# VeriSaas das-Peak API V1

## *Release 2019Q4.1*

| Release | Date | Description | Author | Reviewer | Approver |
|---|---|---|---|---|---|
| 2.2.1 | 17/01/2020 | VeriSaas das-Peak 2019 Q4.1 | SPC | MSY | MSY |

# 0. What's new?

This new version of das-Peak incorporates two new endpoints to the API for speaker identification functionalities. Briefly, this new version of das-Peak introduces the following changes:

- Identification endpoint to compare a wav file with a voice credentials list, returning the highest score credential and the rest of scores.
- Identification endpoint to compare a voice credential with a voice credentials list, returning the highest score credential and the rest of scores.

# 1. das-Peak microservice

Voice biometrics is a state-of-the-art technology that allows a person to be validated by his/her voice. VERIDAS solution captures the unique physical features of the vocal apparatus and features such as frequency, speed and accents and compiles them together into a virtually **unique voice biometric vector** per person.

**The voice biometric vector is a mathematical descriptor obtained from the characteristics of the voice in an audio recording. This mathematical conversion from voice into a biometric vector is irreversible. Therefore, it is not possible to recover a person's voice signal from the calculated biometric vector.**

VERIDAS has developed an own speaker verification engine (das-Peak) as a cloud-based solution that can be consumed via APIs.

VERIDAS' voice biometrics technology is based on the use of neural networks and has been evaluated at position number 13 out of 204 participants (**being the 4th best company**), worldwide, in the **NIST (National Institute of Standards and Testing, USA) SRE 2018. Veridas achieved 0.56% of SRE on NIST dataset.**

das-Peak calculates the similarity between two audio recordings (in terms of the speakers present in them) using biometric algorithms. das-Peak engine allows to identify users voice **without** the need of using a password or predefined phrase (passive recognition) as it is based on **text-independent technology**. This means that the biometric comparison is related to the voice

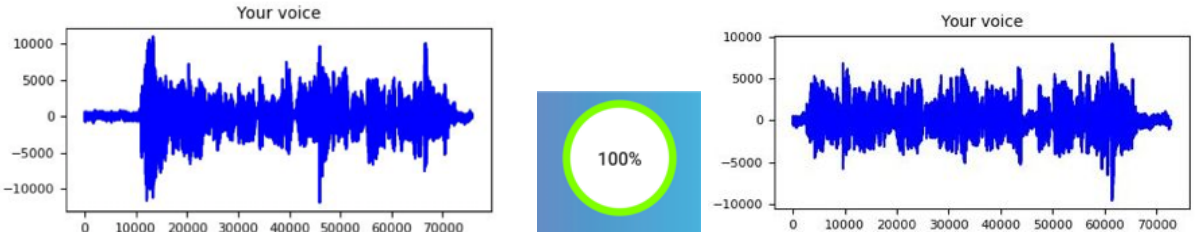
characteristics and not to the content of the sentence. However, the system is flexible to use pre-defined phrases in order to fulfill customer requirements or additional controls.

Within the voice biometrics field, two scenarios are typically handled:

- **Verification**: The process of checking the identity of a person by comparing two audios.
- **Identification**: The process of searching a person or a set of persons within a database of identities and its audio input data.

So far, das-Peak holds solution for the verification and identification problem.

