ITUPublications
Recommendations

International Telecommunication Union
Standardization Sector

Recommendation

ITU-T F.748.32 (10/2024)

SERIES F: Non-telephone telecommunication services

Multimedia services

Requirements and architecture of artificial intelligence (AI)-based detection technologies for multimedia messages

ITU-T F-SERIES RECOMMENDATIONS

Non-telephone telecommunication services

TELEGRAPH SERVICE	F.1-F.109
Operating methods for the international public telegram service	F.1-F.19
The gentex network	F.20-F.29
Message switching	F.30-F.39
The international telemessage service	F.40-F.58
The international telex service	F.59-F.89
Statistics and publications on international telegraph services	F.90-F.99
Scheduled and leased communication services	F.100-F.104
Phototelegraph service	F.105-F.109
MOBILE SERVICE	F.110-F.159
Mobile services and multidestination satellite services	F.110-F.159
TELEMATIC SERVICES	F.160-F.399
Public facsimile service	F.160-F.199
Teletex service	F.200-F.299
Videotex service	F.300-F.349
General provisions for telematic services	F.350-F.399
MESSAGE HANDLING SERVICES	F.400-F.499
DIRECTORY SERVICES	F.500-F.549
DOCUMENT COMMUNICATION	F.550-F.599
Document communication	F.550-F.579
Programming communication interfaces	F.580-F.599
DATA TRANSMISSION SERVICES	F.600-F.699
MULTIMEDIA SERVICES	**F.700-F.799**
ISDN SERVICES	F.800-F.849
UNIVERSAL PERSONAL TELECOMMUNICATION	F.850-F.899
ACCESSIBILITY AND HUMAN FACTORS	F.900-F.999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T F.748.32

Requirements and architecture of artificial intelligence (AI)-based detection technologies for multimedia messages

Summary

Recommendation ITU-T F.748.32 specifies the requirements and architecture of artificial intelligence (AI)-based detection for multimedia messages, including the overall requirements, the functional architecture, detection strategy, detection procedure, as well as some additional considerations.

History *

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T F.748.32	2024-10-29	16	11.1002/1000/16187

Keywords

AI, architecture, detection, multimedia message, requirements.

* To access the Recommendation, type the URL https://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, and information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents/software copyrights, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the appropriate ITU-T databases available via the ITU-T website at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T F.748.32

Requirements and architecture of artificial intelligence (AI)-based detection technologies for multimedia messages

1 Scope

This Recommendation specifies the requirements and architecture of artificial intelligence (AI)-based detection technologies for multimedia messages, including the requirements of using AI technologies to detect text, image, audio, video, file and other types of multimedia message as well as the architecture of general detection signalling, procedure and system.

The scope of this Recommendation includes:

– AI-based detection architecture, including the typical architecture of the detection system, functional components and interfaces;

– Requirements of AI-based detection methods for different kinds of multimedia messages;

– Requirements of detection strategies used in reference architecture;

– Requirements of detection procedure.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T H.264] Recommendation ITU-T H.264 (V15) (2024), *Advanced video coding for generic audiovisual services*.

[IETF RFC 6151] IETF RFC 6151 (2011), *Updated Security Considerations for the MD5 Message-Digest and the HMAC-MD5 Algorithms*.

[IETF RFC 6234] IETF RFC 6234 (2011), *US Secure Hash Algorithms (SHA and SHA-based HMAC and HKDF)*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 optical character recognition (OCR) [b-ISO/IEC 22989]: Conversion of images of typed, printed, or handwritten text into machine-encoded text.

3.1.2 rich communication suite [b-GSMA RCC.07]: It is used to provide a framework for discoverable and interoperable advanced communication services and detailed specifications for a basic set of such advanced communication services. The functional requirements for these services and the framework components as well as their integration into the client's user experiences are described in [b-GSMA RCC.71].

