A Methodology for Deriving VoIP Equipment Impairment Factors for a mixed NB/WB Context

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Outline

Background

- VoIP enables packet-based telecommunication.

- It is cheap and cost effective.
- Supports WB telephony conveniently.
- QoS provisioning remains a problem.
- Speech quality estimation is important.

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Figure: Various categories of speech quality assessment methods.

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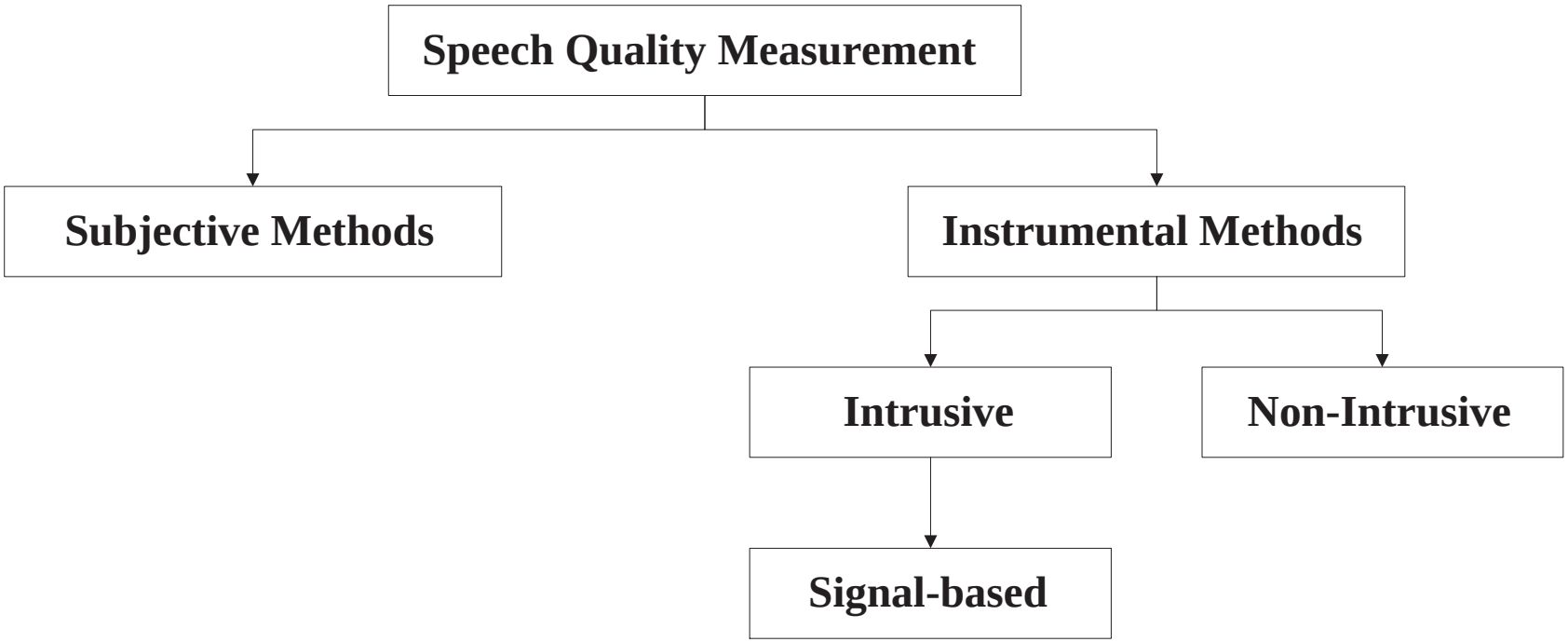
Speech Quality



