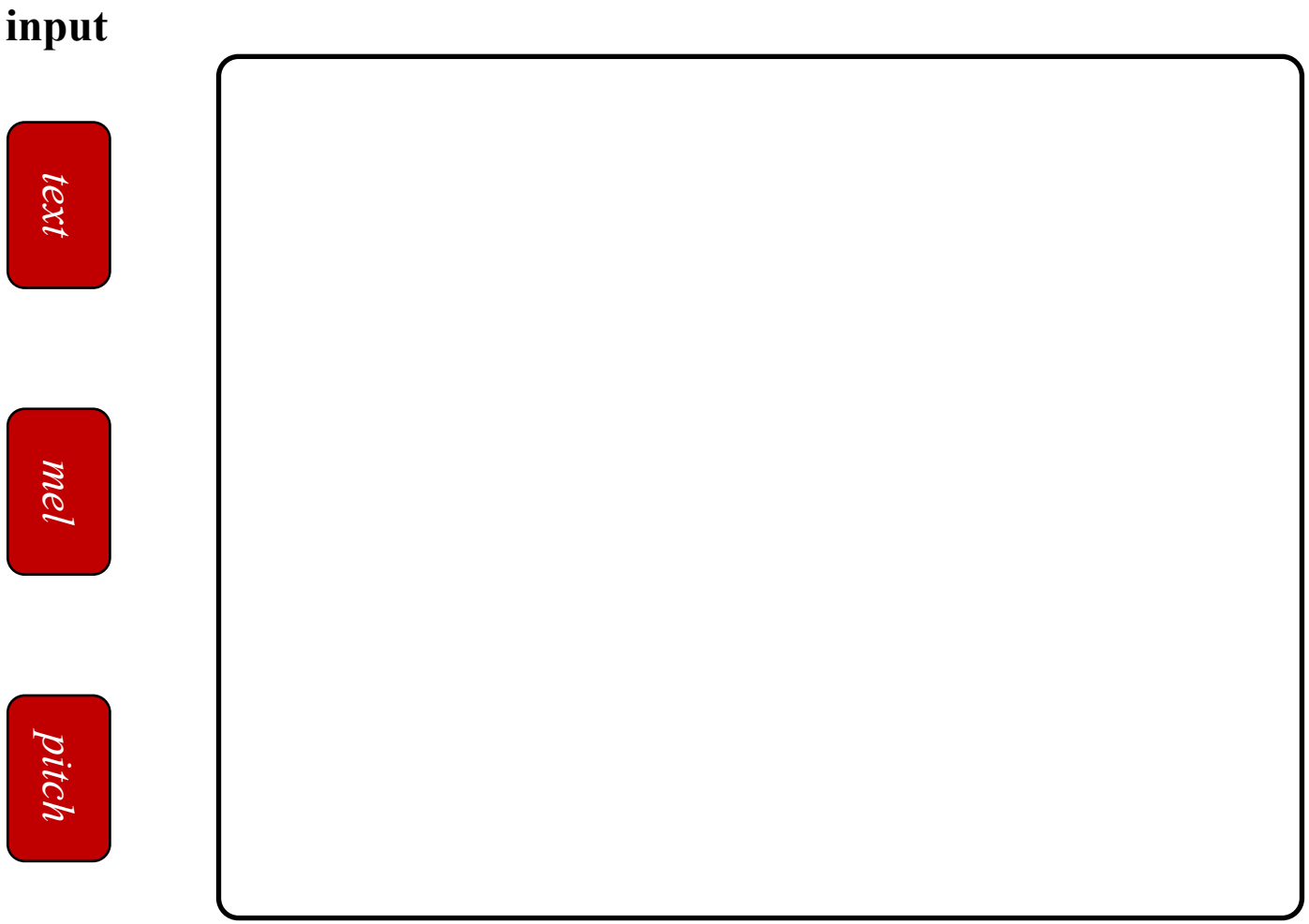

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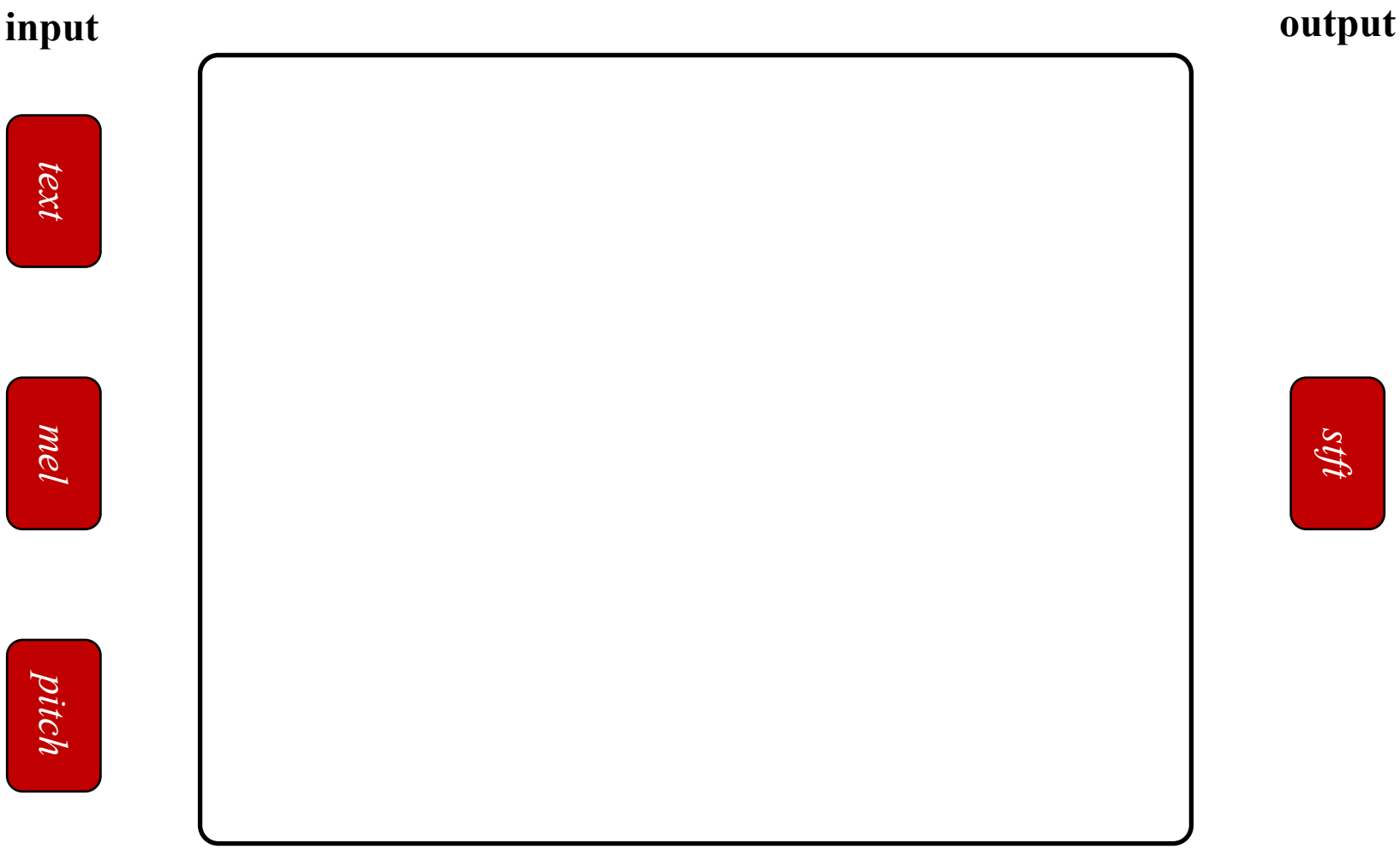

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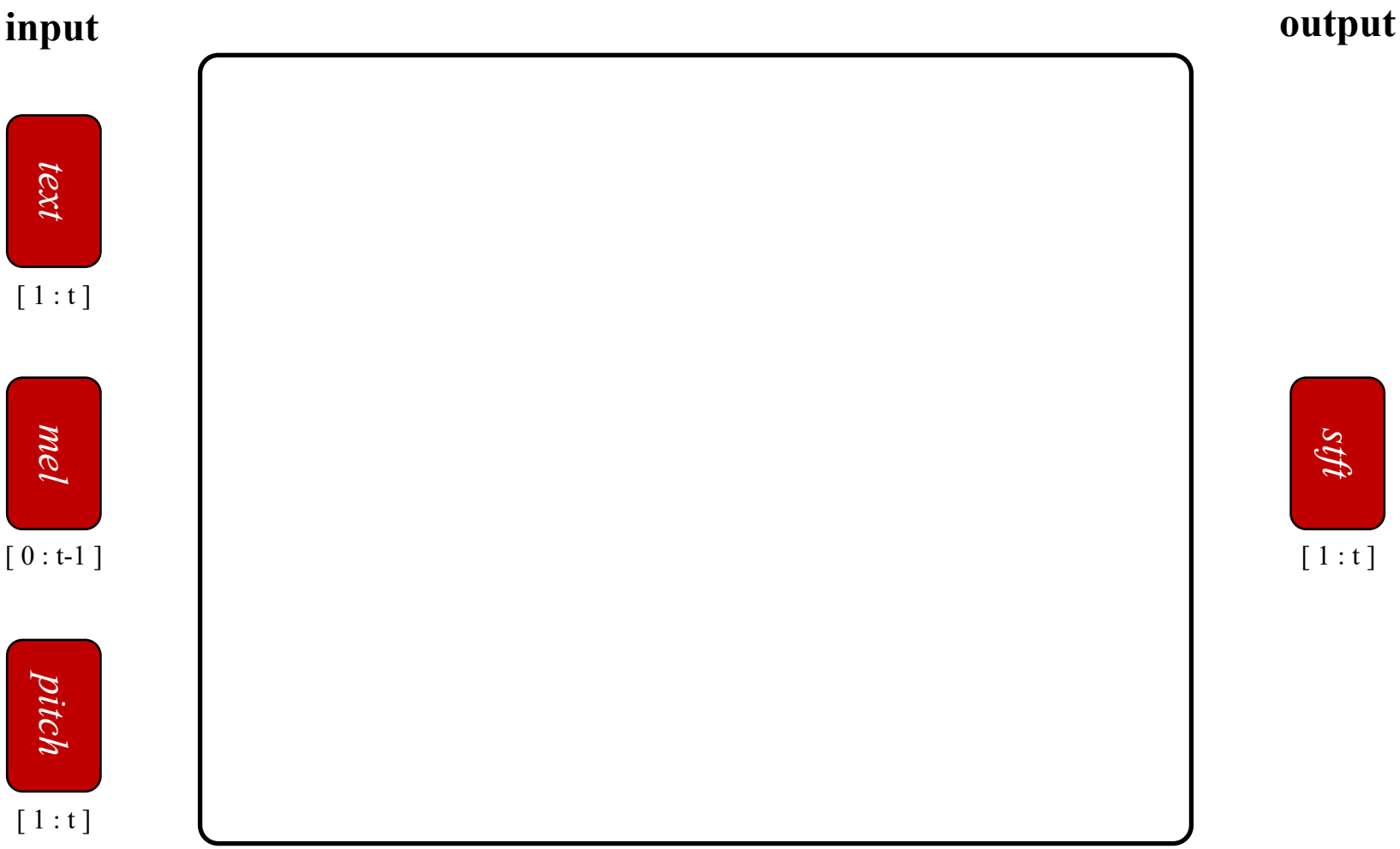