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 message as a platform: A kind of messaging capabilities established by communication operators to enable industry clients to provide information services in various media formats to their users.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

3GP	3GPP file format
A2P	Application to Person
AAC	Advanced Audio Coding
AI	Artificial Intelligence
ADS	AI-based Detection System
AMR	Adaptive Multi-Rate
BS	Business System
ComParE	Computational Paralinguistics challenge
CNN	Convolutional Neural Network
GeMAPS	Geneva Minimalistic Acoustic Parameter Set
JPEG	Joint Photographic Experts Group
M4A	MPEG-4 Audio
MD5	Message Digest 5
MFCC	Mel-Frequency Cepstral Coefficients
MPEG-4	Moving Pictures Experts Group-4
MP3	Moving Picture Experts Group Audio Layer III
OCR	Optical Character Recognition
P2P	Person to Person
PNG	Portable Network Graphics
RNN	Recurrent Neural Network
SHA	Secure Hash Algorithm
WEBM	WebMedia

5 Conventions

In this Recommendation:

– The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

– The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement needs not be present to claim conformance.

– The keywords "can optionally" and "may" indicate an optional requirement which is permissible, without implying any sense of being recommended. These terms are not

intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 AI-based detection framework

The IMT-2020 standards encourage the implementation of a rich communication suite (RCS) in networks. Multimedia messages represent a kind of service that complies with GSMA RCS UP standards, which instructs operators to develop and deploy advanced communication services for customer messages and industry messages.

Since multimedia messages can support a variety of message types which are quite different from traditional ones, including text, image, audio, video, file and other potentially possible message types. On the one hand, it provides users and enterprises with more rich services, on the other side, it brings substantially more challenges and difficulties to message detection technologies. For example, message using message-as-a-platform to implement industry messages, which is an application to person (A2P) message, leads to much more complicated situations especially for message detection strategies.

With a large development of AI technologies using neural networks and deep learning algorithms, it has been applied into many practical tasks of detection, classification and recognition. While facing lots of challenges for multimedia message detection, it is necessary to initiate a new standard on clarifying the requirements and framework of AI-based detection for multimedia messages, including the overall requirements, the general framework, recommended detection strategy, detection procedure, as well as some additional considerations.

7 Functional architecture

The architecture shown in Figure 7-1 consists of two systems, which are a business system (BS) and an AI-based detection system (ADS). ADS is a system which detects and determines whether a multimedia message contains any specific information by using different kinds of AI algorithms.

A business system is developed by a carrier to provide various multimedia message services [b-GSMA RCC.07], [b-GSMA RCC.71], such as person to person (P2P) messages and A2P messages. With the aid of AI technologies, an ADS is used to detect and determinate whether a multimedia message contains any specific information.

The functional architecture of ADS presented in Figure 7-1 consists of eight main components, namely, message access unit, message process unit, strategy detection unit, algorithm detection unit, message feature database, data analysis unit, detection result unit, and system management unit.