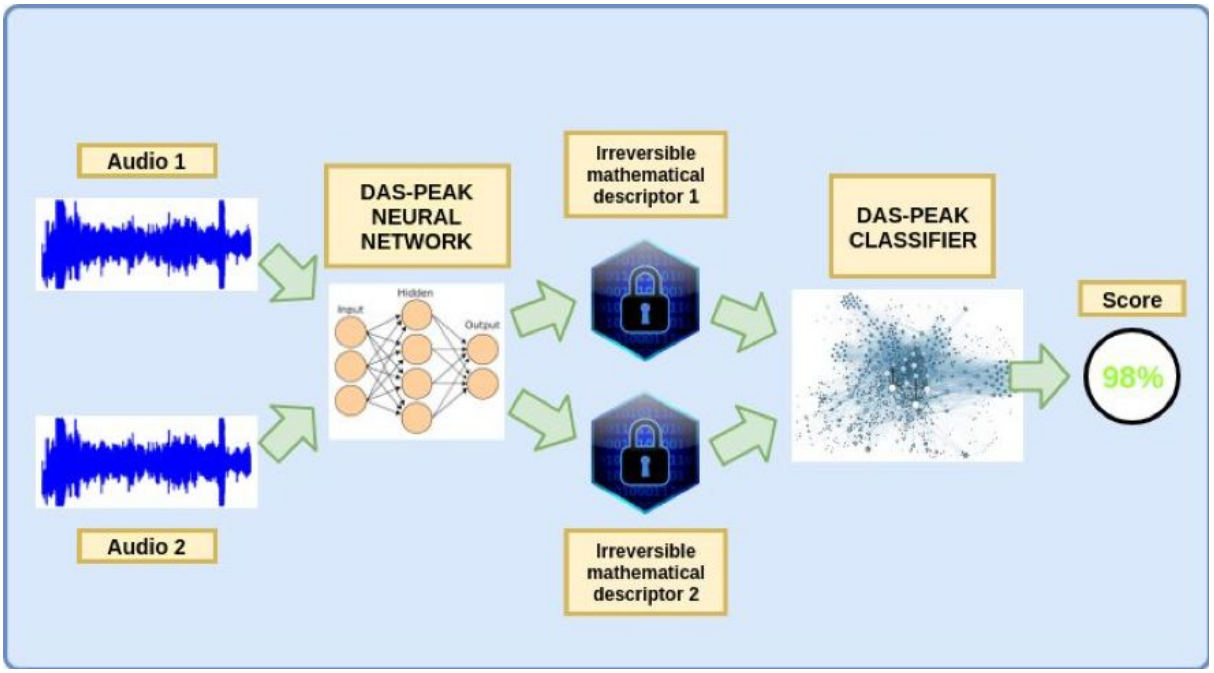
Given two audio recordings, the system returns a score based on the similarity of both of them, not regarding to speech recognition but to the speakers present in them.




das-Peak is offered as an API REST format. The process to obtain the value of similarity between two audios is described below.

1. Two audio recordings are sent to the API.
2. The audio recordings are pre-processed. This process detects voice in the audio recordings (removing parts of silence) and analyzes the noise of the signals.
3. The audio recordings are converted into irreversible mathematical descriptors (voice biometric vectors).
4. Both mathematical vectors are compared and a matching score between 0 and 1 is provided. This matching score represents the probability that the audios belong to the same person. The higher the score, the greater the certainty to be the same person.
5. You can use this matching score to validate the identity of a customer. Recommendation to define a threshold within required confidence level using the FPR (False Positive Rate) and FNR (False Negative Rate) expected ratios (see section 1.1.1.2)

das-Peak also provides the biometric vector generated from audio. With this information, it is possible to carry out the verification between a biometric registration vector and a new audio, instead of between two audios.




VERIDAS does not store any personal data in the cloud. All the user information (i.e., both the audio recordings as well as the processed data) is **immediately deleted**.

## 3. Main features

The main features of the das-Peak voice biometrics engine are:

- **Text-independent**: Allows to compare phrases with different content. That is, the user does not have to remember any phrase or have to read the same phrase to be authenticated.
- **Certified technology**: VERIDAS achieved 0.56% of SRE on NIST 2018 dataset, being the 4th best company worldwide.
- **Language-independent**: Allows to compare voices in different languages. The biometric voice engine has been specially trained for the following languages: German, English, Spanish, French, Italian, Chinese, Taiwan, Dutch, Estonian, Persian, Turkish, Welsh, Kabyle, Catalan and Euskera.
- **Minimum duration:** Allows verifying audios with a minimum voice duration of 5 seconds.
- **Verification time:** 0.14 seconds for comparing a biometric vector and an audio.
- **Minimum size biometric vector:** The biometric vector size is 1.1 Kbytes.
- **Voice activity detection**: Compute the total quantity of voice in the input audio to accept a verification request.
- **Noise detection**: Compute the total quantity of noise against voice in the input audio to accept a verification request.

To ensure optimal performance, recommendation for audios to be captured under specific conditions is needed. VERIDAS offers different proprietary SDKs for audio recording, and they are available for different platforms (iOS, Android). These SDKs ensure that capture process is performed following the best conditions. Most relevant conditions are:

- **Audio format:** WAV.
- **Number of channels**: Mono.
- **Bits per Sample**: 16.
- **Sampling frequency**: At least 8 kHz.

das-Peak can process any audio that meets the above conditions, not just audios recorded with the SDKs.