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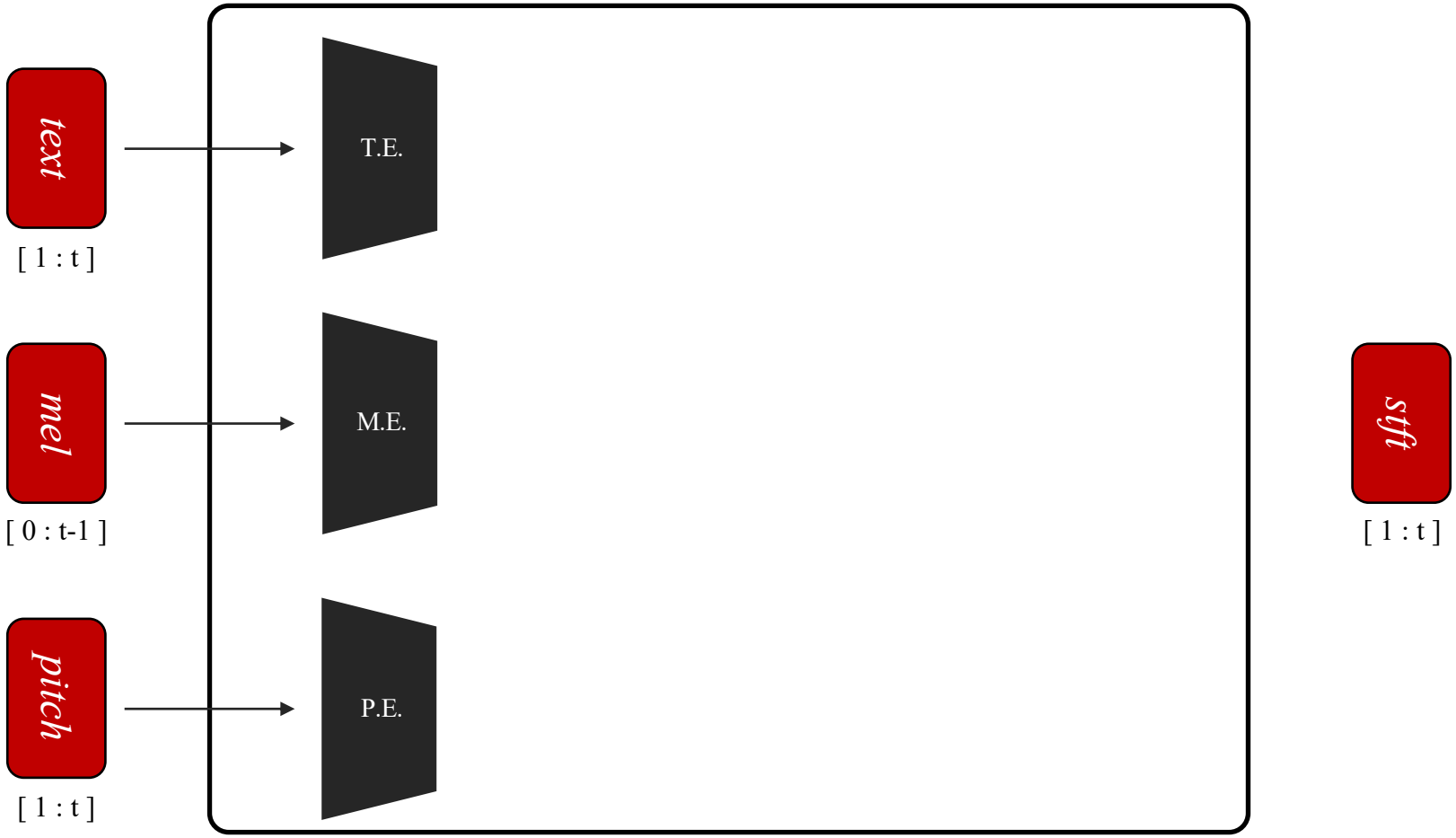
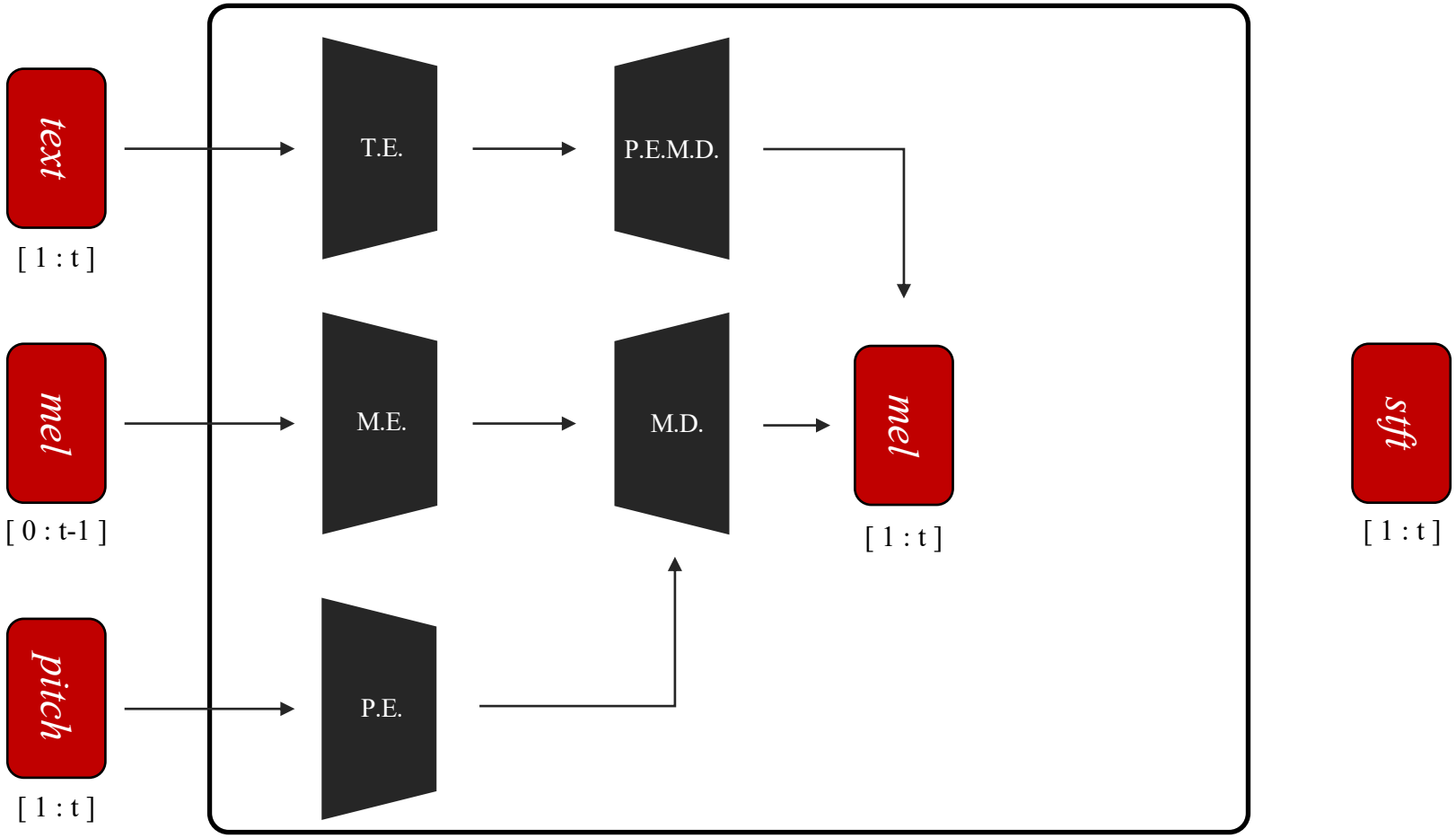


T.E. : text encoder
M.E. : mel encoder
P.E. : pitch encoder

Proposed System Overview



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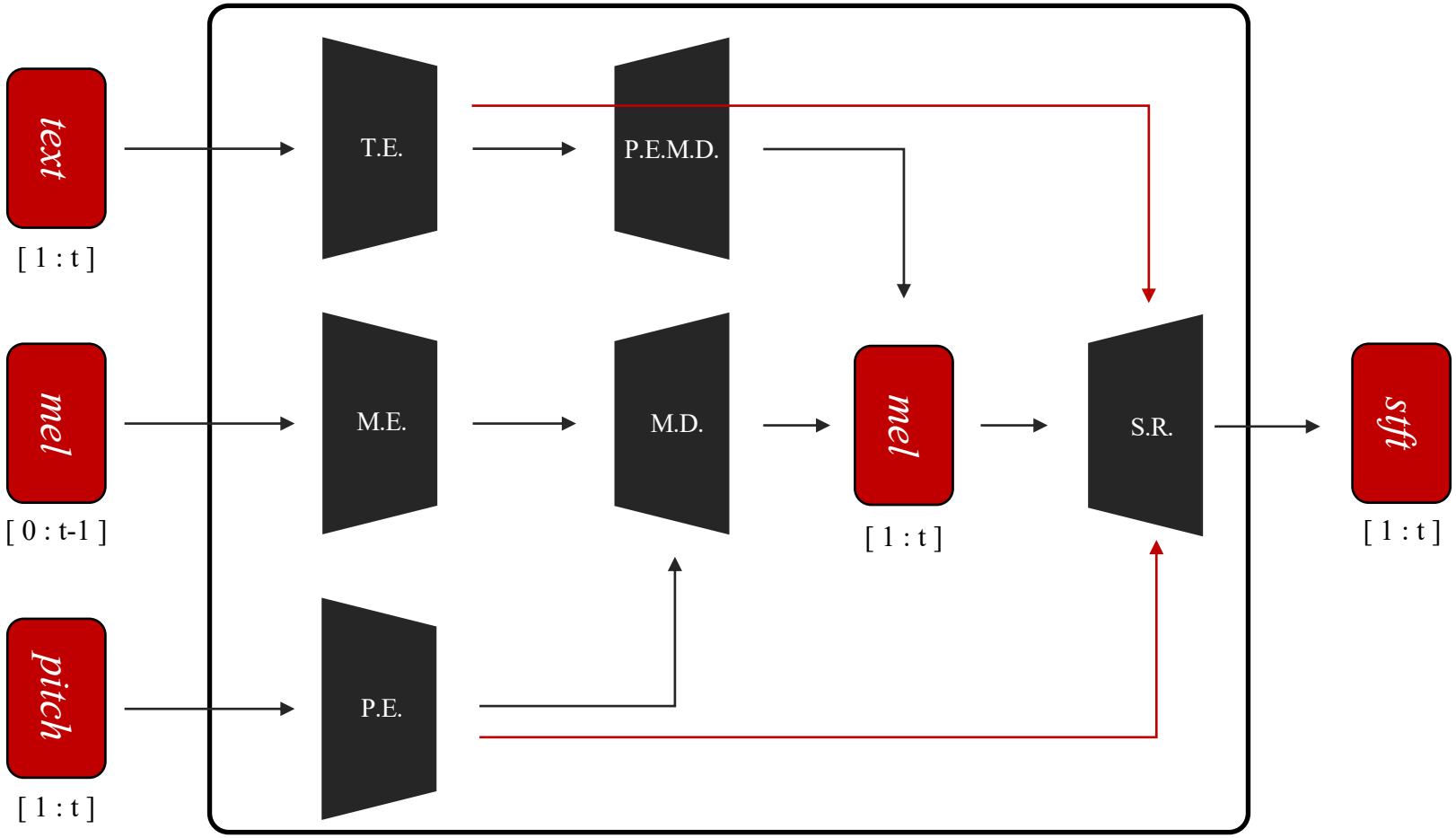

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S.R. : super-resolution network

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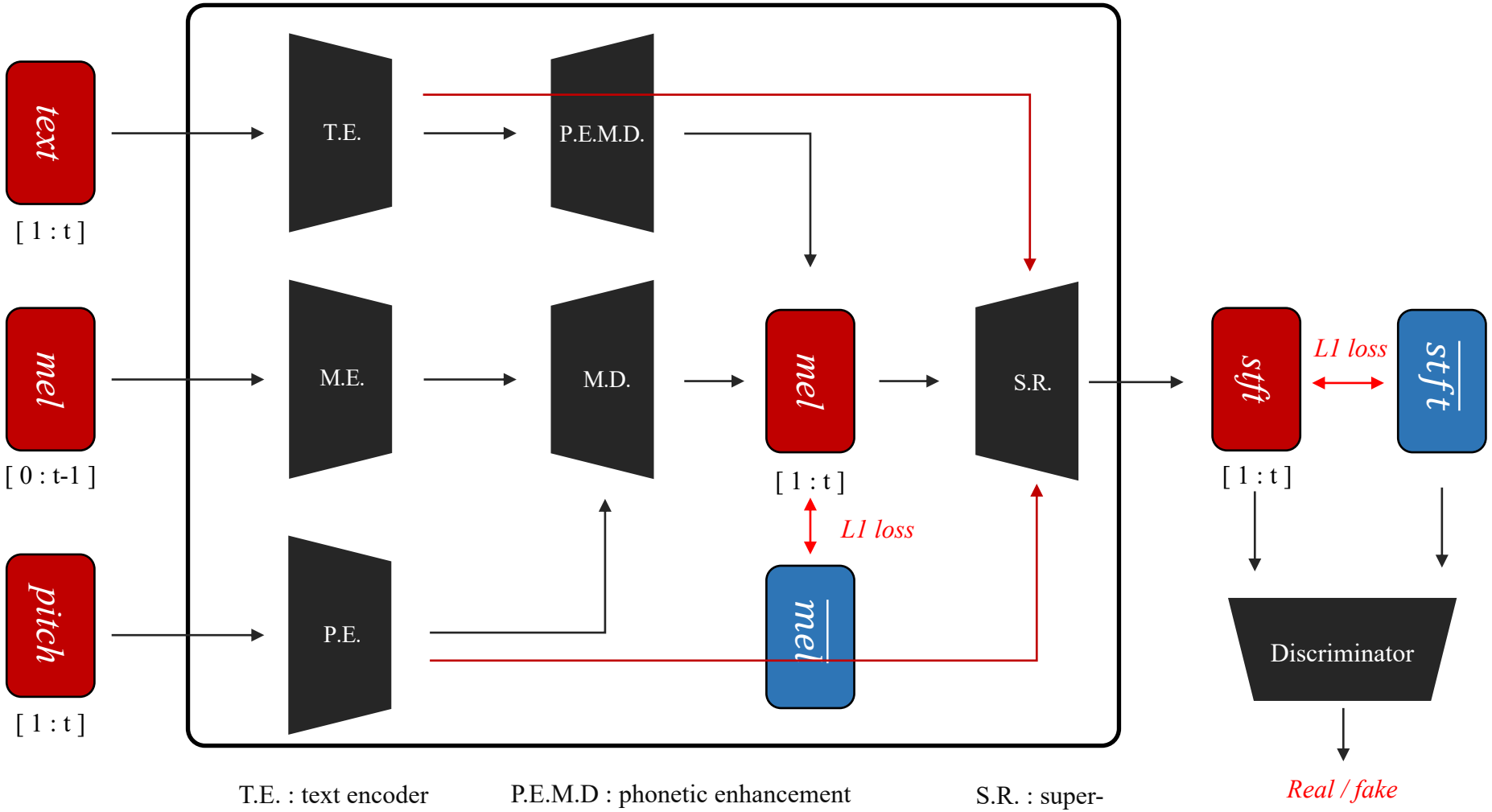

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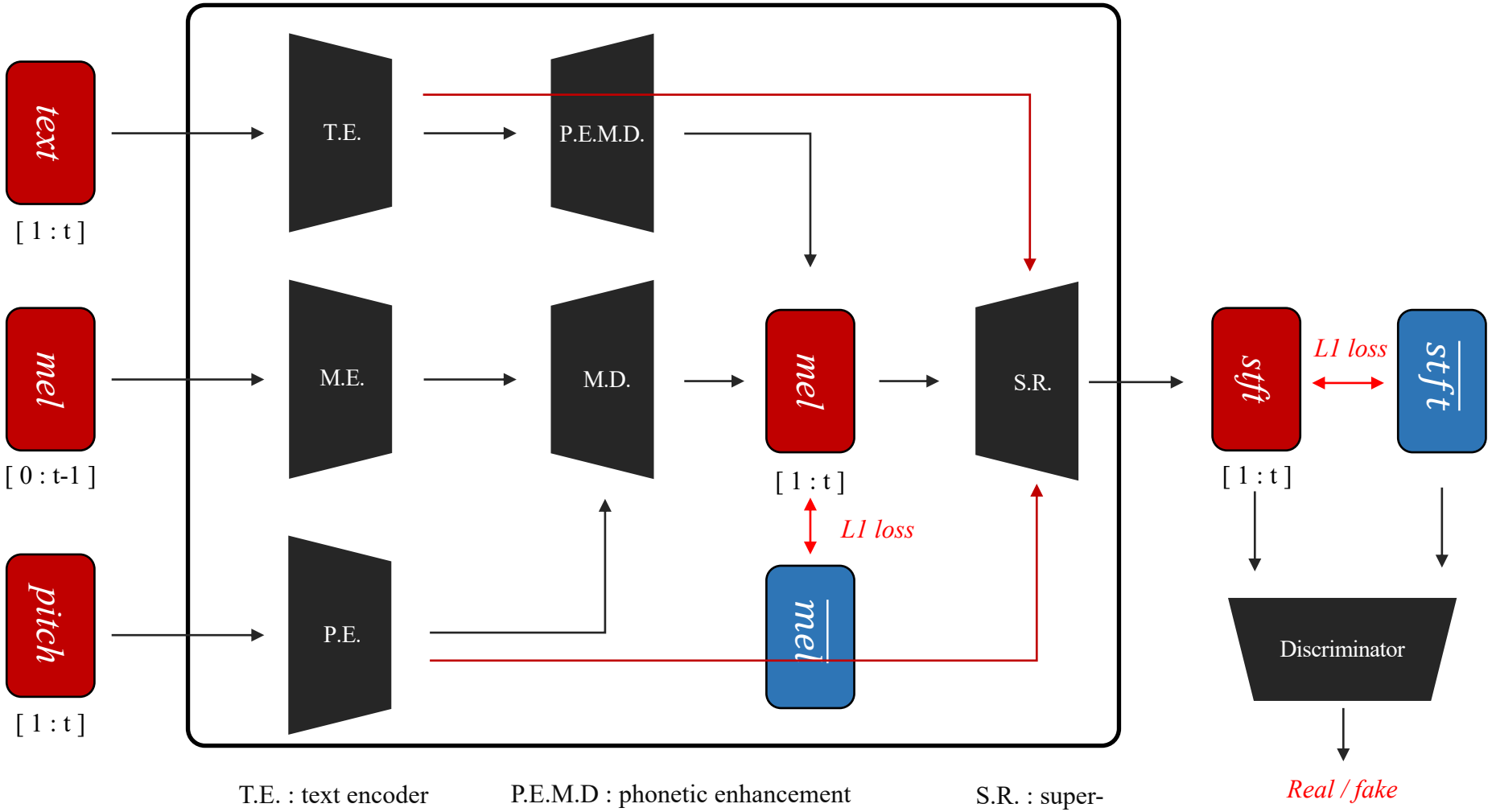
Phonetic Enhancement masking

