What is Signalyze?

Signalyze is an interactive program for the analysis of speech and other acoustic material. It contains a large set of signal editing, analysis and manipulation tools. Signalyze runs only on Macintosh computers. Buy Signalyze and a Macintosh AV or a Power Macintosh, and you have all you need to record, analyze and reproduce professional 16-bit sound.

Uses for Signalyze

Signalyze can be used for a wide variety of signal analysis tasks.

Stimuli for perception experiments

- Signal splicing
- Mix noise into a speech signal
- Align dichotic stimuli

Perform interactive speech analysis

- Make superb 256-grayscale or color spectrograms
- Measure duration, frequency and amplitude
- Perform pitch extractions
- Slow down or speed up speech
- Filter signals

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1 Do you work in an IBM-compatible or UNIX environment? No problem—check out the new PowerPC from Apple. They run Macintosh, DOS and UNIX environments on a single machine.
Signalyze™ 3.0 Information

• Manipulate signals
• Change the sampling frequency of a signal

Foreign language instruction
• Work on an AV- or Power Macintosh or plug in an Apple®, MacRecorder®, MacAdios™ or AudioMedia digitizer,
• Record a sentence,
• Replay the recording,
• Show its fundamental frequency (intonation pattern)

Signalyze at a glance

The Signalyze main window

![Signalyze main window diagram]
Signalyze™ 3.0 Information

Signalyze Features

Signal management in Signalyze
Signalyze will manage up to 100 signal files at a time, depending on the size of the files, the amount of RAM installed on your machine, and the amount of memory you give Signalyze.

Signals are shown in individual tracks on cards, the maximum number of tracks depending on the size of your screen. Each card can show as many signals as fit on a screen (or fewer).

To see more signals, you simply jump to another card.

Synchronous or asynchronous alignment for all signals

Move one signal—
and all other signals stay time-aligned
(even signals on other cards).

or —
keep any signal stationary
Multilingual menus and help

The program switches instantaneously into English, French or German. Menus, buttons, information dialogs, the Online Help, and Balloon help switch instantly into the desired language. Online Help is also available in Italian.

16-bit sound sampling

- They are less difficult to record. With 16-bit signals, there’s less danger of excessive or insufficient recording amplitude. Record spontaneous speech, children’s or pathological speech with much less fuss than with 8-bit signals.
- They encode high-frequency information more reliably. Frequency information above 2 kHz is weak or insufficient in 8-bit signals. 16-bit signals give you the full range.
- They encode the full range of amplitude information. 8-bit signals only give you 42 dB of amplitude. 16-bit signals can encode about 90 dB — which covers the usual range of speech, music and animal sounds.

But can I still work with 8-bit signals?

Of course. 8-bit signals are automatically translated into 16-bit format. For much of speech analysis—especially for time measures—8-bit signals are just fine. Also, 8-bit recording and reproduction equipment is less expensive than 16-bit equipment. In fact, every Mac ever built can reproduce 8-bit sound, more recent Macs have at least 8-bit recording equipment built right in, and Macintoshes of the “AV”- and Power Macintosh generation have built-in capability for recording and playing back 16-bit sound.
User-Friendly interface

- **Apple interface guidelines** are followed. Commands are in the expected places.
- **Several signals** are in a single window. No weaving through a tangle of signal windows.
- There are only *a few windows and palettes* to learn. Even beginners quickly find their way around Signalyze.
- **Turn on Balloon Help** under System 7 to get instant explanations.
- Use the *extensive On-board Help* (in English, French and German). You don’t have to chase down the manual. Users tell us that Signalyze has an “exceptionally helpful” Help. Contains extensive “How To” section, as well as a detailed reference section.
- But when you need it, the Manual is there: *professional and detailed answers* to nearly all you need to know about what the program does and how it does it.
- Eight detailed tutorials to get you started.
- 250 pages in English, 270 pages in French.