# 4. System quality report

## 4.1. Verification performance

VERIDAS has evaluated its voice biometrics model (das-Peak 2019Q4.1 version) with an internal database with different duration enrollment audios and different duration audios test (26.544 comparisons) in different acoustic conditions obtaining the values of False Positive Rates (FPR) and False Negative Rates (FNR) with different threshold values. The FPR is the probability to accept a non legit person and the FNR is the probability to reject a legit person. With this values it is possible to choose the desired working point of the voice biometric system.

| | Enrollment=5s Verification=5s | | Enrollment=10s Verification=5s | | Enrollment=10s Verification=10s | |
|---|---|---|---|---|---|---|
| **Similarity Threshold** | **FPR(%)** | **FNR(%)** | **FPR(%)** | **FNR(%)** | **FPR(%)** | **FNR(%)** |
| 0.5 | 1 | 2.01 | 1 | 0.7 | 1 | 0.1 |
| 0.55 | 0.7 | 2.4 | 0.7 | 0.9 | 0.7 | 0.15 |
| 0.6 | 0.5 | 3.02 | 0.5 | 1.3 | 0.5 | 0.26 |
| 0.65 | 0.3 | 3.8 | 0.3 | 1.6 | 0.39 | 0.29 |
| 0.7 | 0.2 | 4.8 | 0.27 | 1.9 | 0.27 | 0.59 |
| 0.75 | 0.17 | 6.3 | 0.17 | 2.7 | 0.18 | 0.69 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.8 | 0.1 | 8.7 | 0.1 | 3.6 | 0.1 | 1.1 |
| 0.85 | 0.05 | 12.2 | 0.05 | 5.4 | 0.06 | 1.7 |
| 0.9 | 0.02 | 18.5 | 0.02 | 8.8 | 0.02 | 2.7 |
| 0.95 | 0.01 | 32.9 | 0.01 | 17.1 | 0.01 | 5.7 |

This calibration shows different security work points depending on the similarity threshold and the audios voice duration that are compared.

For example, If the use case is 5 seconds to register and 5 seconds to verify, with a threshold equal to 0.6, it is obtained FPR=0.5% and FNR=3.02%. In this case, 96.98% of the comparisons of a person voice and its corresponding voice registration will be considered as authentic, and only 0.5% of the cases comparing voices to different persons will be incorrectly classified as authentic.

Possibility to further calibrate system with real use cases (if call recordings provided) during integration process.

### 4.2. Identification performance

VERIDAS has evaluated its voice biometrics model (das-Peak 2019Q4.1 version) with a internal database with 250 speakers and 5896 audios for the identification 1:N use case (N=2 to 10). In this database, speakers have been recorded in different sessions with different acoustic conditions (street, pub, train station, room, church,...). A number of 1000 random identification tasks have been performed for each N (from N=2 to 10). For example, in a 1 to 10 identification process (N=10) the probability to identify the right individual is **97.8 %**. The identification accuracy results for N=2 to 10 can be observed in the following table:

| **Nº Speakers** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|
| **Accuracy (%)** | 99.6 | 99.1 | 98.9 | 98.7 | 98.4 | 98.2 | 98.0 | 97.9 | 97.8 |

# 5. API Considerations

The following are some general considerations about this API that must be taken into account before consuming the service.

## 5.1. Authentication

This service sits behind a gateway responsible for authenticating end users and routing requests. The authentication method is API key based.

## 5.2. Requests

- The multipart/form-data content type must be used on every request.
- The wav files sent to das-Peak must have a format extension (.wav).
- The API is HTTP-based and uses SSL everywhere with valid certificates. For security reasons, customers should never trust das-Peak endpoints exposing invalid certificates.
- Endpoints attempt to conform to the design principles of Representational State Transfer (REST).
- The service includes an /alive endpoint that returns the 200 HTTP status code if the service is up and running. This can be used to check the service's health.

All responses will be encoded using JSON, regardless of the accepted content-type specified by the client. Responses will return a suitable HTTP status code indicating if the request was successful (200 or 204 if nothing else is returned) or not (any other code). Responses will also include a code field in the JSON body that can provide more information about the concrete error on each case.

In general, successful responses will have the following format:

HTTP Status: 200 OK

```
{
      "data": {
            DATA
      }
}
```

or

In case of error:

| Field | Description |
|---|---|
| exception | exception that raised the error |
| error | A message indicating what went wrong |

Example:

```
{
	“exception”: “InputException”,
	“error”: “The wav is not mono.”
}
```

### 5.3 Versioning

The API version will be included in the URL, after the base url and before the endpoint:

`https://<base_url>/<service>/v{number:integer}/<endpoint>`

Non-backwards compatible changes will cause a version increment. As of now, the API only supports the **v1** version.