Phonetic Enhancement masking



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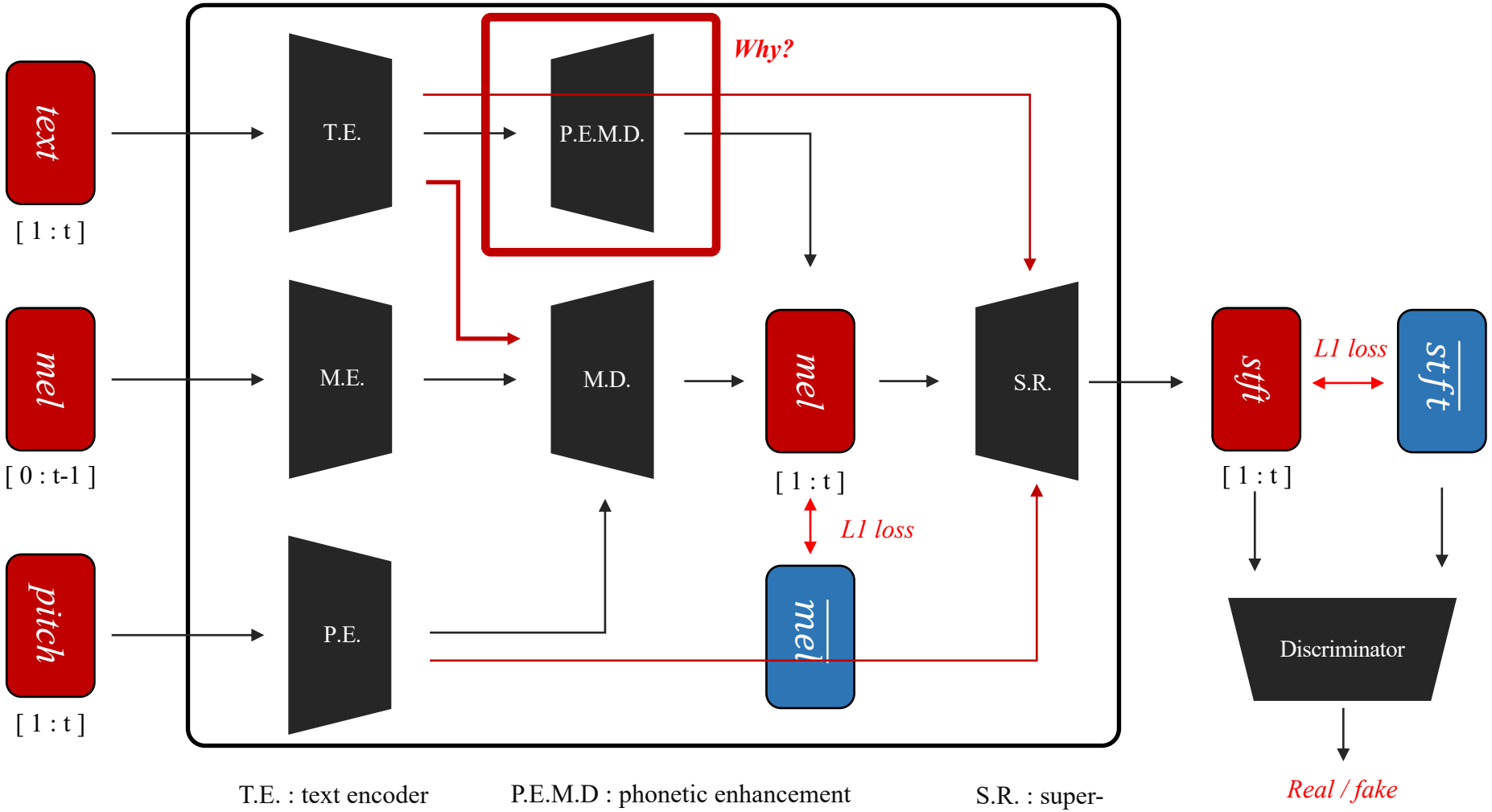

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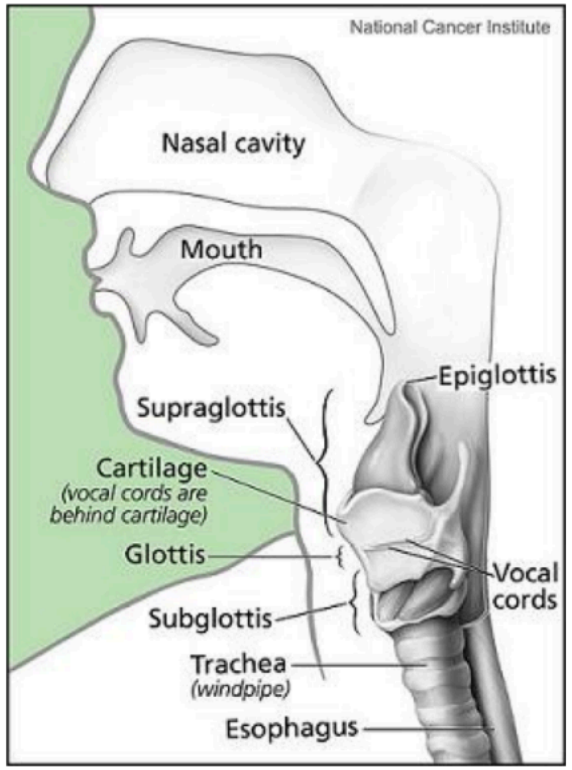
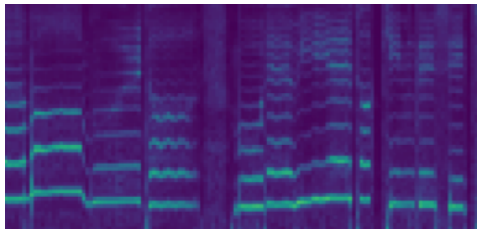
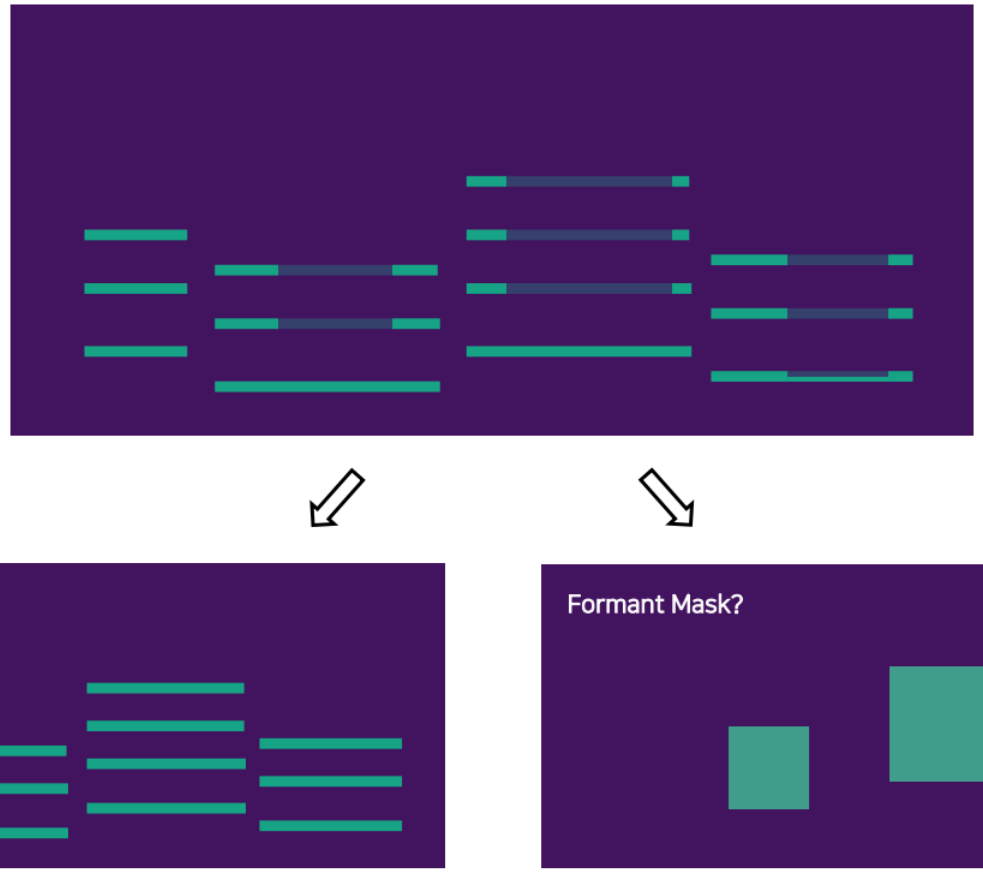


Phonetic Enhancement masking

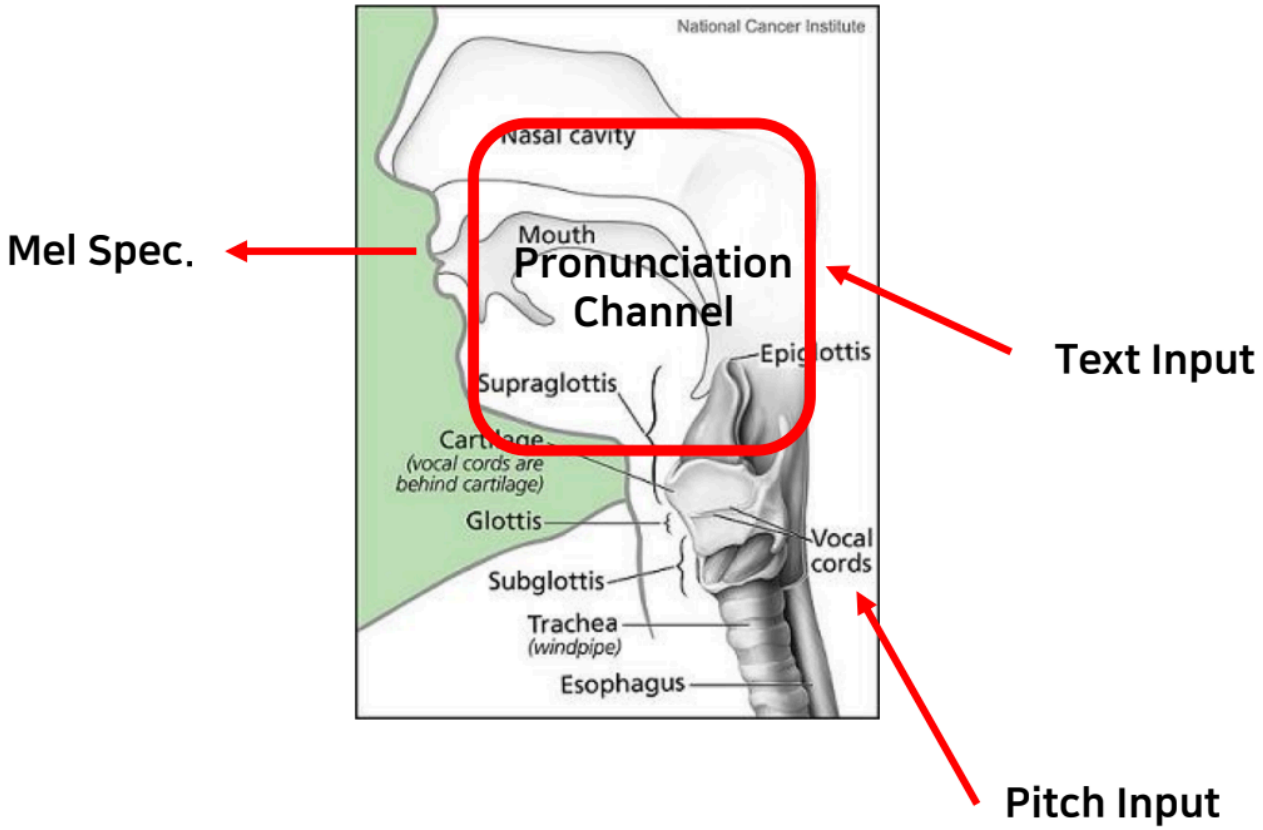
Mel-spectrogram from singing voice



abstraction



Phonetic Enhancement masking



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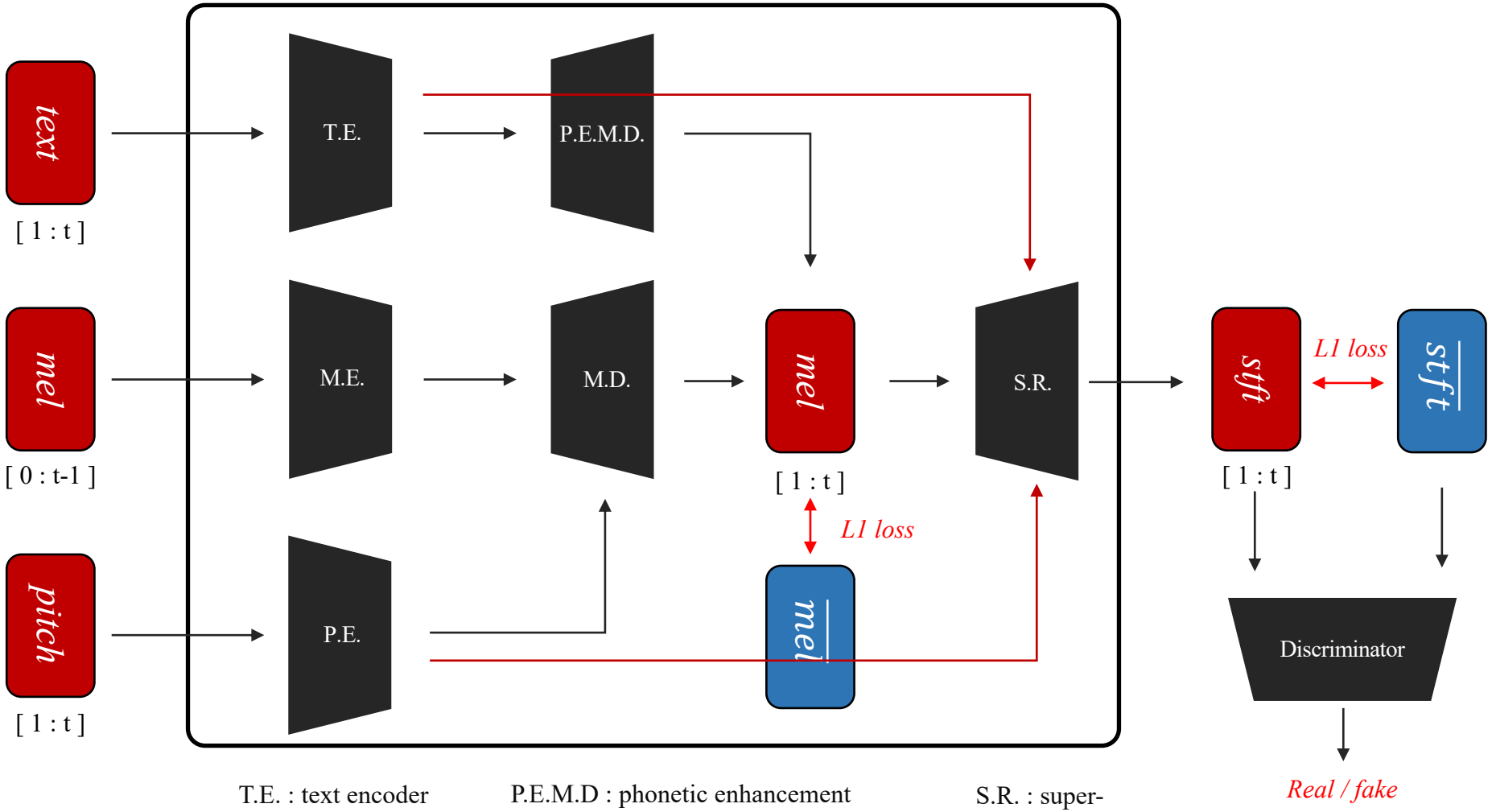