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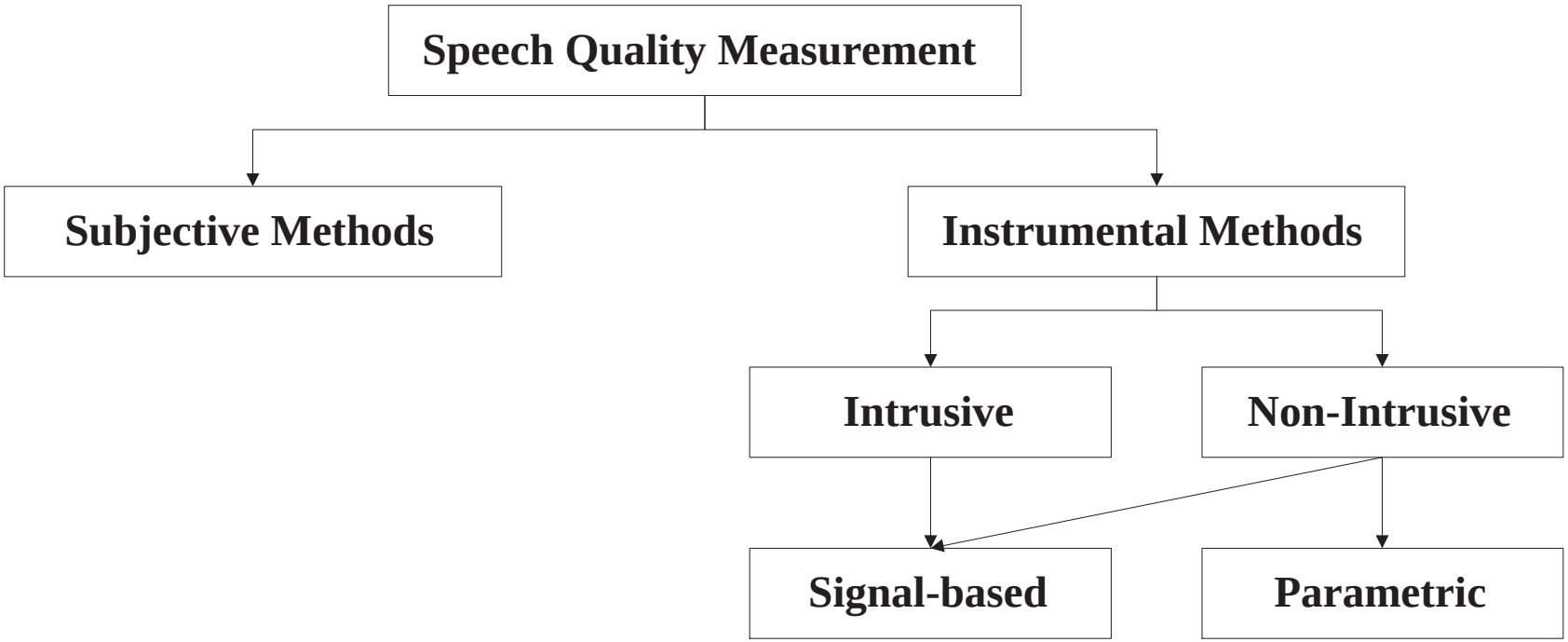

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Background
Speech Quality Standardization

- International Telecommunications Union – ITU-T – deals with the standards.
- Intrusive: ITU-T P.862.* – NB-PESQ and WB-PESQ.
- Nonintrusive:
  1. Parametric: ITU-T G.107 – The E-Model.
  2. Signal-based: ITU-T P.563.

Our Goal
Equipment Impairment Factor

To derive equipment impairment factors for WB VoIP as described by the E-Model:

$$SpeechQuality = f(Impairments) \tag{1}$$

$$I_{e,WB,eff} = f(codec, loss, ...) \tag{2}$$

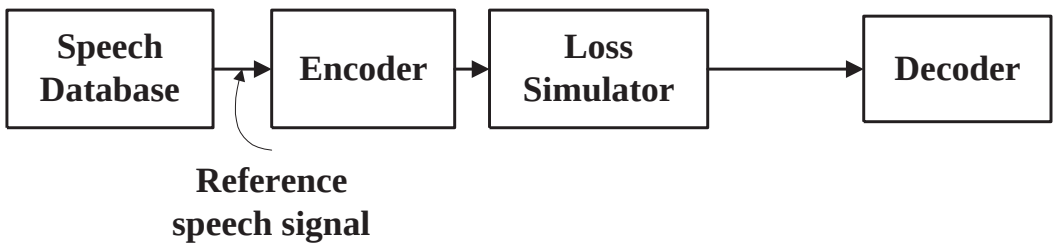
Our Approach

To evolve $I_{e,WB,eff}$ using GP.