## 6. API Definition

This service is a REST API where the following endpoints are exposed:

**Public Base URL** (v1):

https://<base_url>/daspeak/v1/

**Resources**:

| Method | Public URL | Description |
|---|---|---|
| **GET** | /alive | Checks if the service is up |
| **POST** | /credential/wav | Generate a biometric credential from a given audio input, using the latest available model |
| **POST** | /similarity/credential2wav | Computes the voice similarity between an audio input and a previously generated voice biometric credential, and returns how similar are both voices |
| **POST** | /similarity/wav2wav | Computes the voice similarity between two audio inputs, and returns how similar are both voices |

| | | |
|---|---|---|
| **POST** | /identification/wav2credentials | Computes the voice similarity between an input wav and a list of voice credentials, and returns the guess result and a list of all results. A result contain credential ID and its score. |
| **POST** | /identification/credential2credentials | Computes the voice similarity between a reference voice credential and a list of voice credentials, and returns the guess result and a list of all results. A result contain credential ID and its score. |

### 6.1. Check if the service is alive

The service receives a GET request with no params, and returns a 200 status code indicating that the server is up.

**GET** /alive

#### Response: 200

Empty response.

#### Response: 500

Server error response.

Content-Type: application/json

| exception | error message |
|---|---|
| ServerError | Unexpected server fatal error |

### 6.2. Generate a voice biometric credential

This endpoint is used to generate a voice biometric credential from a given audio input, using the latest available model. The biometric credential size is 1.1 Kbytes.

**POST** `/credential/wav`

### Request Body

Request for voice biometric credential generation.

| Name | Req. | Type | Description |
|---|---|---|---|
| audio | yes | WAV file | Audio with the target speaker voice. As multipart/form-data, it should be a file, as application/json, the file content encoded in base64. |

### Response: 200

Returns one voice biometric credential for the given audio file.

#### Content-Type: application/json

| Name | Req. | Type | Description |
|---|---|---|---|
| credential | yes | string | A biometric credential string |
| version | yes | string | An object with two items: hash of the model used to generate the biometric credential, and the operation mode used to configure the model. |

### Response: 400

Request format error.

#### Content-Type: application/json

| exception | error message |
|---|---|
| InputException | The wav is not mono |
| InputException | The wav sample rate is not 8000 |
| InputException | The wav bits per sample are not PCM_16 |
| InputException | The wav duration is longer than 30s |
| InvalidAudio | Noise level exceeded |
| InvalidAudio | The duration of the voice is not enough: 2.5 s less than 3.0 s |

### Response: 500

Server error response.

Content-Type: application/json

| exception | error message |
|---|---|
| Exception | Error opening <_io.BytesIO object at 0x7f6baab4dbf8>: File contains data in an unknown format. |

## 6.3. Compute similarity between biometric credential and audio

Computes the voice similarity between an audio input and a previously generated voice biometric credential, and returns how similar are both voice.

**POST** `/similarity/credential2wav`

Request Body

Request for voice verification with a voice biometric credentials and wav audio input.

| Name | Req. | Type | Description |
|---|---|---|---|
| credential_reference | yes | string | A reference voice biometric credential string generated with 6.2 API endpoint |
| audio_to_evaluate | yes | WAV file | Audio to evaluate with the speaker voice. As multipart/form-data, it should be a file, as application/json, the file content encoded in base64. |

Response: 200

Returns the confidence (or similarity) between the audio to evaluate and the biometric voice credential, being more similar as much close this number is to one. The number is in range [0,1].

Content-Type: application/json

| Name | Req. | Type | Description |
|---|---|---|---|
| confidence | yes | number | A probability number in range [0,1] |
| version | yes | string | API version |

Response: 400

Request format error.

Content-Type: application/json

| exception | error message |
|---|---|
| InputException | The wav is not mono |
| InputException | The wav sample rate is not 8000 |
| InputException | The wav bits per sample are not PCM_16 |
| InputException | The wav duration is longer than 30s |
| InvalidAudio | Noise level exceeded |
| InvalidAudio | The duration of the voice is not enough: 2.5 s less than 3.0 s |

Response: 500

Server error response.

Content-Type: application/json

| exception | error message |
|---|---|
| Exception | Decryption error |
| Exception | Incorrect padding |
| Exception | Error opening <_io.BytesIO object at 0x7f6baab4dbf8>: File contains data in an unknown format. |

## 6.4. Compute similarity between two audios

Computes the voice similarity between two audio inputs, and returns how similar are both voices.