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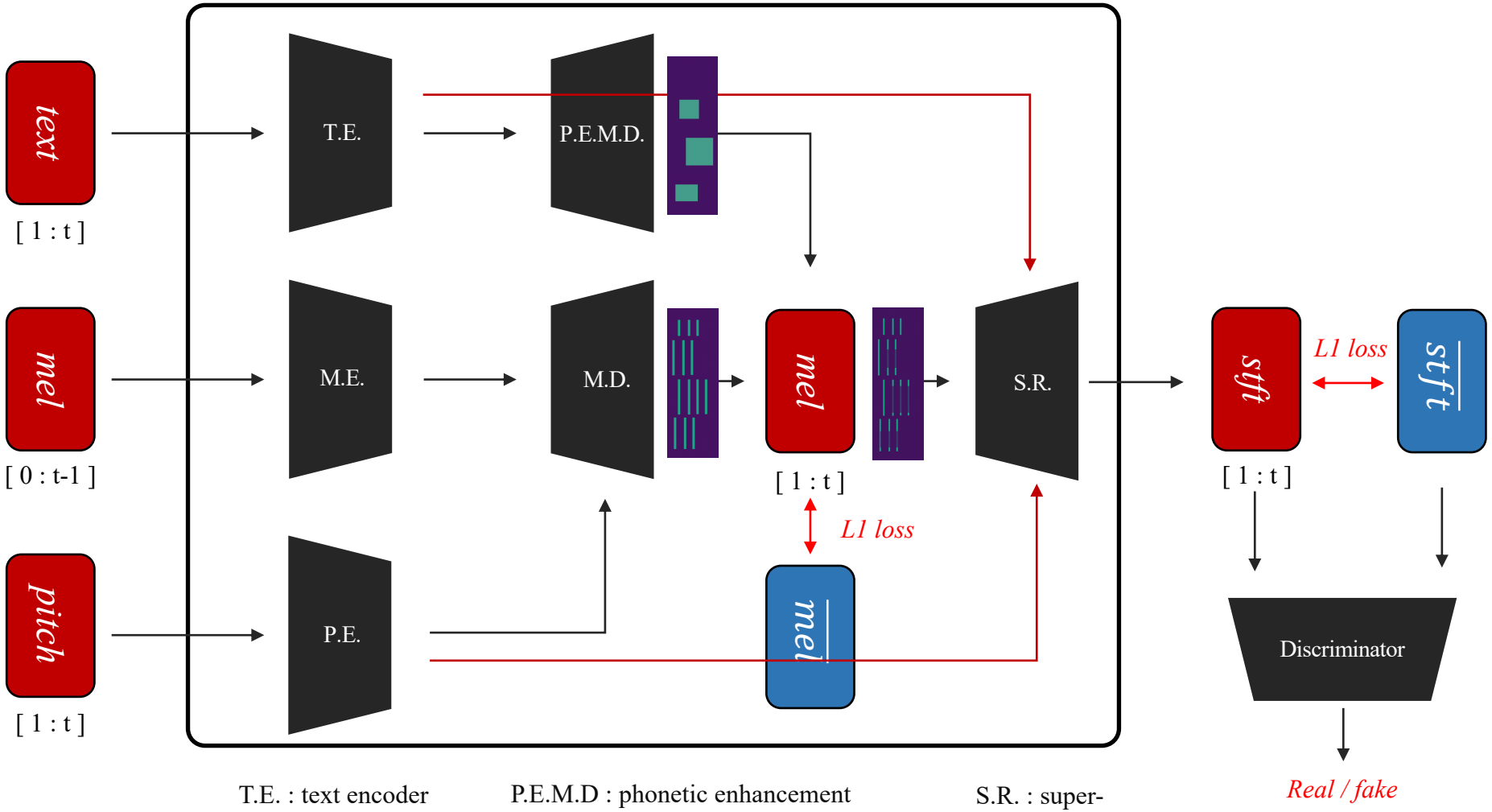

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Local conditioning pitch & text to SR

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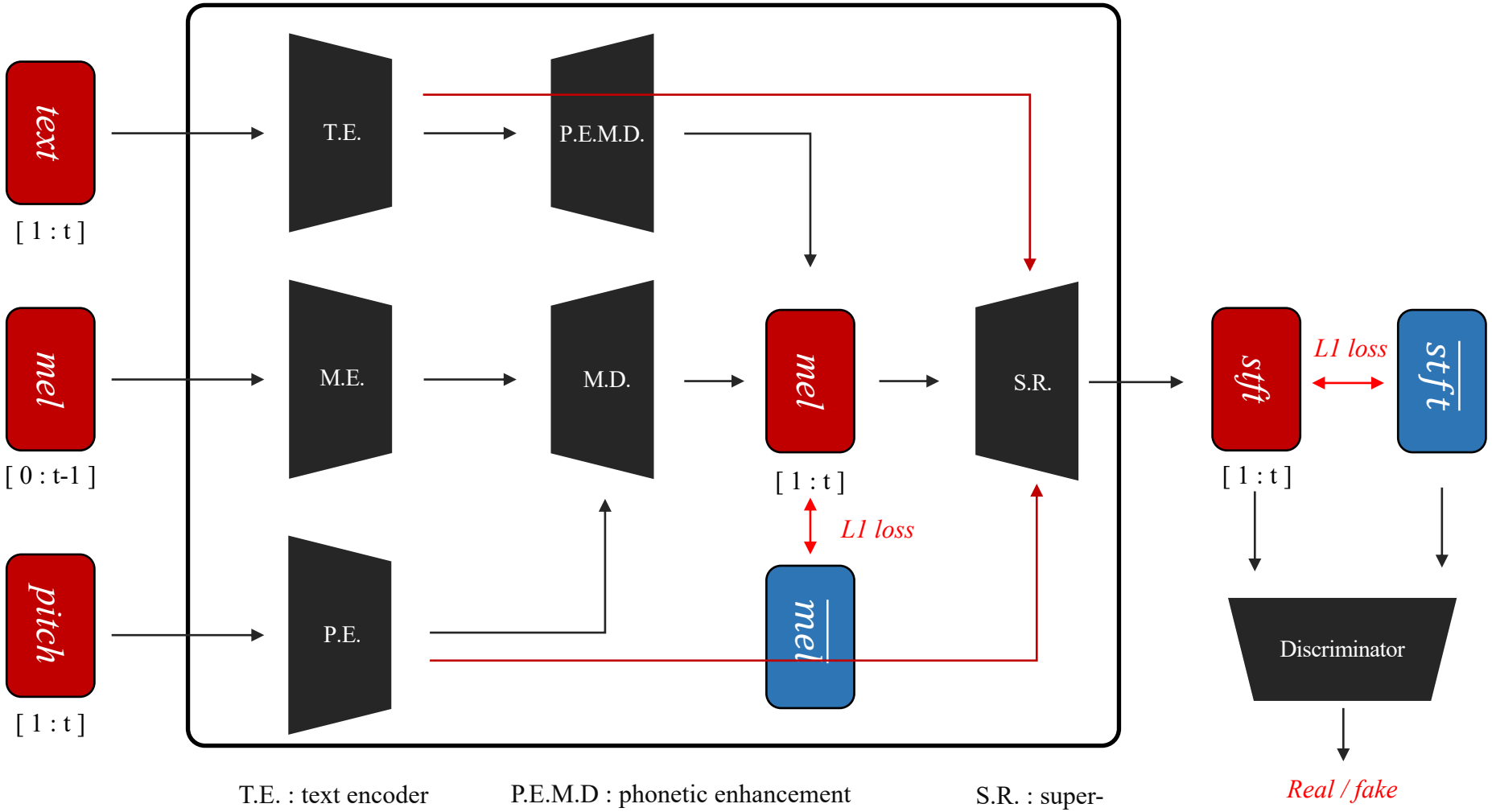

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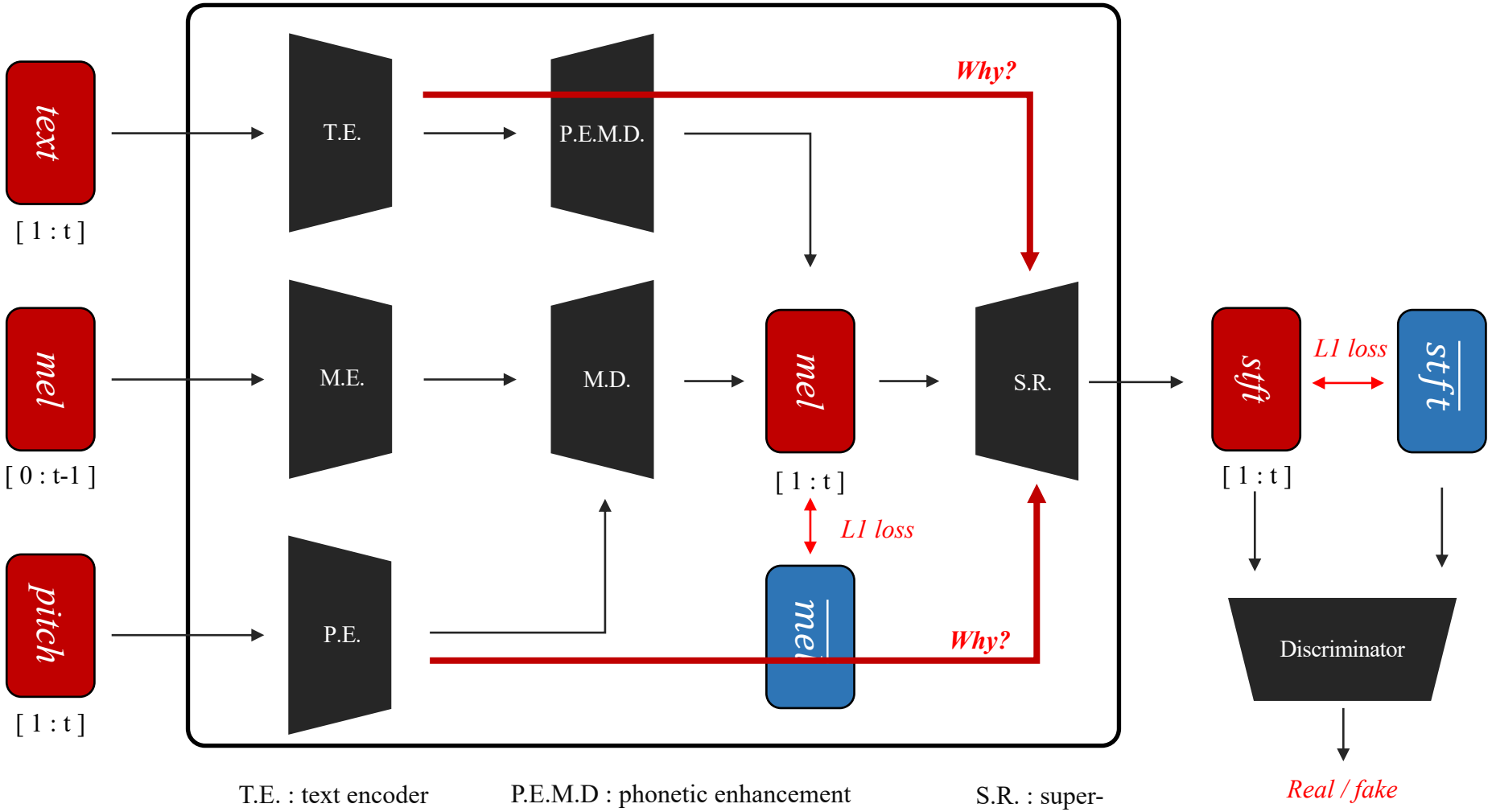

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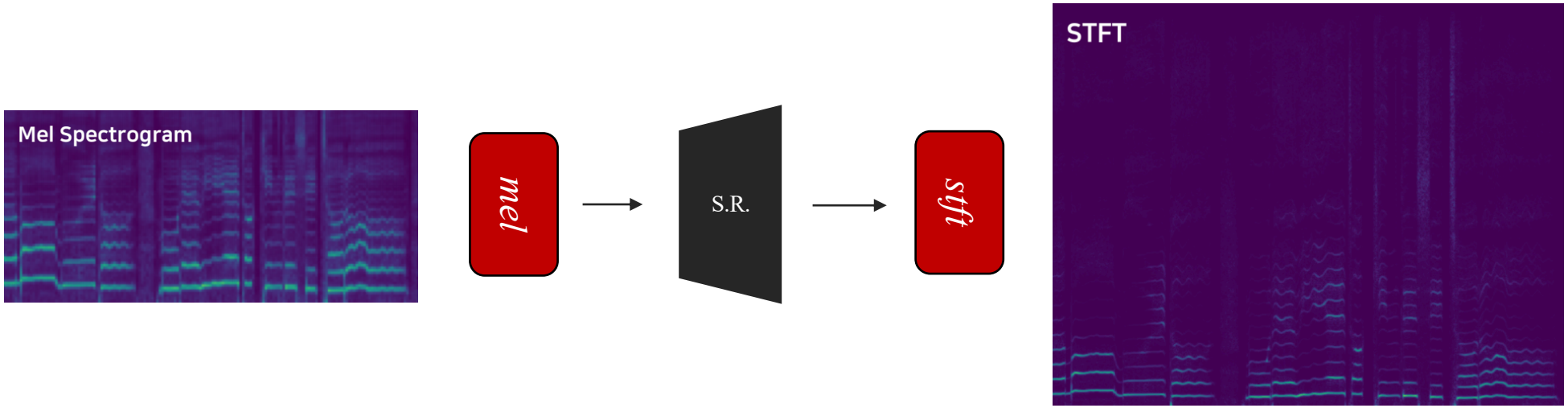