Signalyze Tools

Signal editing tools

- Copy, cut, paste and clear whole signals or parts of signals
Signalyze™ 3.0 Information

- Optional splicing at signal junctions

- Optional cosine taper at signal ends

Slow down or speed up speech

Click: Set speed to 20%: Fastest
normal (100%) 100%: Normal
(200%) 500%: Slowest

Click: Play Sound according to Audio Setup specifications

Loudspeaker Volume:
0: silent
8: maximum

- Slows speech down by up to five times (500%)
- Speeds speech up by up to five times (20%)
- At 75-150%, sound quality is largely preserved for most voices
- Save modified signals optionally

Manual scoring made easy

“Manual scoring” means getting numeric values directly from the signal. In this way, you can easily get:
- the duration of a speech sound
- the frequency from a spectral peak
- amplitude differences between two vowels
- much more
Duration

1. Blacken part of a signal
2. Click on the duration field
3. The duration is shown in the edit window
4. Double-click or press “return” to transfer duration to the cumulative text storage

Get Frequency

1. Place cursor
2. Click on spectrum button (not shown)
3. A spectrum is produced
4. Click in spectrum and press shift-command

5. Frequency and original time is displayed
Amplitude Differences Between Two Vowels

1. Make power or RMS envelope from signal
2. Blacken space between two peaks
3. Request amplitude difference through statistics command
4. dB amplitude difference is shown in edit window

Amplitude or Frequency Differences from Spectra

1. Click in signal
2. Make spectrum
3. Blacken distance between two peaks
4. Activate statistics command with “dB difference” and “Hz difference”
5. dB and frequency differences between peaks are shown in edit window
**Signalyze™ 3.0 Information**

**An extensive labeling facility**

- Easy to use
- Coded for up to nine levels (e.g., syllable, segment, etc.)
- Label points or sections of the signal
- Saved as TAB-delimited text files
- Use the included phonetic font or any other font & font size
- Edit existing labels
- Insert or add new labels
- Delete any label or all labels
- Search by label
- Search by level
- Two label search patterns
- Switch between search patterns with the shift lock key

**Spectral Analysis Tools**

Signalyze provides a wide range of tools suitable for the spectral analysis of speech:
- Narrow-band and wide-band spectra (seven spectral bandwidths: 300 Hz, 200 Hz, 125 Hz, 40 Hz, 33 Hz, 20 Hz, 10 Hz)
- Narrow-band and wide-band spectrograms at the named bandwidths
- Spectral zoom (full/half/quarter range)
- High-quality spectrogram displays for grayscale and color (16 colors/grays and 256 colors/grays)
- Autorecorrelation (inverse) filtering for Fo
- Cepstra and cepstrograms
- Linear Predictive Coding (LPC), orders 8-25
- Cone kernel spectra and spectrograms (256/512 pts.)
- Long-term averaged spectrum

**Narrow-band spectrum**

- Narrow-band spectrum of a female speaker
  - $F_o = 305$ Hz
  - Harmonic 2 = 605 Hz

**Wide-band spectrum**

- Wide-band spectrum of an /a/-vowel
  - Formant 1 = 580 Hz
  - Formant 2 = 1220 Hz

**LPC spectrum**

- LPC spectrum of /æ/-vowel
  - Formant 1 = 700 Hz
  - Formant 2 = 1350 Hz
Narrow-band cepstrum

Narrow-band cepstrum of female voice
Fo cycle duration = 3.5 ms
Fo = 286 Hz

Narrow-band spectrogram

Narrow-band spectrogram of syllable with falling intonation produced as grayscale spectrogram in Signalyze and dithered with the freeware program “NIH Image”
Wide-band spectrogram

Wide-band spectrogram of the syllable /ka/

Produced as a grayscale spectrogram in Signalyze and dithered with the freeware program NIH Image.

You need a 256 grayscale/color monitor, but you can print this on any printer.

Wide-band spectrogram w/scales

The same wide-band spectrogram with scales.

As printed directly from Signalyze on a pre-PowerMac machine.
**Wide-band spectrogram (256-grayscale)**

Wide-band spectrogram of the syllable /ka/

256-grayscale spectrogram.

A grayscale or color monitor is required to see this image correctly.

A grayscale or color-capable printer is required to print this image.

**Waterfall representations**

Waterfall representation obtained with the freeware program NIH Image from the same spectrogram as used in the previous figures.

Side view.
Waterfall representation obtained with the freeware program NIH Image from the same spectrogram as used in the previous figures.

Front view.

Wide-band FFT & Wide-band Cone Kernel

Wide-band FFT (left) and Wide-band Cone Kernel (right) side by side.

Cone Kernel techniques provide much greater precision in the temporal and frequency domains.

Particularly useful for formant determination.

Printed with the color/grayscale option.
A signal waveform and an LPC-gram of the word “Signalyze”.

When well adjusted, LPC’s show rather clear formant tracks.