Table: Input domain parameters used in evolutionary modeling

No.	Input Parameter	Description
1	$I_{e,WB}$	Impairments due to codecs
2	mlr	mean loss rate
3	PI	packetization interval (ms)
4	mbl	mean burst length
5	grad	Coarse estimate of codec specific loss robustness factor

Our Approach
Simulation Environment



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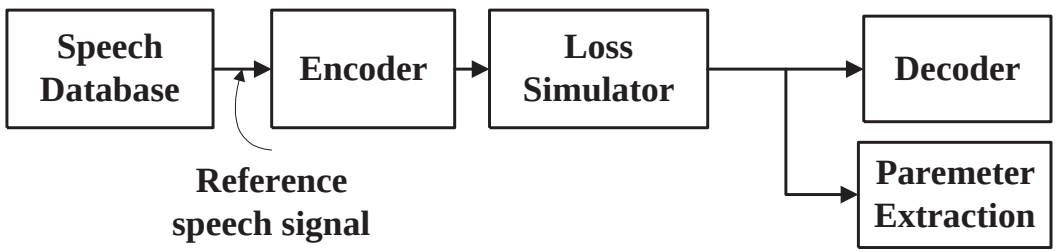

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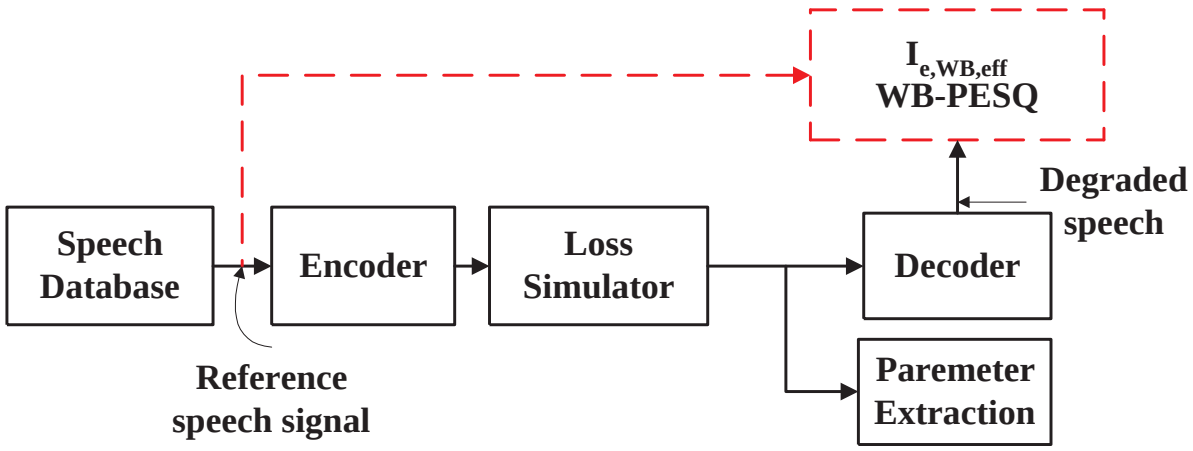

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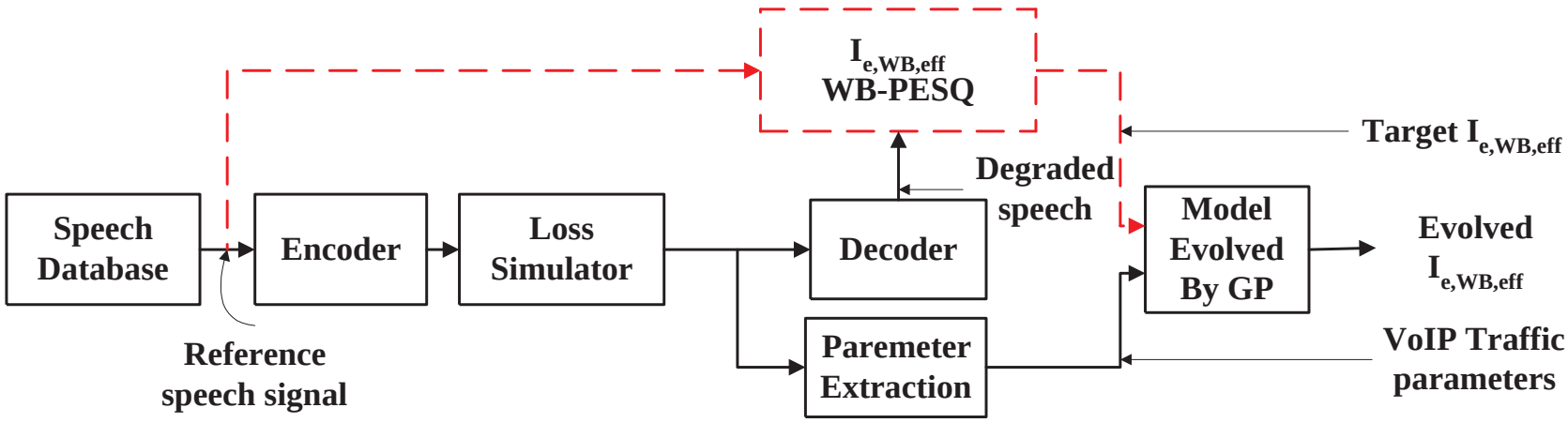