< General super-resolution network >

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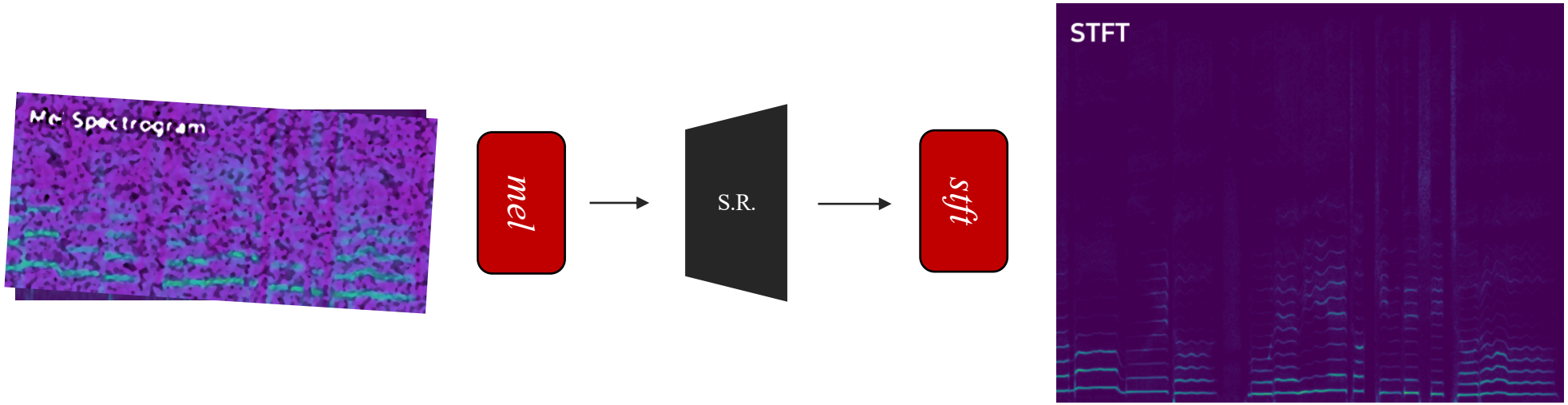

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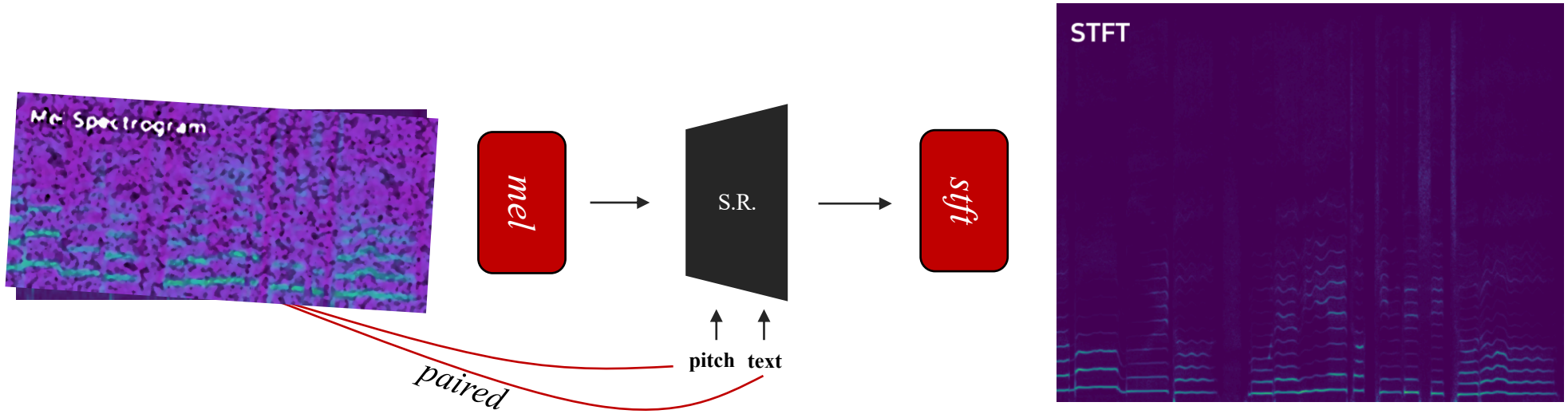

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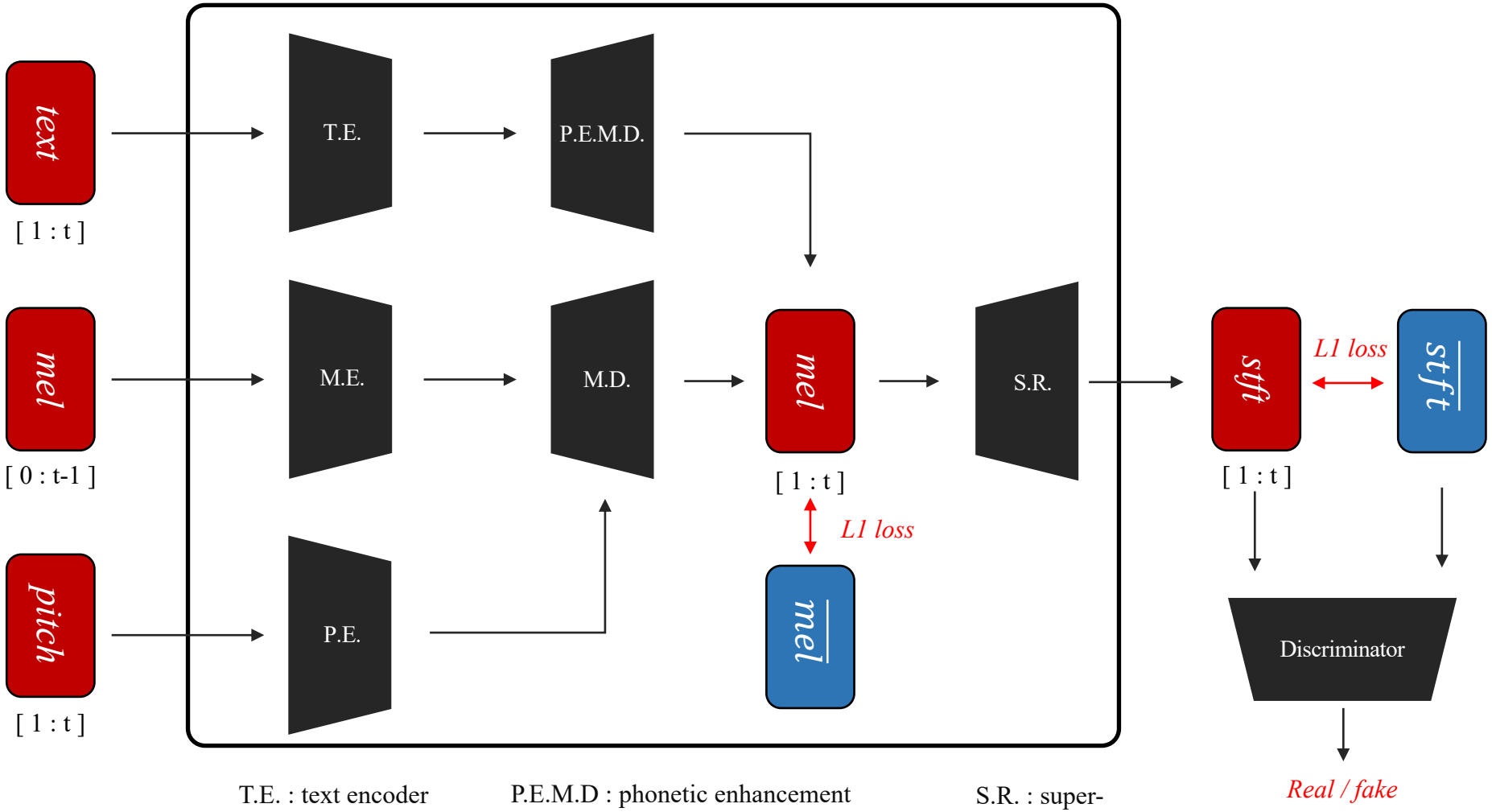

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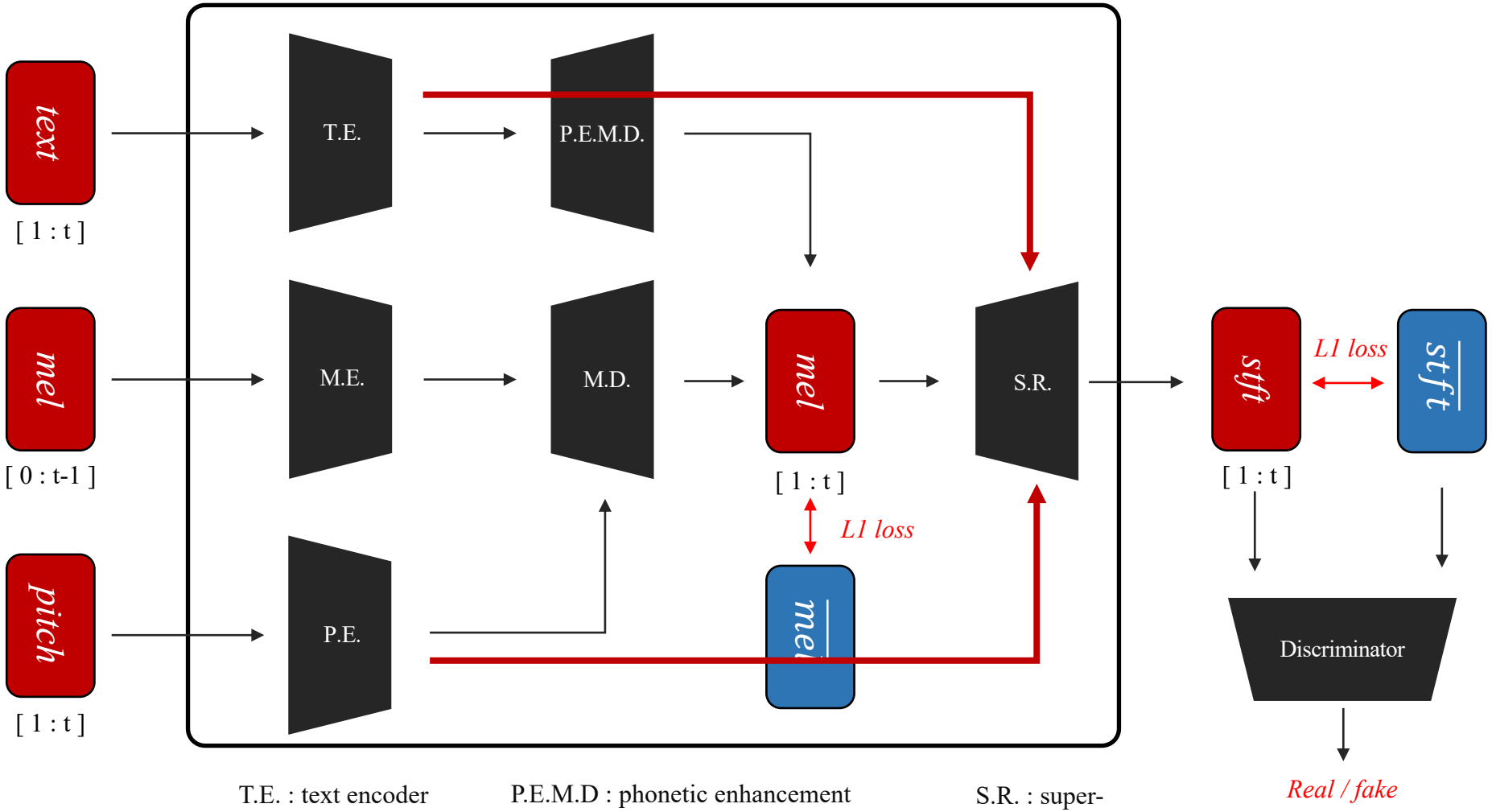

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Adversarial training

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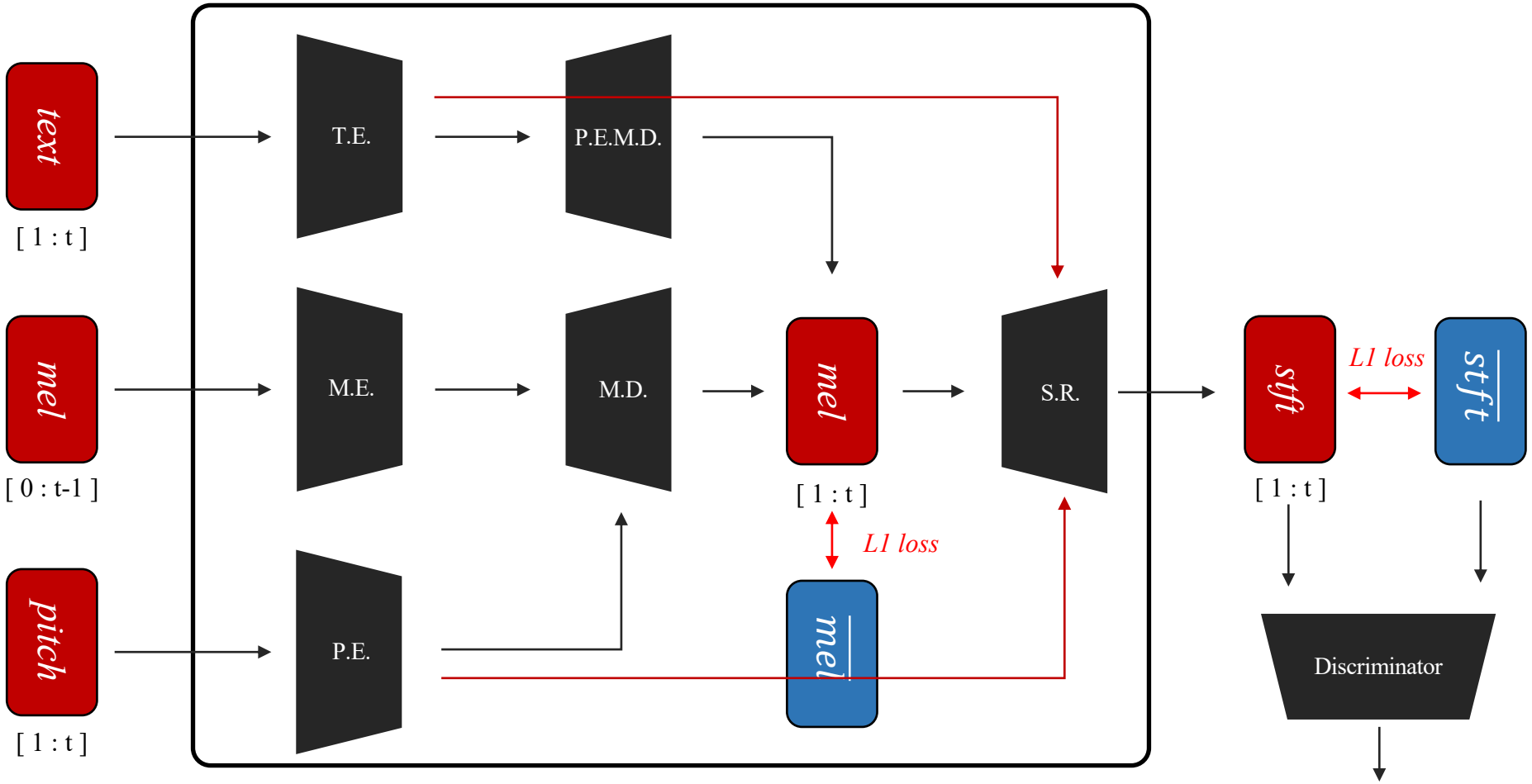