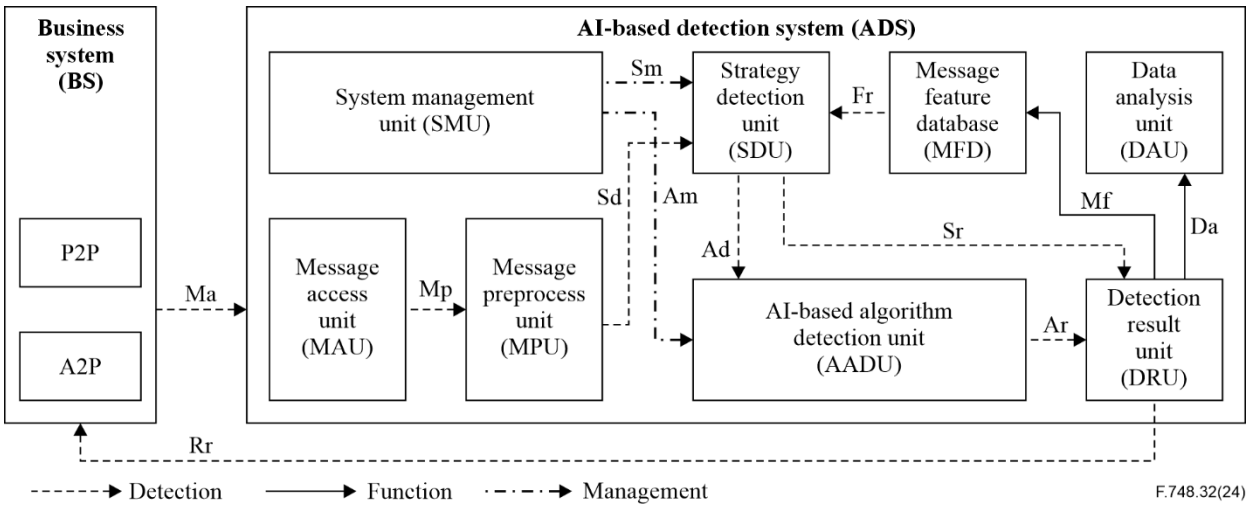

Figure 7-1 – Functional architecture of ADS

7.1 Functional entities

7.1.1 MAU: message access unit

Message access unit (MAU) is used to receive both P2P and A2P messages from BS. It is recommended to support the functions of protocol conversion, message parsing, and message delivery for MAU.

a) Protocol transfer: converting the external transmission protocol used between BS and ADS to an internal protocol used in the ADS.

b) Message parsing: verifying the correctness of a received message, correctly parse the fields in the message, and obtain the message elements which could be texts, images, audios, videos, files and URLs.

c) Message delivery: support some delivery modes that include the following functional requirements.

- Balance: requests are uniformly sent to servers;
- Response priority: a request is sent to a server giving the first response;
- Message type: the request containing different message types is sent to the corresponding server;
- Server performance: the number of requests is proportional to the performance of the server. The higher the performance a server has, the more requests it receives.

7.1.2 MPU: message preprocess unit

Message preprocess unit (MPU) is used to preprocess the message from MAU. It is recommended to support the functions of number location query, user rank query, and special symbol elimination.

a) Number geo-location query: identifying the geographic locations of both calling and called numbers.

b) User rank query: inquiring about the user rank in terms of service plan, payment credit, and communication authority.

c) Special symbol elimination: realizing the function of finding and eliminating some special symbols.

7.1.3 SDU: strategy detection unit

Strategy detection unit (SDU) is used to detect whether the message is specific or not by using different kinds of strategies that may include block list, keyword matching, message fingerprint (cryptographic hash) and behaviour monitor.

a) Block list: using a block list to identify users who have sent a specific message.

b) Keyword matching: using regular expression to search whether the specific keyword exists in the text message.

c) Message fingerprint: using fingerprint to identify whether the message is specific or not, especially for image, audio and video messages.

d) Behaviour monitor: monitoring the behaviour that includes the send-and-receive frequency, message throughput.

7.1.4 MFD: message feature database

Message feature database (MFD) is a fingerprint-like feature database of a specific message for different data types. It is recommended to support the functions of calculating, updating and storing the fingerprint-like feature of specific messages.

a) Message fingerprint: using cryptographic hash algorithm to generate a unique string as a fingerprint.

b) Message fingerprint record: storing and maintaining a fingerprint database of specific messages.

c) Database update: updating the database at a certain time interval.

7.1.5 AADU: AI-based algorithm detection unit

Algorithm detection unit is required to use different kinds of AI-based algorithms to detect whether the message is specific or not. It is recommended to support several AI-based algorithms for analysing different types of content such as plain text, image, audio, video and file.

a) Text: support text classification, text clustering.

b) Image: support object detection, image classification, image matching, optical character recognition (OCR).

c) Audio: support audio classification, speech text conversion.

d) Video: support video content classification.

e) File: support extract the elements, such as text, image, audio, video, in the file, and then call the interface of the corresponding AI-based algorithm.