**POST** `/similarity/wav2wav`

### Request Body

Request for voice verification with two audios.

| Name | Req. | Type | Description |
|---|---|---|---|
| audio_reference | yes | WAV file | Audio with the reference speaker voice. As multipart/form-data, it should be a file, as application/json, the file content encoded in base64. |
| audio_to_evaluate | yes | WAV file | Audio to evaluate with speaker voice. As multipart/form-data, it should be a file, as application/json, the file content encoded in base64. |

### Response: 200

Returns the confidence (or similarity) between both speaker voices, being more similar as much close this number is to one. The number is in range [0,1].

### Content-Type: application/json

| Name | Req. | Type | Description |
|---|---|---|---|
| confidence | yes | number | A probability number in range [0,1] |
| version | yes | string | API version |

### Response: 400

Request format error.

### Content-Type: application/json

| exception | error message |
|---|---|
| InputException | The wav is not mono |
| InputException | The wav sample rate is not 8000 |
| InputException | The wav bits per sample are not PCM_16 |
| InputException | The wav duration is longer than 30s |

| | |
|---|---|
| InvalidAudio | Noise level exceeded |
| InvalidAudio | The duration of the voice is not enough: 2.5 s less than 3.0 s |

Response: 500

Server error response.

Content-Type: application/json

| exception | message |
|---|---|
| Exception | Error opening <_io.BytesIO object at 0x7f6baab4dbf8>: File contains data in an unknown format. |

### 6.5. Compute voice identification between a wav input and a list of credentials

Computes the voice similarity between an input wav and a list of voice credentials, and returns the identification results and the scores.

**POST** /identification/wav2credentials

Request Body

Request for voice identification with one audio input and a voice credentials list.

| Name | Req. | Type | Description |
|---|---|---|---|
| audio_reference | yes | WAV file | Audio with the reference speaker voice. As multipart/form-data, it should be a file, as application/json, the file content encoded in base64. |
| credentials_list | yes | Dictionary | List of voice credentials with its corresponding identification tags. Each element on this list shall contain user ID and its credential using a dict with fields “id” and “credential” |

Response: 200

Returns the identification tag  with the score and a dictionary with all the tags and scores.

Content-Type: application/json

| Name | Req. | Type | Description |
|---|---|---|---|
| result | yes | Dictionary | Tuple with the identification tag and its score. |
| scores | yes | Dictionary | Results with the identification tags and scores. |

Response: 400

Request format error.

Content-Type: application/json

| exception | error message |
|---|---|
| InputException | The wav is not mono |
| InputException | The wav sample rate is not 8000 |
| InputException | The wav bits per sample are not PCM_16 |
| InputException | The wav duration is longer than 30s |
| InvalidAudio | Exceeded Noise Level |
| InvalidAudio | The duration of the voice is not enough: 2.5 s less than 3.0 s |
| InputException | Length of credentials list exceeds the maximum allowed. |

Response: 500

Server error response.

Content-Type: application/json

| exception | message |
|---|---|
| Exception | Error opening <_io.BytesIO object at 0x7f6baab4dbf8>: File contains data in an unknown format. |

## 6.6. Compute voice identification between a reference credential and a list of credentials

Computes the voice similarity between a reference voice credential and a list of voice credentials, and returns the identification results and the scores.

**POST** /identification/credential2credentials

### Request Body

Request for voice identification with one reference voice credential and a voice credentials list.

| Name | Req. | Type | Description |
|---|---|---|---|
| credential_reference | yes | Dictionary | Tuple with the voice credential and its identification tag. |
| credentials_list | yes | Dictionary | List of voice credentials with its corresponding identification tags. Each element on this list shall contain user ID and its credential using a dict with fields “id” and “credential” |

### Response: 200

Returns the identification tag with the score and a dictionary with all the tags and scores.

Content-Type: application/json

| Name | Req. | Type | Description |
|---|---|---|---|
| result | yes | Dictionary | Tuple with the identification tag and its score. |
| scores | yes | Dictionary | List with the identification tags and scores. |

### Response: 400

Request format error.

Content-Type: application/json

| exception | error message |
|---|---|
| InputException | Length of credentials list exceeds the maximum allowed. |

Response: 500

Server error response.

Content-Type: application/json

| exception | message |
|---|---|
| Exception | Error opening <_io.BytesIO object at 0x7f6baab4dbf8>: File contains data in an unknown format. |

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