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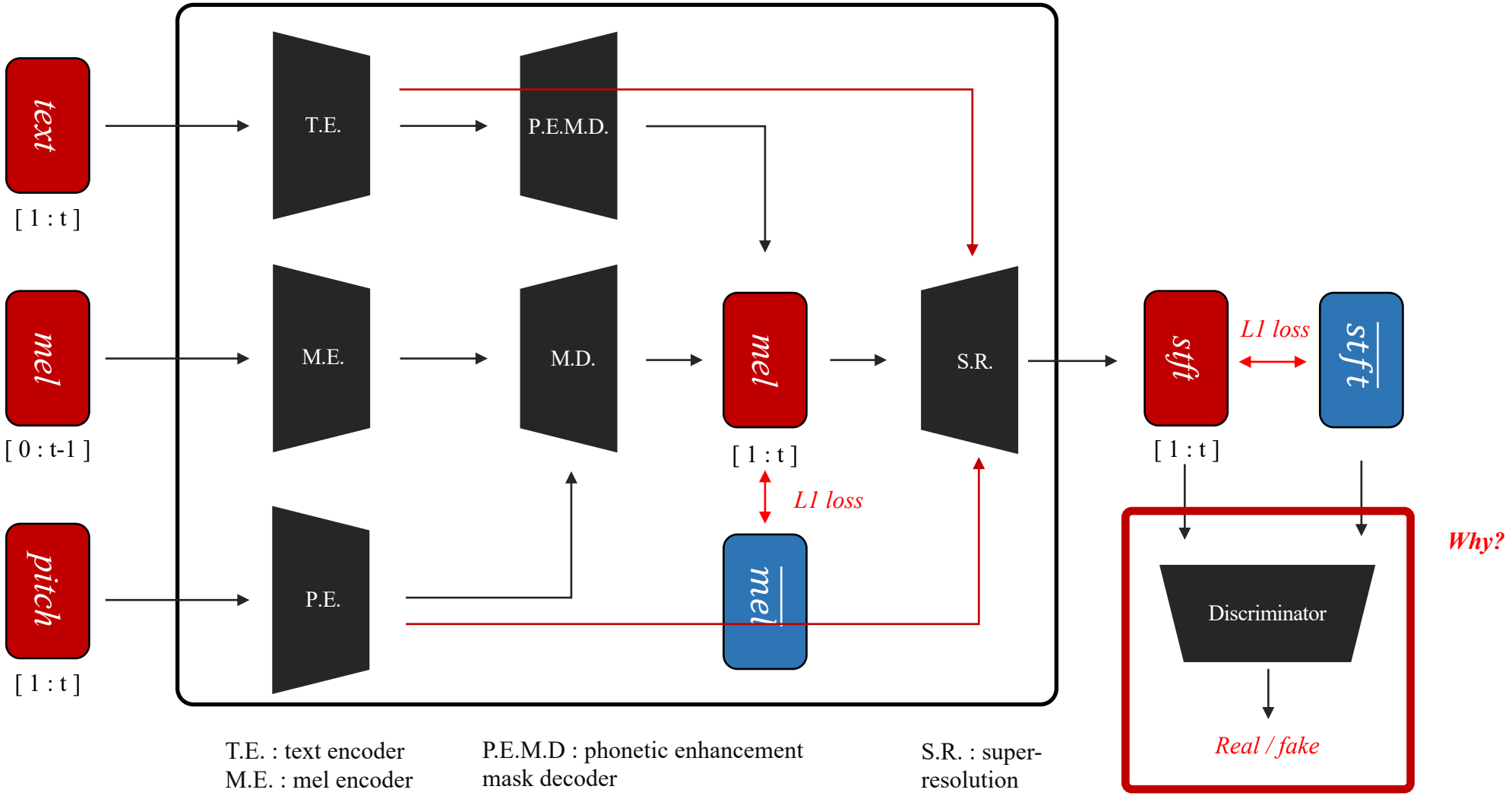

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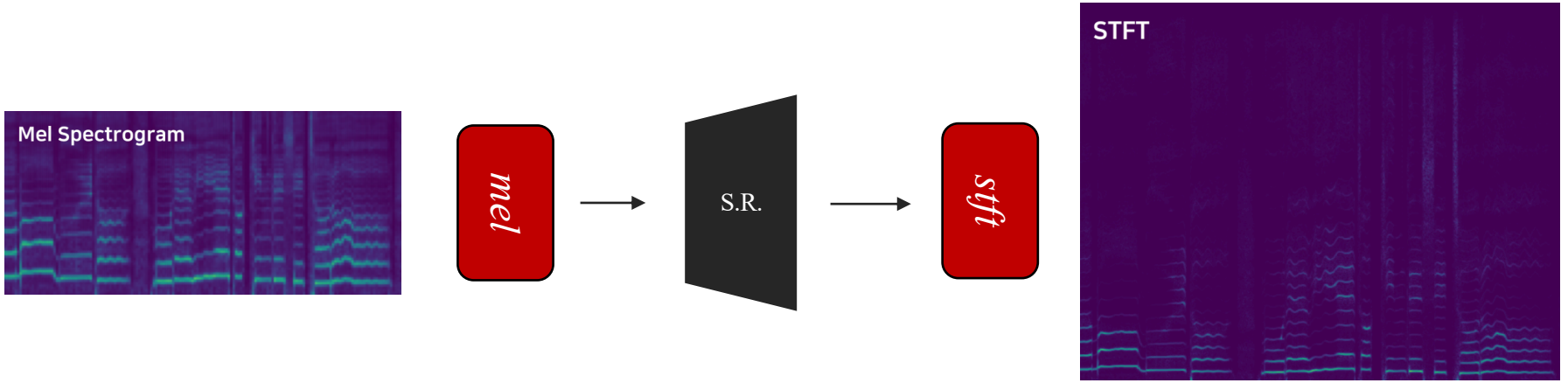
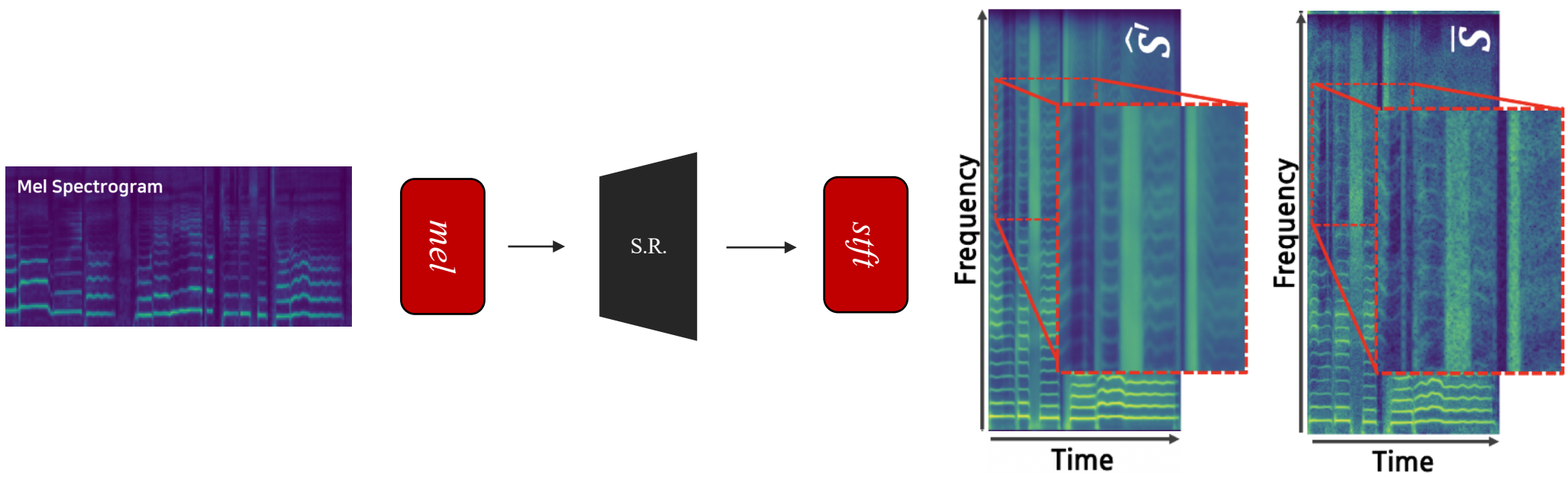


< Super-resolution network >

Adversarial training

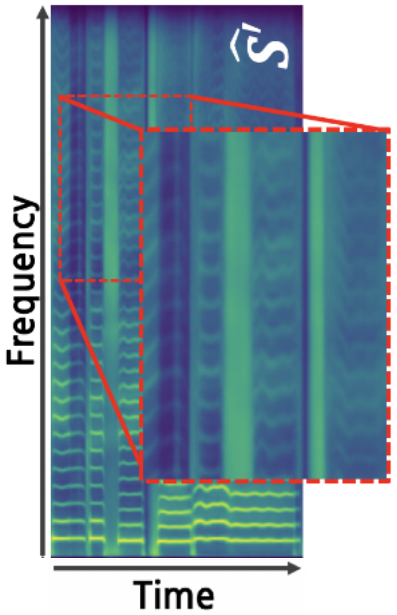


< Super-resolution network >

generated

Ground truth

Adversarial training



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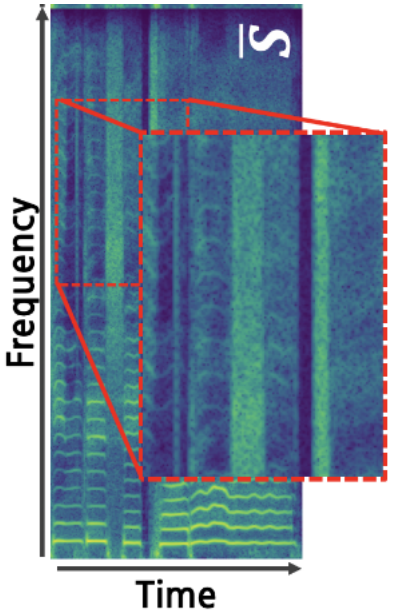
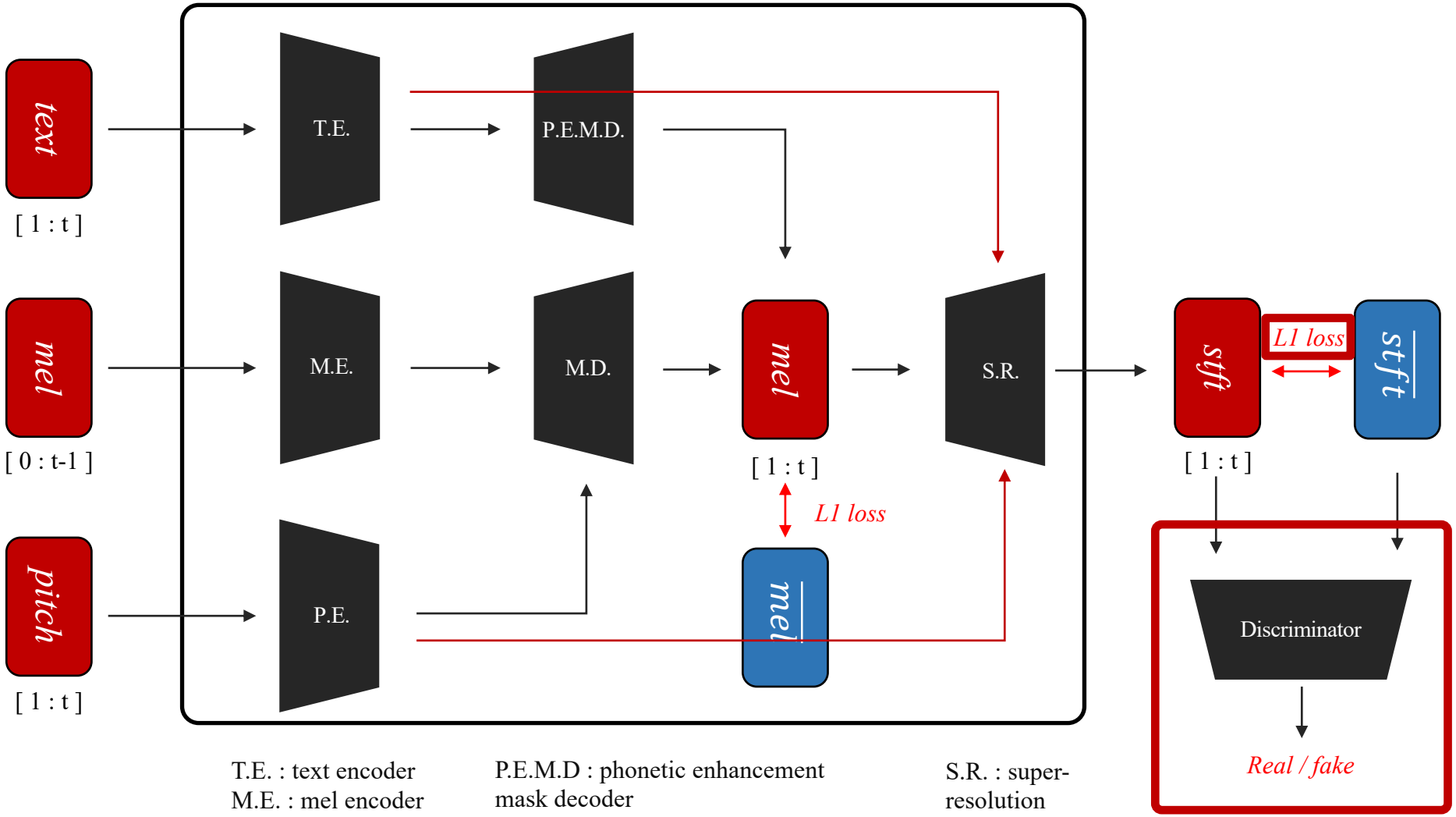