Printed with the color/grayscale option.

**Fundamental frequency**

Signalyze provides three algorithms for Fo extraction:

- Temporal structure analysis
- FFT Comb
- Autocorrelation

Why *three* algorithms? Because signals are not all alike. Each algorithm has its advantages and disadvantages. Signalyze lets you choose the algorithm that fits your data best.

**Limits of Fundamental Frequency Analysis**

Fundamental frequency extraction is rarely an easy task. Algorithms do exist that provide a very high reliability in extracting fundamental frequency from a signal, but these are too processor-intensive for an interactive micro-computer application like Signalyze. The algorithms incorporated in Signalyze aim for a reasonable compromise between speed and reliability.
Temporal Structure Analysis (TSA)

**Advantages**
- Fast
- Continuous frequency response
- Ignores information in harmonics
- One extraction every pitch period

**Disadvantages**
- Frequency window must be defined closely
- Has difficulty with frequency shifts much greater than an octave

Male speaker, /ka/, falling intonation

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FFT-Comb Analysis

**Advantages**
- Quite robust
- One frequency window fits all voices
- Uses information from harmonics

**Disadvantages**
- Quantized frequency steps
- Cannot handle divergences between fundamental frequency and harmonics

Male speaker, /ka/, falling intonation, output filtered to reduce effect of quantization
**Autocorrelation**

![Graph showing autocorrelation](image)

**Advantages**
- Suitable for noisy signals
- Continuous frequency response

**Disadvantage**
- Relatively slow (but still faster than autocorrelation in other programs)

Male speaker, /ka/, falling intonation

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**Filtering**

Signalyze provides a number of software filters. Most prominent are the well-known Butterworth and Chebychev filters. There are also very fast 3-point triangular and 7-point hamming filters, as well as a simple moving average (convolution) filter.

**Some Examples:**

**Butterworth Filter**

Top: Signal of /a/-vowel
Middle: Narrow-band spectrum without filtering
Bottom: Narrow-band spectrum after high-pass filtering at 800 Hz (5th order Butterworth)
Chebychev Filter

Top: Signal of /a/-vowel
Middle: Narrow-band spectrum without filtering
Bottom: Narrow-band spectrum after high-pass filtering at 800 Hz (5th order Chebychev with 10 dB ripple)

3-point Triangular Filter

Top: Signal of male speaker pronouncing /m'orgen/
Middle: Narrow-band spectrum without filtering
Bottom: Narrow-band spectrum after application of triangular filter (select “smoothing” in spectral analysis setup)

Signal Modification

Signalyze provides numerous routines to modify signals:
• arithmetic transformations
• transcendental transformations
• slow down or speed up speech signals
• down- and up-sampling
  (from and to any frequency 50-100,000 Hz)
• derivative differences
• power and RMS envelopes
• splines
• zero-crossings
• trim off “quiet” signal ends

Some Examples:
**Down-sampling**
(substitute an average for the first of every two samples and delete the second sample)

**Up-sampling**
(Add interpolated samples between pairs of samples)

**Differentiation**
(calculate differences between succeeding samples)

**Splines**
(calculate spline curves and their derivative signals)
Sound Input and Output

Sound input and output is easy with Signalyze™ running on the Mac.

1. Old-style Input and Output
   • Input: Prior to System 7.0, each device had to be supported individually. Signalyze supports three such devices:
     a. MacroMind’s MacRecorder (anti-aliased):
        • Works with all Macs, incl. PowerBooks
        • Optional recording directly to disk
     b. Digidesign’s AudioMedia, Audiomedia II and AD IN.
     c. Some GW Instruments AD boards and the Model 411. Be sure to get an anti-alias filter.
   • Output: Signalyze has suitable playback via the built-in loudspeaker on old-style Macintoshes (MacPlus, MacSE, Portable, etc.)

2. New-style Input and Output
   Starting with System 7.0, the Macintosh supports sound input and output directly via the Sound control device (found in the Control Panel in the Apple Menu). Signalyze supports all devices defined in this way. This includes:
   a. Apple’s built-in microphone (Macintosh LC, SI, CI, PowerBooks, etc.)
   b. Apple’s built-in loudspeaker (any Macintosh)
   c. Any other device for which a System 7.0-compatible driver exists. This includes AV-Macintoshes and PowerMacintoshes, at the maximum bitwidth that the machine supports (AV-Macintoshes and PowerMacintoshes: 16 bits. Other machines: 8 bits). For best results, on pre-Power Macintosh computers you should make sure that you have SoundManager 3.0 (available from Apple) in your System Folder. The Power Macintosh includes SoundManager 3.0 in its system. This driver assures the best sound input and output quality on all Macintoshes.