7.1.6 DRU: detection result unit

Detection result unit (DRU) is used to record detection results from SDU and ADU, and then send them to BS. It is required to extract the element in the specific message and make them into a specific sample library.

7.1.7 DAU: Data analysis unit

Data analysis unit (DAU) is used to count detection results that are recorded in the DRU. It is recommended to provide several statistical data given as follows.

a) total number of detected messages

b) total number of detected specific messages

c) number of specific messages detected by SDU

d) number of specific messages detected by ADU

e) number of P2P messages with specific information

f) number of A2P messages with specific information

g) precision rate of text detection algorithm

h) precision rate of image detection algorithm

i) precision rate of audio detection algorithm

j) precision rate of video detection algorithm

k) precision rate of file detection algorithm

7.1.8 SMU: system management unit

System management unit (SMU) is used to configure the parameters of SDU and ADU. It is recommended to support the following configurations:

a) Strategy configuration

– Block list: support the operation of adding and deleting the number or unique ID in the list

Keyword: support the operation of adding and deleting keyword in the keyword library

Message feature: support adding and deleting feature data in the MFD

Behaviour: support modifying the send-and-receive frequency and the message throughput

Strategy set: support adding and deleting the strategy item into the set

b) AI-based algorithm configuration:

Model: support changing the AI-based algorithm model for text, image, audio and video detection

Threshold: support modifying the threshold configured in the algorithm model to meet different detection criterion

7.2 Interfaces

7.2.1 Interface Ma: BS-MAU

Interface Ma is between the BS and the MAU.

It is used to send both P2P and A2P messages from the BS to the MAU of ADS.

7.2.2 Interface Mp: MAU-MPU

Interface Mp is between the MAU and the MPU.

After protocol conversion, it is used to deliver messages from the MAU to the MPU in one of the delivery modes mentioned in clause 7.1.1c.

7.2.3 Interface Sd: MPU-SDU

Interface Sd is between the MPU and the SDU.

It is used to send message elements of different data types from the MPU to the SDU.

7.2.4 Interface Fr: SDU-MFD

Interface Fr is between the SDU and the MFD.

It is used to send the message fingerprint request from the SDU to the MFD, and then receive the response.

7.2.5 Interface Sr: SDU-DRU

Interface Sr is between the SDU and the DRU.

It is used to send the strategy detection result from the SDU to the DRU.

7.2.6 Interface Ad: SDU-ADU

Interface Ad is between the SDU and the AADU.

It is used to send the message elements of different data types from the SDU to the AADU.

7.2.7 Interface Ar: AADU-DRU

Interface Ar is between the AADU and the DRU.

It is used to send the AI-based algorithm detection result from the AADU to the DRU.

7.2.8 Interface Da: DRU-DAU

Interface Da is between the DRU and the DAU.

It is used to get detected results from the DRU to the DAU in order to make analysis and statistics.

7.2.9 Interface Mf: DRU-MFD

Interface Mf is between the DRU and the MFD.

It is used to send the specific message from the DRU to the MFD to calculate the fingerprint and update the MFD.

7.2.10 Interface Sm: SMU-SDU

Interface Sm is between the SMU and the SDU.

It is used to send the strategy configurations from the SMU to the SDU.

7.2.11 Interface Am: SMU-AADU

Interface Am is between the SMU and the AADU.

It is used to send the AI-based algorithm configurations from the SMU to the AADU.

7.2.12 Interface Rr: DRU-BS

Interface Rr is between the DRU and the BS.

It is used to send the detected results of each P2P and A2P message from the DRU to the BS.

8 Message feature algorithm

To avoid the same or similar messages being redundantly detected within a short period, it is required to use the following algorithms to generate a unique feature for each message.

For a text message, image message, audio message or video message, it is required to use a kind of hash algorithms, such as message digest 5 (MD5) [IETF RFC 6151] or secure hash algorithm (SHA) [IETF RFC 6234] to generate its unique feature.

It is recommended to use some additional feature algorithms for a text message, audio message or video message.