Ground truth

*Proper, but **fake** distribution*

Adversarial training



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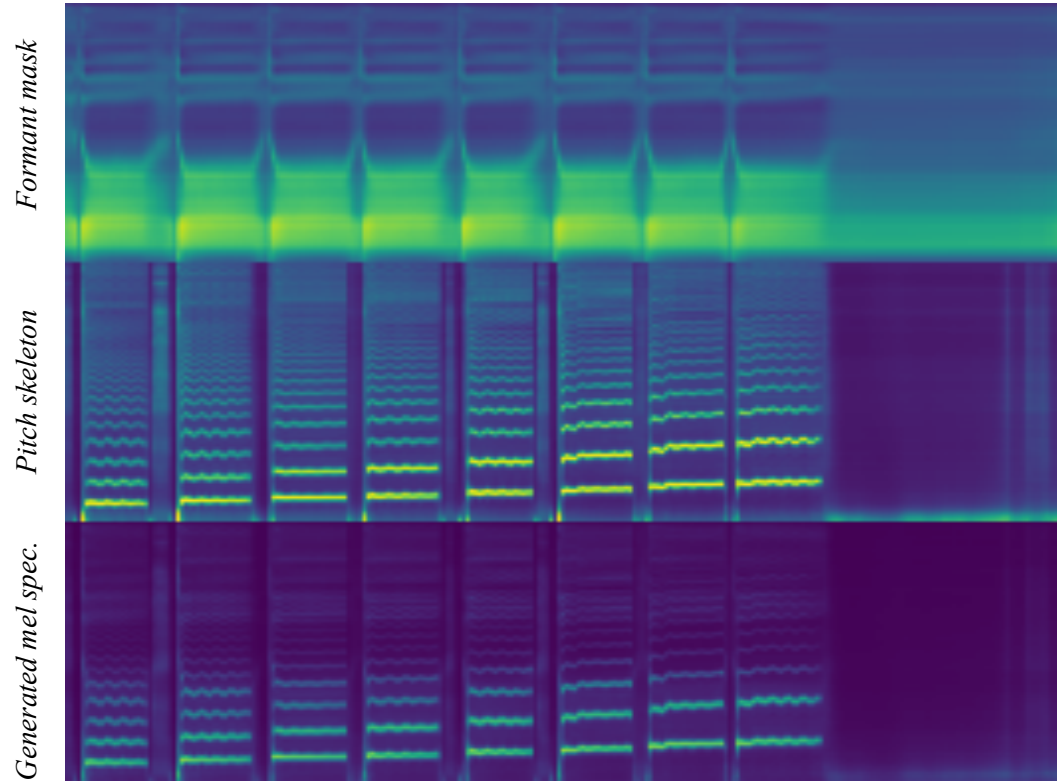
Evaluation Result

Evaluation Result : spectrogram analysis

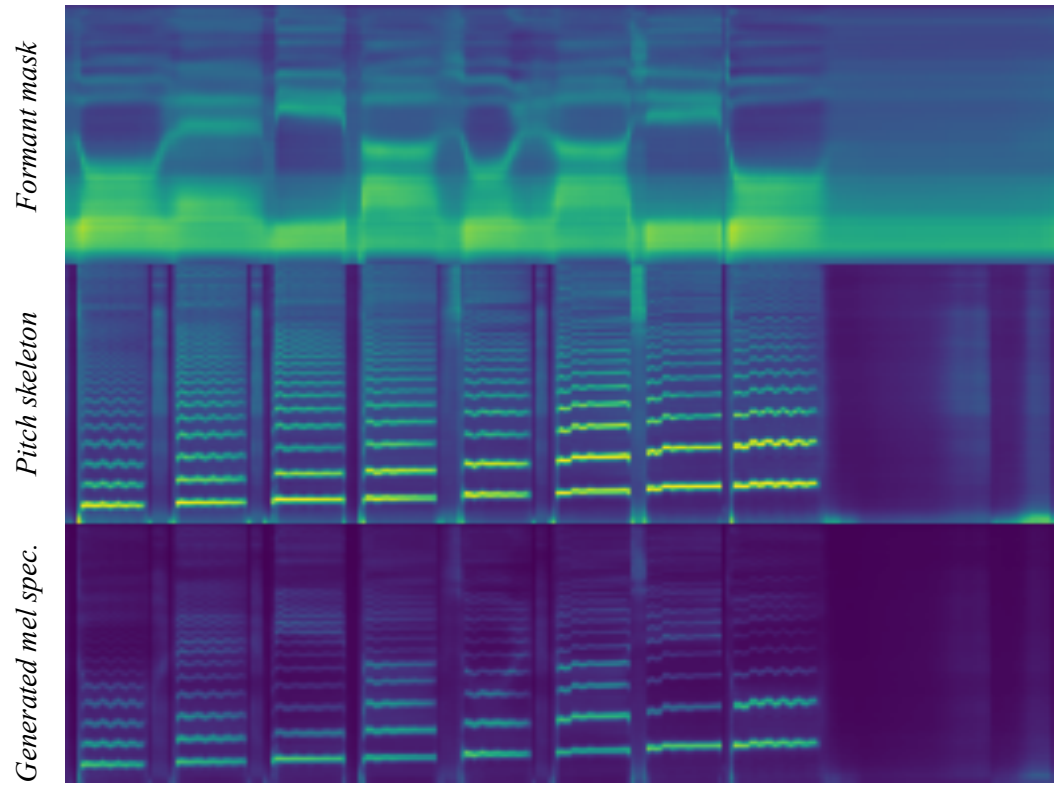


Input text : “do do do do do do do do”

Input pitch : [C D E F G A B C]

Generated audio :

Evaluation Result : spectrogram analysis

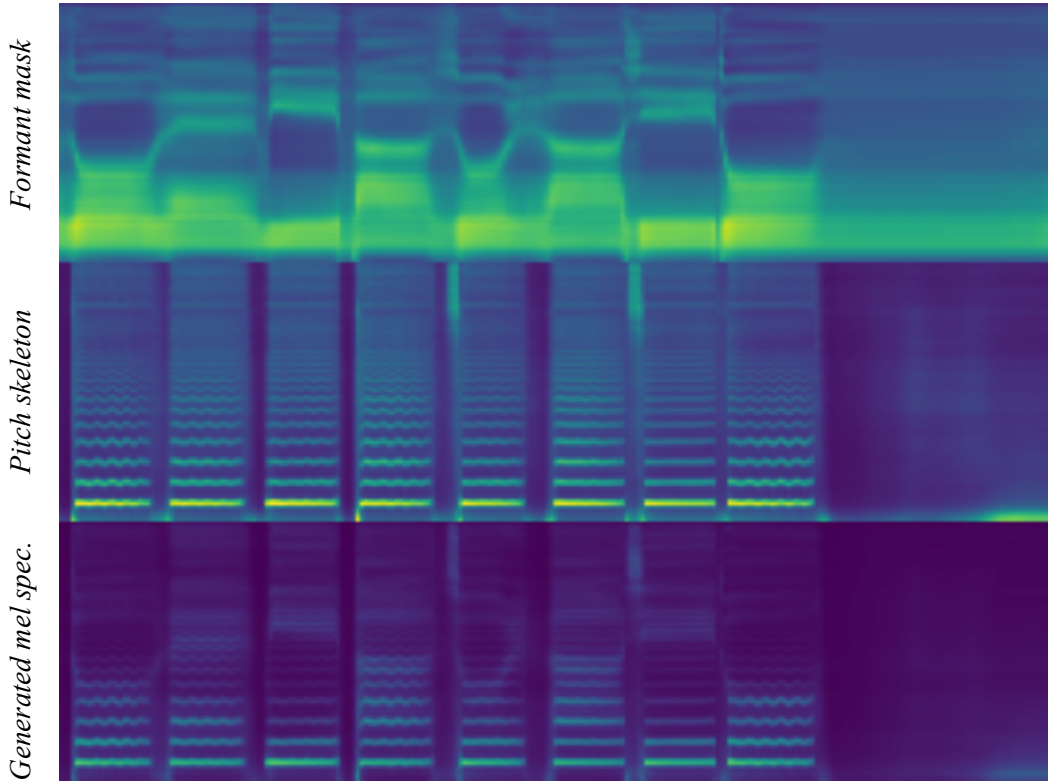


Input text : “do re mi fa sol ra ti do”

Input pitch : [C D E F G A B C]

Generated audio :

Evaluation Result : spectrogram analysis



Input text : “do re mi fa sol ra ti do”

Input pitch : [C C C C C C C C]

Generated audio :

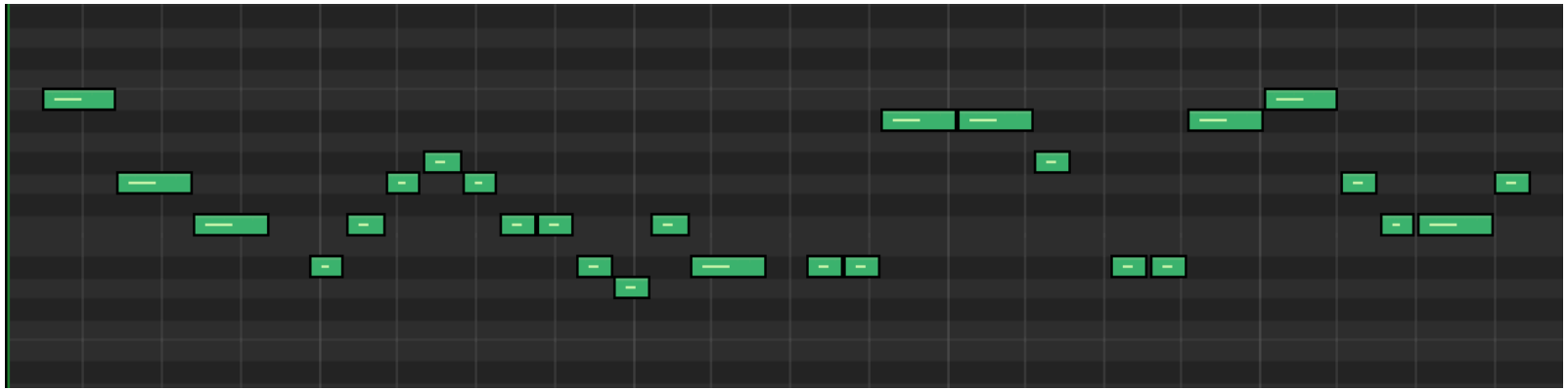
Evaluation Result : spectrogram analysis

Input text

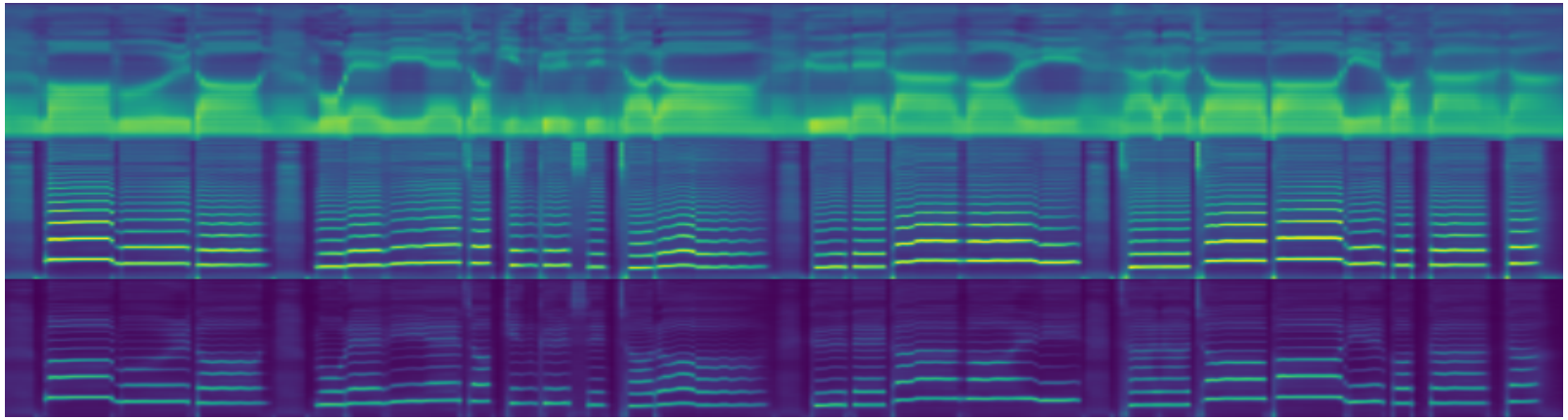
“머물던 모래 위에 적힌 글씨처럼 그대가 멀리 사라져 버릴것같아”

“Meo mul deon mo lae wi e jeog hin geul ssi cheo reo um geu dae ga meol li sa ra jyeo beo lil geot gat a”