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Our Results
The Derived Models

$$I_{e,WB,eff} = \{11 - mbl + ln(grad) + grad \times mlr + I_{e,WB} - 2.log_2(PI)\} \times 0.8619 + 9 \quad (3)$$

$$I_{e,WB,eff} = \left\{ ln\left(\frac{9 \times (I_{e,WB} + mlr \times grad^2)}{mbl^5 - mlr} \right) + mlr + I_{e,WB} + grad \times mlr \right\} \times 0.8303 + 8.9977 \quad (4)$$

$$I_{e,WB,eff} = \left(log_{10}(log_{10}(log_2(I_{e,WB} - 2 \times mbl) + mlr))\right) \times 321.7017 + 95.3708 \quad (5)$$

Our Results
Comparison with E-Model

Table: Prediction gain over E-Model in various network operating conditions

Loss Type	Train	Test
General (Bursty)	14.54	16.36
Specific (Random)	36.72	35.89

Network conditions:

- Fulfilled by ITU-T G.1050.
- 11,280 input/output patterns.
- training data – 70%.
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Codecs

Table: The following codecs were employed

Codec	Type	Modes
ITU-T G.722.1	WB	2
ITU-T G.722.2	WB	9
ITU-T G.729	NB	1
ITU-T G.723.1	NB	1
AMR-NB	NB	2
Total	–	15