With Signalyze running on a Power Macintosh, you have all you need for professional speech signal analysis.
File Input and Output

Signalyze can read and write most common Macintosh file formats for signals. Additional signal formats are available through the freeware program FileConverter (included in the Signalyze™ package). Signalyze also supports common text and graphics formats.

Signal File Formats
Signalyze can read and write signals in the following formats:
- Signalyze
- AIFF mono/stereo
- AudioMedia I & II/Sound Designer II mono/stereo
- MacADIOS
- SoundEdit/MacRecorder mono/stereo
- A simplified SoundEdit Pro format
- SoundWave
- Common sound resource formats
- ASCII-text formats (single channel)

- Start as many files as fit into the program (batch start)
- Automatic up/down-sampling when saving to non-Signalyze, fixed sampling-frequency formats

FileConverter

The FileConverter utility converts between Signalyze and other formats, including:
- Digidesign: AudioMedia, Sound Designer I/II mono/stereo
- AIFF, mono/stereo
- MacSpeech Lab/MacAdios
- SoundEdit/MacRecorder, mono/stereo
- Sound Wave/Impulse
- Engineering Design
- ADF (BLISS, CSRE) format
- Europec-SAM (European sound audio format)
- Haskins Lab PCM format
- NSP (Kay)
- Phonetics-Munich format
- Sun/NeXT μ-law
- Generic binary (Intel-type and Motorola-type)
**Signalyze™ 3.0 Information**

- FileConverter is supplied free of charge to all buyers of Signalyze
- FileConverter can convert all files in a given folder at once
- FileConverter can work in background mode

**Text Format**
Numeric results are stored in a text editor. This information can be saved and re-opened in TEXT format (compatible with common text processing, spreadsheet and statistics programs: Excel, StatView, SYSTAT, etc.)

**Graphics Format**
Spectrograms and other graphs can be saved and re-opened in PICT format (compatible with most graphics programs: Microsoft Word, Canvas, Claris Works, SuperPaint, PhotoShop, NIH Image, etc.)

**The Manual**
The *Manual* is 250 pages packed with information:
- A quick guide to *Version 3.0 additions*.
- A *guided tour* of Signalyze: Shows you how to do (nearly) everything you can do with Signalyze
- Numerous *“how-to” summaries* for common speech analysis techniques.
- *Installation suggestions*
- *Reference section*: Keys, buttons, menus, setup dialogs in detail
- *Technical information*: Ergonomics, memory management, file formats, numeric formats
- It is *one of the most extensive and most detailed manuals* that comes with any speech analysis system

**Requirements**
Signalyze™ runs on any Macintosh starting with the Macintosh Plus. The program takes advantage of larger screens by showing more signals per screen. Much improved spectrograms are possible on Macs equipped with grayscale and color monitors. The program is System 7.0-compatible. It runs in background with adjustable background priority.

**Memory Requirements**
Signalyze™ Version 3 requires a minimum of 4 megabytes of memory. But for added comfort, do consider getting more. 8 megabytes is comfortable. 16 megabytes is memory paradise. Anything above that is memory heaven.

**Suggested configurations**

Signalyze has been tested on all Macintoshes from the Macintosh Plus to the 2000 G4’s; this includes PowerBooks. If you are forced to use Signalyze on anything short of a PowerMac, the Signalyze support site has information and suggested for getting the most out of your machine.

**La version française**

Ces dernières années, Signalyze™ a été bien accueilli dans les pays francophones, particulièrement en France et en Suisse. Par conséquent, nous avons fait un effort spécial pour convertir tous les aspects du logiciel en français. On vous offre le suivant:

- **Une interface française.** Au moyen d’une simple sélection de menu, vous pouvez choisir l’interface française. Tous les menus, boîtes de dialogue, messages, etc., seront affichés en français.

- **Aide en français.** Une fois que vous fonctionnez en mode français et dans la mesure où le logiciel se trouve dans le même dossier où on retrouve le fichier «Aide-Signalyze», vous pouvez consulter Aide en français. Aide vous fournit des informations sur toutes les fonctions du logiciel ainsi que de précieux conseils concernant son utilisation générale. Il suffit de cliquer sur un des multiples boutons «Aide» qu’on retrouve un peu partout dans le logiciel.