8.1 Text feature algorithm

If a text message is a webpage or a document, it is recommended to use MinHash [b-IEEE MinHash] and SimHash [b-IEEE SimHash] to generate its unique feature. The text of a webpage or a document is firstly parsed into many keywords. Each keyword has a weight that is proportional to its frequency of appearance. Then the feature of the text message is given by a feature matrix composed of the encoded keywords or a fixed length string calculated by a series of encoding methods.

8.2 Audio feature algorithm

It is recommended to use an audio parameter set to represent the feature of an audio message. The algorithm is used to extract the parameters, such as short-time zero-crossing rate of signal from the time domain, mel-frequency cepstral coefficients (MFCC) from the frequency domain and many other parameters. The audio parameter set commonly used in research and application fields are Geneva minimalistic acoustic parameter set (GeMAPS) [b-IEEE GeMAPS], and computational paralinguistics challenge (ComParE) [b-IEEE ComParE].

8.3 Video feature algorithm

It is recommended to use a key frame feature set to represent the feature of a video message. The algorithm is used to extract key frames from a video, such as I-frames [ITU-T H.264], and make a feature set of key frames calculated by MD5 [IETF RFC 6151] or SHA [IETF RFC 6234].

9 AI-based detection algorithm

As AI-based detection methods are used for different kinds of rich media types, it is suggested to analyse different requirements for each type of media.

9.1 Text detection

Text detection is used to infer whether the content of a text involves specific information.

TDR-01: It is required to support text classification to implement text detection.

TDR-02: High-performance real-time detection of messages (including emoticons) in text format is required to be supported, including emoji emoticons and symbolic emoticons.

TDR-03: Segmented real-time detection or combined real-time detection for MSRP long message is required to be supported.

TDR-04: Real-time detection of uppercase and lowercase letters and mixed alphanumeric characters in the text is required to be supported.

TDR-05: Detection of website link in text is required to be supported.

The algorithm procedure of text classification is given as follows.

a) Split a text into words or phrases

b) Extract the features of each word or phrase by using convolutional neural network (CNN) or recurrent neural network (RNN) based algorithms

c) Concatenate all features to form a feature matrix

d) Calculate the probability of the text involving specific information by using an inference model.

9.2 Image detection

Image detection is used to infer whether the content of an image involves specific information.

IDR-01: It is required to support three types of AI-based algorithms, including object detection, image classification and OCR to implement image detection.

IDR-02: The format of the image messages or files for detection is required to include at least Joint Photographic Experts Group (JPEG), JPG, portable network graphics (PNG), and BMP (panoramic picture included).

IDR-03: Text or character recognition is required to be supported in real-time detection when there are text graphics in an image message.

9.2.1 Object detection

The algorithm procedure of object detection is given as follows.

a) Extract the localization and semantic information of one or multiple interest targets in an image by using CNN based algorithm

b) Concatenate all features to form a feature matrix

c) Use a set of anchor boxes to predict the actual localization of one or multiple interest targets in an image

d) Calculate the probability of each detected target involving specific information by using an inference model.

9.2.2 Image classification

The algorithm procedure of image classification is given as follows.

a) Extract the feature of an image by using CNN based algorithm

b) Concatenate the feature to form a feature vector

c) Calculate the probability of the image involving specific information by using an inference model.

9.2.3 OCR operation

OCR is implemented by character pattern detection and character recognition. The algorithm procedure of OCR is given as following steps:

a) Use the step 1, 2, 3 of object detection in 9.2.1 to obtain the character pattern

b) Extract the sequence feature of the character pattern by using a RNN based algorithm

c) Extract the feature of each character by using CNN based algorithm

d) Calculate the probability of the character pattern involving specific information by using text detection.

9.3 Audio detection

Audio detection is used to infer whether the content of an audio involves specific information.

ADR-01: The format of the audio messages or files for detection is required to include at least 3GPP file format (3GP), Moving Picture Experts Group audio layer III (MP3), Moving Pictures Experts Group-4 (MPEG-4) audio (M4A), advanced audio coding (AAC), and adaptive multi-rate (AMR).