Input pitch



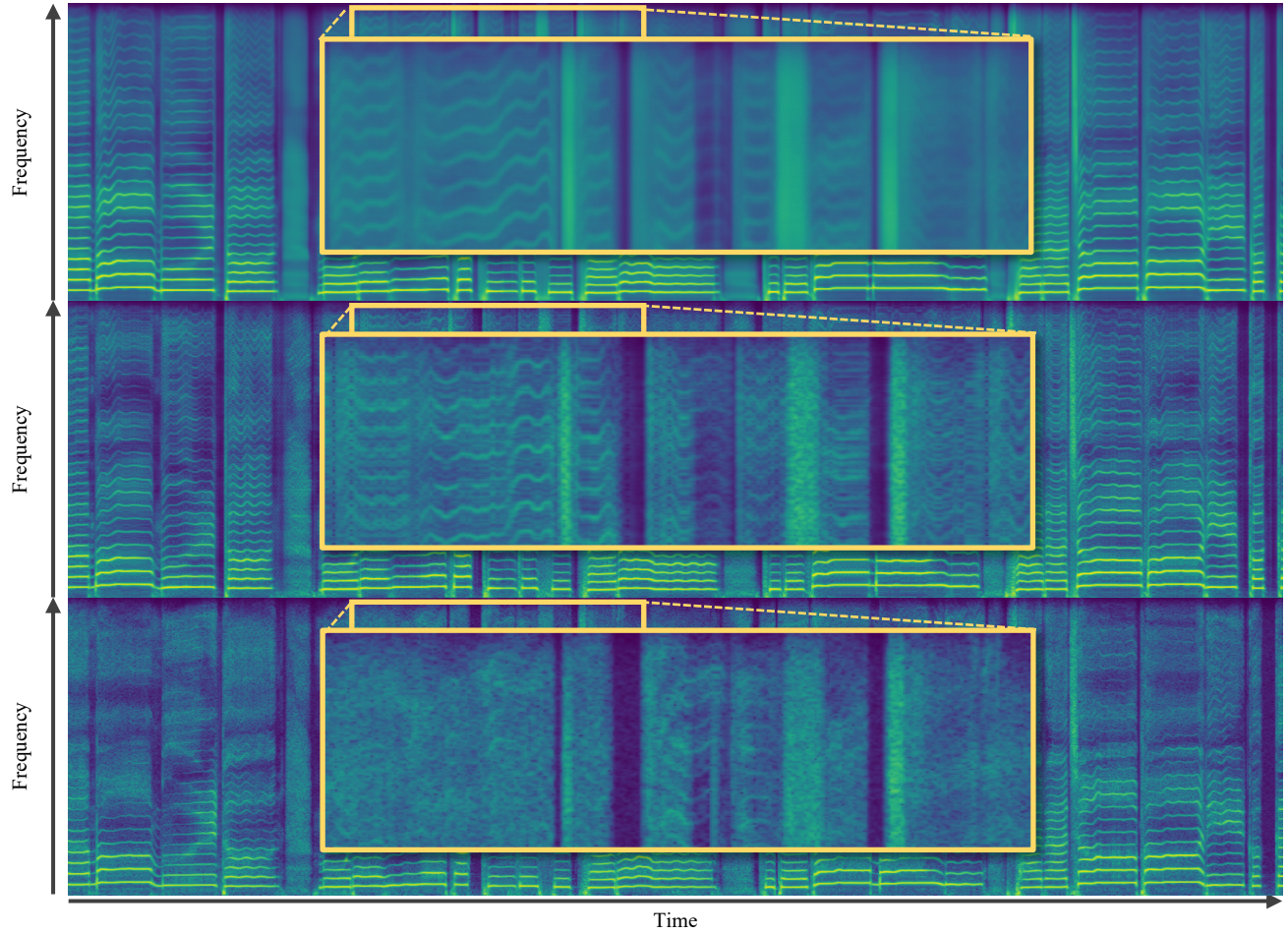
Generated result



Audio samples

Generated singing with melody

Evaluation Result : spectrogram analysis

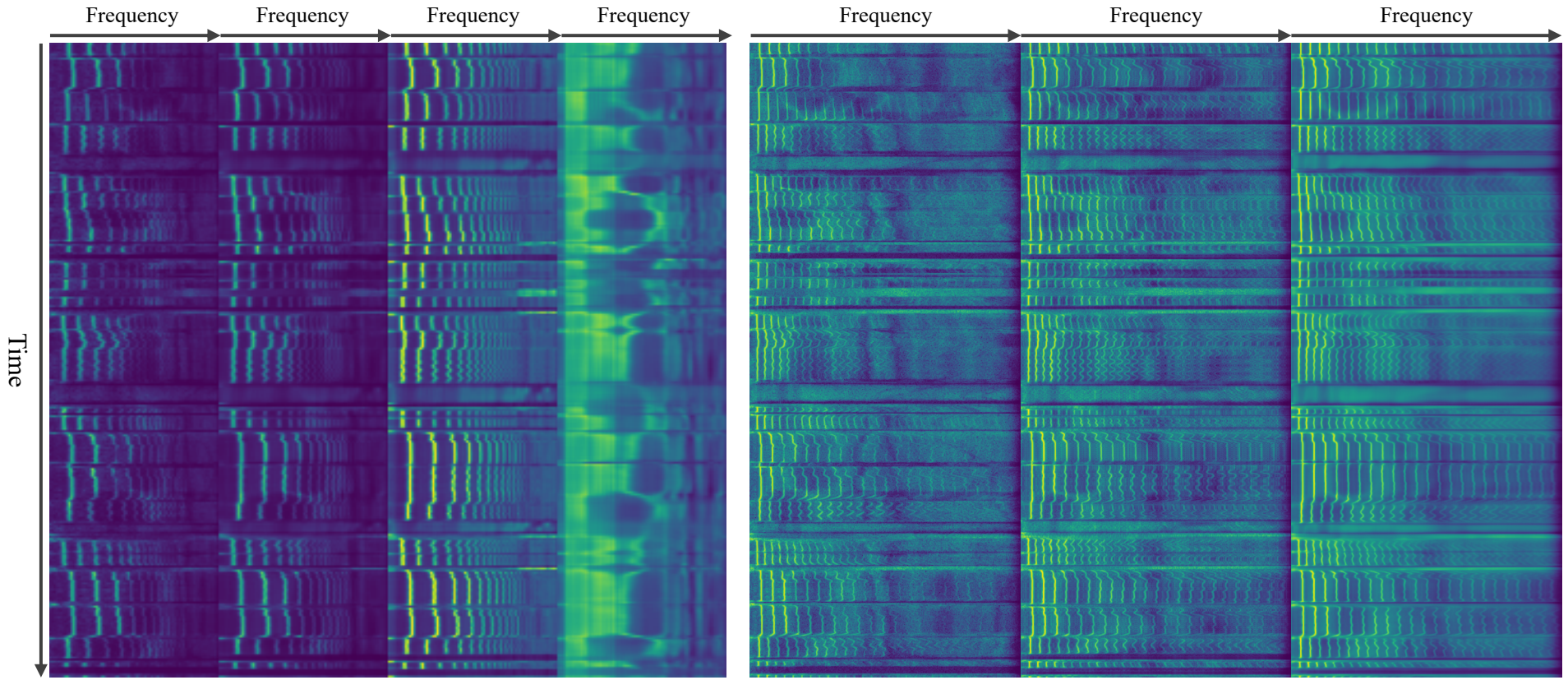


(a)
Generated
STFT spectrogram
without Adv loss

(b)
Generated
STFT spectrogram
with Adv loss

(c)
Ground truth
STFT spectrogram

Evaluation Result : spectrogram analysis



(a) Ground truth Mel Spectrogram

(b) Generated Mel Spectrogram

(c) Output of mel decoder

(d) Output of P.E.M decoder

(e) Ground Truth STFT Spectrogram

(f) Generated STFT Spectrogram with Adv loss

(g) Generated STFT Spectrogram without Adv loss

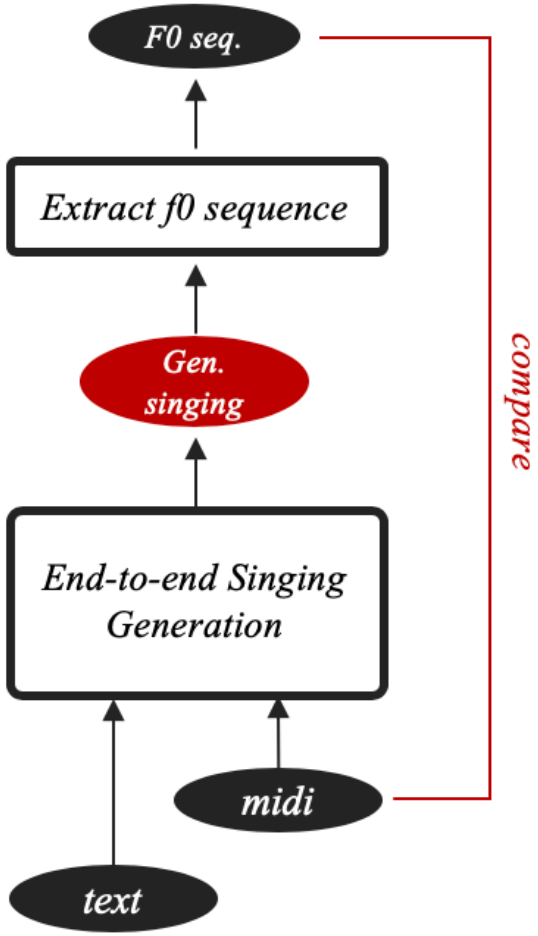
Evaluation Result : Quantitative

Method 1 *: Phonetic Enhancement Mask*

Method 2 *: Local conditioning pitch and text to SR*

Method 3 *: Adversarial training method*

		Quantitative		
	Model	Precision	Recall	F1-score
Baseline	model1	0.771	0.832	0.800
Baseline + 1	model2	0.780	**0.843**	0.810
Baseline + 2	model3	0.755	0.814	0.783
Baseline + 1,2	model4	0.792	0.832	0.811
Baseline + 1,2,3	model5	**0.872**	0.821	**0.846**
	Recons	0.805	0.830	0.782
	Ground	0.826	0.772	0.798



Evaluation Result : Qualitative

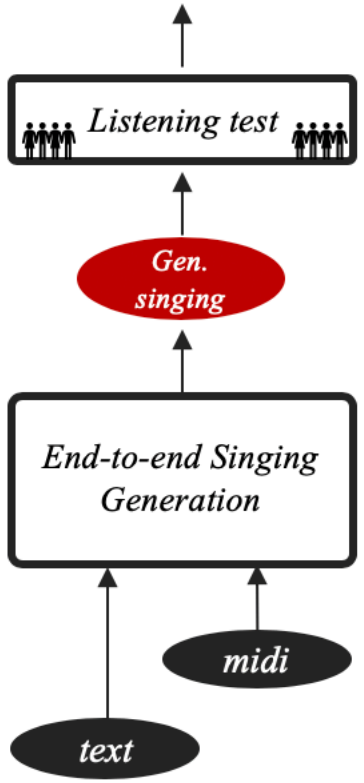
Method 1 *: Phonetic Enhancement Mask*

Method 2 *: Local conditioning pitch and text to SR*

Method 3 *: Adversarial training method*

		Qualititative		
	Model	Pronun.acc	Sound.quality	Naturalness
Baseline	model1	2.29 ±1.15	2.32 ±0.89	2.11 ±0.98
Baseline + 1	model2	2.62 ±1.00	2.28 ±0.84	2.22 ±0.91
Baseline + 2	model3	2.69 ±1.06	2.37 ±0.86	2.22 ±0.93
Baseline + 1,2	model4	2.92 ±1.08	2.43 ±0.86	2.36 ±0.94
Baseline + 1,2,3	model5	**3.23 ±1.19**	**3.37 ±0.94**	**3.07 ±1.10**
	Recons	4.85 ±0.47	4.46 ±0.77	4.72 ±0.62
	Ground	4.90 ±0.36	4.74 ±0.57	4.85 ±0.43

Pronun.acc / Sound.quality / Naturalness



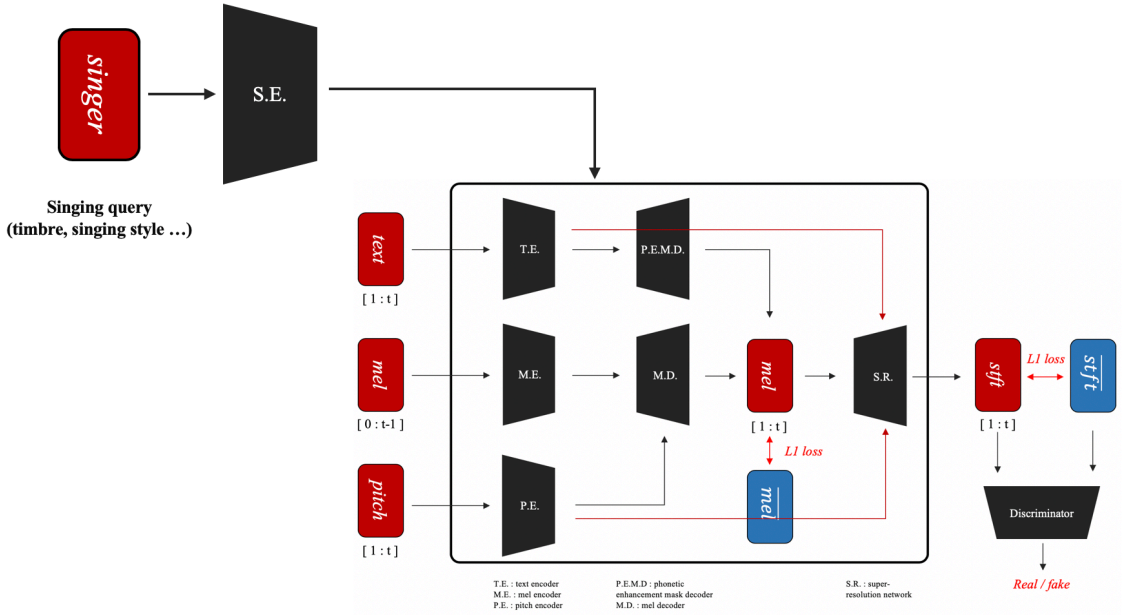
Conclusion

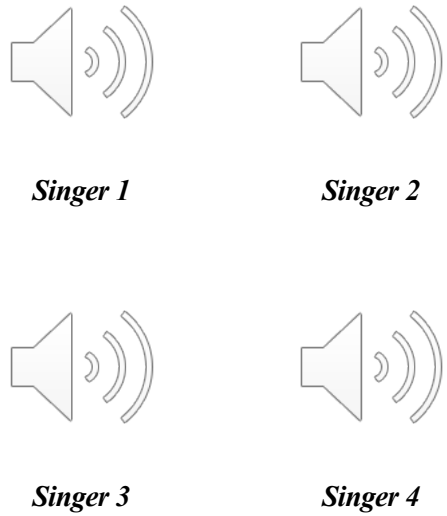
Conclusion

- We proposed End-to-end Korean Singing Synthesis System.
- **Phonetic Enhancement masking method** improves pronunciation accuracy and sound quality.
- **Local conditioning text & pitch to *SR*** improves pronunciation accuracy and sound quality.
- **Adversarial training method** improves pronunciation accuracy and sound quality

Conclusion – Future works

- **Multi-singer model**
- We will add query based speaker encoder, expanding out model to a multi-singer model.

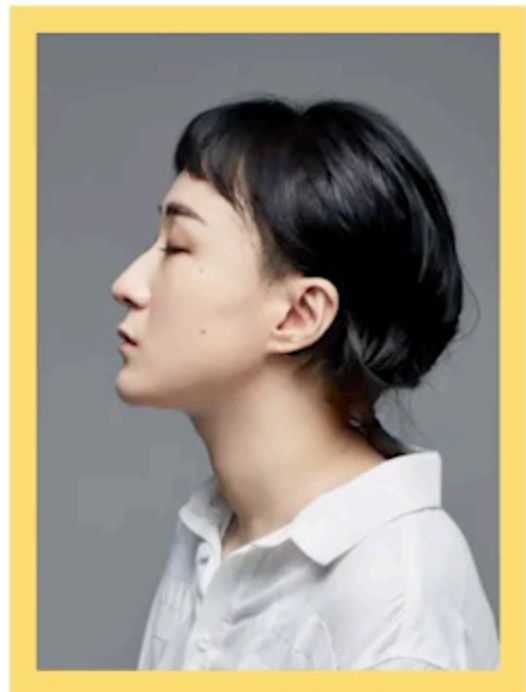




Conclusion – Future works

- **Few-shot voice adaptation**
- We will also study a meta-learning based methodology that replicate voice & singing style with a small amount of real world samples.

Few-shot voice adaptation & Singing generation



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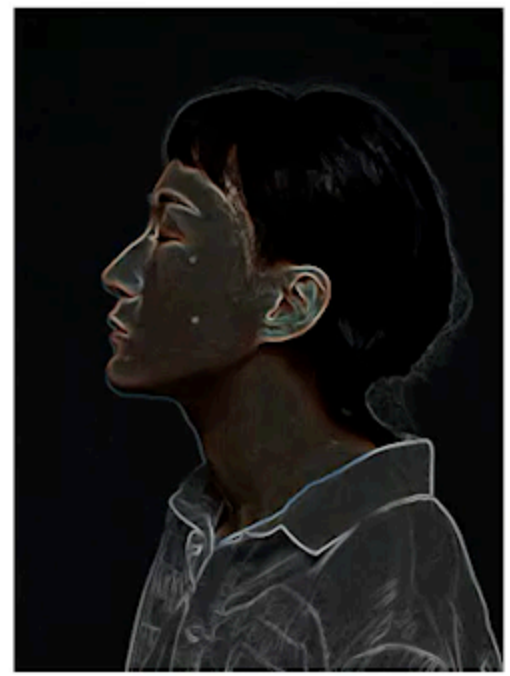
Adaptation query



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generated

Thank you!

Q & A