- **Les bulles d’aide sous Système 7.** Après avoir activé les bulles d’aide, de petits messages en français vous guident dans l’apprentissage des différentes composantes de l’interface du logiciel.

- **Le manuel en français.** Le manuel est dorénavant disponible en français (270 pages). Vous y trouverez une introduction détaillée à l’emploi et au fonctionnement du logiciel.

**Die deutschsprachige Version**

Signalyze™ funktioniert zu großen Teilen auf Deutsch:

- **Eine deutschsprachige Benutzeroberfläche.** Mittels einer einfachen Menüeinstellung können Sie die Benutzeroberfläche auf Deutsch umstellen. Alle Menüs, Dialogboxen, Fehlermeldungen, usw. erscheinen auf Deutsch.

- **„Hilfe” in Deutsch.** Wenn Sie die deutschsprachige Oberfläche eingeschaltet haben, und wenn Signalyze sich im gleichen Ordner wie „Signalyze-Hilfe” befindet, erscheint „Hilfe” auf Deutsch. „Hilfe” gibt Erklärungen über die verschiedenen Funktionen sowie nützliche Hinweise zur allgemeinen Bedienung des Programms. Man
braucht nur auf einen der „Hilfe“-Knöpfe zu klicken, die ein bisschen überall im Programm zu finden sind.

- **Die „Hilfe“-Ballons unter System 7.** Wenn Sie unter System 7 die „Hilfe“-Ballons eingeschaltet haben, erscheinen über der Signalyze Benutzeroberfläche hilfreiche Meldungen, die Ihnen das Erlernen der Oberfläche erleichtern.

### Credits and Philosophy

The original Signalyze™ code was been written by Eric Keller with assistance from (in alphabetical order): Philip Keller, Lorenzo Morellini, Pascal Perrier, Thomas Styger and Stefan Werner, our valued beta testers, and many others whose precious time and code has found its way into the program.

Eric Keller (the author of Signalyze) holds a Ph.D. in Linguistics and is professor for computer science at the University of Lausanne, Switzerland. He’s published in the phonetic sciences for the last 14 years.

Signalyze is being developed in private initiative as an extension of software used for internal purposes in the “Laboratoire d’analyse informatique de la parole” of the University of Lausanne, Switzerland. The program’s development has not been supported by public funds. The University of Lausanne is not in any way responsible or legally liable for this product. The program’s price structure is primarily geared to the recuperation of current costs and not to the generation of profit, nor to the recuperation of the program’s real development costs.

The development of this program has benefited from interaction with a large number of users and speech specialists. All features to the program are under constant review to insure top quality and total reliability in all Macintosh environments. Over the last few years, many user comments have been translated into improvements and new features.

### Trademarks

Signalyze, InfoSignal and the brain-signal icon are trademarks of InfoSignal Incorporated. InfoSignal Inc. is a corporation established under the Federal Laws of Canada. It maintains representations in the U.S. and in Switzerland.

The use of the Signalyze trademark and icon have been licensed for use by Linguist Plus, a corporation established under the State Laws of Washington State, U.S.A. (status currently under review).

1. *InfoSignal Inc. has no links with “NIH Image”* or with its author, W. Rasband. We simply recommend the program as an freeware program to make 3D representations from Signalyze grayscale spectrograms.

2. **To make a 3D spectrogram:**
   - You need a Macintosh capable of 256 colors or grayscales.
   - Make a high-definition grayscale spectrogram with Signalyze.
   - Save the spectrogram in PICT format.
   - Load the spectrogram into “NIH Image”.
   - Frame the part of the spectrogram you want to convert into 3D.
   - Smooth the image
   - Activate the Surface Plot menu command.

3. **Get “NIH Image”:**
   - Via web browser at the NIH Image home page at http://rsb.info.nih.gov/nih-image/
   - Via ftp at the Sunet NIH Image mirror site at ftp://ftp.sunet.se/pub/mac/graphics/graphicsutil/nih-image
   - From ZMAC Forum on CompuServe, Library 1 (Applications) as IMAGE.SIT.

4. **Credits:** “NIH Image” is written by Wayne Rasband for the National Institutes of Health, Research Services Branch (NIMH).