ADR-02: It is required to support two types of AI-based algorithms, including audio classification and speech text conversion.

9.3.1 Audio classification

The algorithm procedure of audio classification is given as follows.

a) Split an audio file into a set of audio clips according to the processing requirements

b) Extract the features of the audio or audio clips by using a RNN based algorithm

c) Concatenate all features to form a feature matrix

d) Calculate the probability of the audio involving specific information by using inference model.

9.3.2 Speech text conversion

The algorithm procedure of speech text conversion is given as follows.

a) Split a voice file into a set of audio clips according to voice interval if it is necessary

b) Extract the feature of each audio clip in a time domain and frequency domain to form a set of feature vectors

c) Evaluate the score of each feature vector by using acoustic mode

d) Evaluate the probability that the voice corresponds to a possible phrase sequence by using a language model

e) Decode the phrase sequence and make the possible text representation by using an existing dictionary

f) Calculate the probability of the audio involving specific information by using text classification.

9.4 Video detection

Video detection is used to infer whether the content of a video involves specific information.

VDR-01: The format of the video messages or files for detection should be required to include at least MPEG4, 3GP, and WebMedia (WEBM).

VDR-02: Text or character recognition is required to be supported in real-time detection when there are text graphics in video message.

VDR-03: Frame sampling parameters in the video may be adjusted according to video size.

VDR-04: It is required to support the algorithms introduced in clauses 9.2 and 9.3 to implement video detection.

VDR-05: It is required to use either frames or audio of a video for video detection.

VDR-06: It is recommended to use I-frames for image classification and audio feature for audio classification.

VDR-07: It is recommended to use mixed feature extracted from a set of consecutive frames and their corresponding audio for video detection.

9.5 File detection

File detection is used to infer whether the content of a file involves specific information.

FDR-01: It is required to support the algorithms introduced in clauses 9.1 to 9.4 to implement file detection.

Bibliography

[b-ISO/IEC 22989] ISO/IEC 22989:2022, Information technology – Artificial intelligence – Artificial intelligence concepts and terminology. <https://www.iso.org/standard/74296.html>

[b-GSMA RCC.07] GSMA RCC.07 (2022), *Rich Communication Suite - Advanced Communications Services and Client Specification*, Version 13.0, 19 December. <https://www.gsma.com/newsroom/wp-content/uploads//RCC.07-v13.0-1.pdf>

[b-GSMA RCC.71] GSMA RCC.71 (2022), *RCS Universal Profile Service Definition Document*, Version 2.6. <https://www.gsma.com/newsroom/wp-content/uploads/RCC.71-v2.6-1.pdf>

[b-IEEE ComParE] B.W. Schuller (2012), *The Computational Paralinguistics Challenge [Social Sciences]*, IEEE Signal Processing Magazine, Volume. 29, Issue. 4, pp. 97-101. <https://portal.fis.tum.de/en/publications/the-computational-paralinguistics-challenge-social-sciences>

[b-IEEE GeMAPS] Eyben, F., Scherer, K.R., Schuller, B.W., Sundberg, J., Andrè, E., and Busso, C. (2016), *The Geneva Minimalistic Acoustic Parameter Set (GeMAPS) for Voice Research and Affective Computing*, IEEE Transactions on Affective Computing, Volume: 7, Issue 2, pp. 190-202. <https://ieeexplore.ieee.org/document/7160715>

[b-IEEE MinHash] Broder, A.Z. (1997), *On the resemblance and containment of documents*, IEEE. <https://ieeexplore.ieee.org/document/666900>

[b-IEEE SimHash] Manku, G.S., Jain, A., and Sarma, A.D (2007), *Detecting near-duplicates for web crawling*, Proceedings of the 16th International Conference on World Wide Web. pp. 141-150. <https://dl.acm.org/doi/10.1145/1242572.1242592>

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	**Non-telephone telecommunication services**
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Published in Switzerland
Geneva, 2025