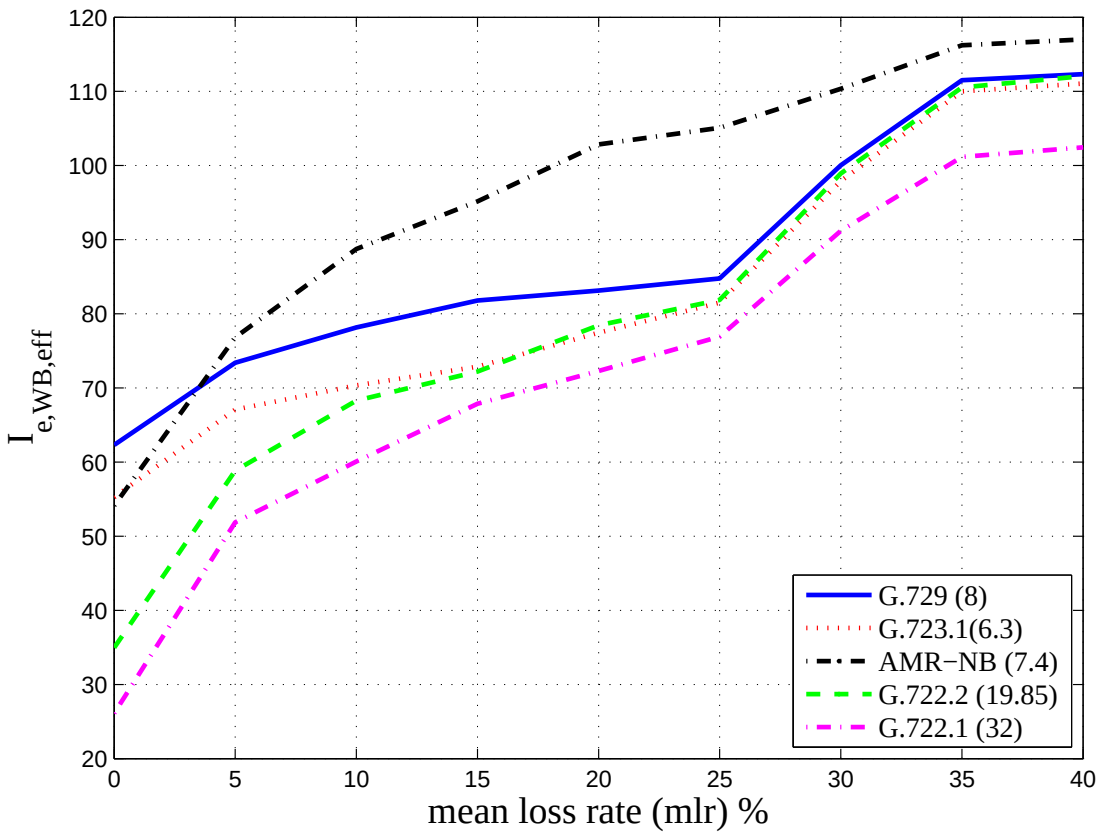
Our Achievements

- Our model outperforms ITU-T recommendation G.107 i.e. The E-Model – Criterion B .
- Demonstrates superior performance for a wide range of ITU-T recommended NB/WB codecs.
- The E-Model is downloadable from `www.itu.int` . Criterion C.

Our Achievements

- The results have been accepted for publication in domain specific IEEE Transactions on Multimedia. Criterion D.
- Successful and parsimonious use of a richer feature space.
- Suitable for real-time evaluation.

Our Achievements



Past approaches:

- Logarithmic – codec specific.
- Quadratic – codec specific.
- The E-Model – unified, superior.

Our model:

- Unified.
- Superior to all the past models.

Criterion E.

Figure: $I_{e,WB,eff}$ as a function of *mlr* for various NB/WB codecs. Past research proposed codec specific proposals.

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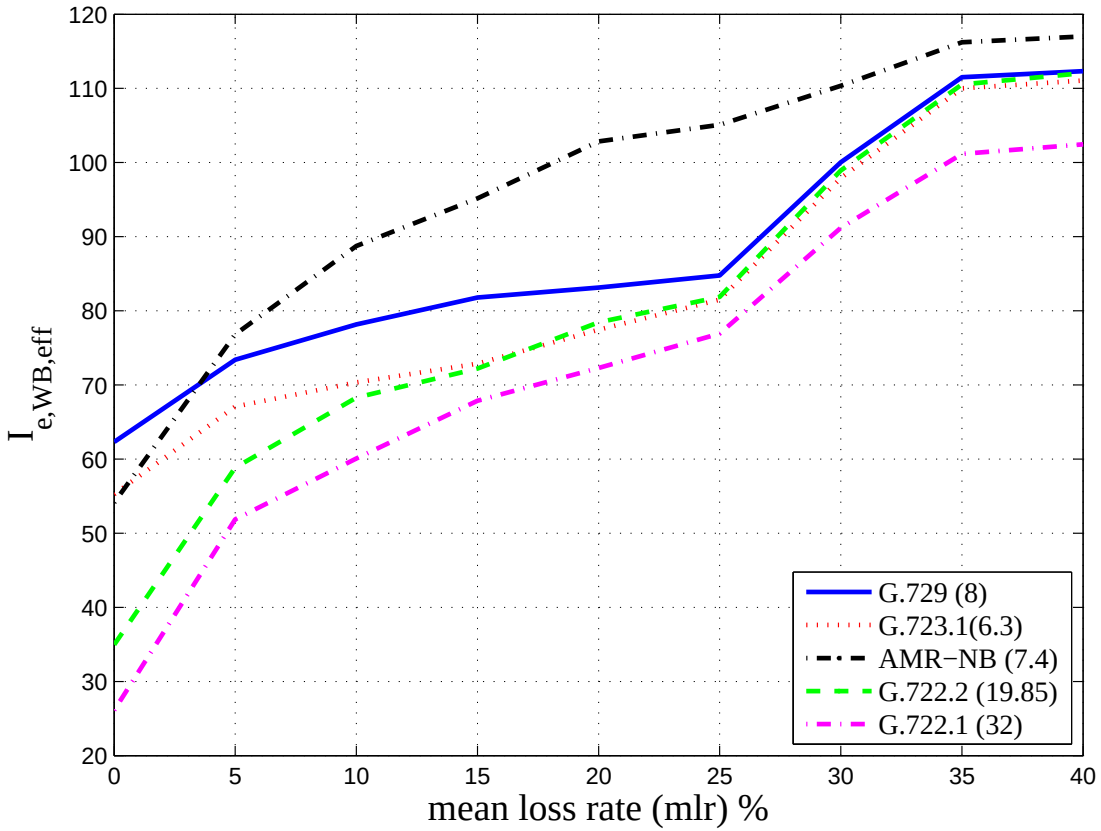

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Thank You