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FUTURE IMPROVEMENTS

Improvements upon and modifications to the S.A.M. system may occur in the future. Such new versions of S.A.M. will be made available at nominal cost to registered S.A.M. owners.

We are also planning to release a new program called ‘SUPERECITER”. RECITER presently has a pronunciation accuracy of about 90%. SUPERECITER will show a major improvement in this area. But, we need your help.

If you hear a word mispronounced by RECITER that you feel is important, jot it down. Send us your list of these words (or proper names) so that we may incorporate them into the expanded rule set of SUPERECITER. Your contributions will be greatly appreciated.

S.A.M. is an ongoing project at DON'T ASK Computer Software. We welcome your comments and suggestions on our software speech synthesis products.
INTRODUCTION

Congratulations!
You have just purchased S.A.M. — the Software Automatic Mouth — a versatile, high-quality speech synthesizer created entirely in software. You have added quality speech to your personal computer for a lower cost than ever before possible and, in the bargain, have gained features that other speech synthesizers cannot offer.

SAM. is designed to be easy to use. With a couple of simple program statements, you can add speech to your BASIC or assembly-language programs. When you have mastered the easy-to-learn phonetic alphabet, the inflection system, and the use of pitch and speed controls, you will be amazed at what you can make S.A.M. do. And, until then, it will already match the performance of other speech synthesizers.

We strongly suggest that you read this manual carefully while learning to use S.A.M. There are thorough discussions of S.A.M.'s features with illustrative examples of how to implement them. There is also a dictionary of useful words and their phonetic equivalents to help you learn the phonetic spelling system.

Also remember that as a registered S.A.M. owner, you are entitled to our services in answering your SAM-related questions, providing updates and improvements to the S.A.M. program at nominal cost, and helping you with your applications of S.A.M. Yes, this is a not-too-subtle hint that you should send in your S.A.M. owner registration card today. We look forward to hearing from you.
THE S.A.M. DISKETTE

The SAM diskette contains several programs.

1. The S.A.M. speech synthesis program —
   This program will boot in automatically and will leave your computer ready to accept speech input through BASIC or machine language programs. The program occupies about 9K bytes.

2. RECITER —
   RECITER is the English text-to-speech program that interfaces the S.A.M. program with ordinary English text input. It is not used for phonetic input and must be loaded in separately (see instructions). It occupies about 6K bytes.

3. SAYIT —
   A short BASIC program that allows you to type in strings of phonemes or text and hear them spoken immediately.

4. DEMO —
   A BASIC program that demonstrates some of S.A.M.’s features by telling a short story.

5. SPEECHES —
   Another BASIC program that features some familiar texts to be spoken aloud by S.A.M.

6. GUESSNUM —
   A vocal version of the old guess-the-number-between-one-and-one-hundred game. Great for kids.

We suggest that you do not write additional data on the S.A.M. diskette. Remove after loading the desired programs.
INSTALLING THE BOARD

Step 1: MAKE SURE THE COMPUTER is OFF!!! Remove the Apple's top Cover.

Step 2: Look at the bottom of the SAM board and locate the edge with the word REAR printed near it. This edge goes next to the back of the computer.

Step 3: With a gentle forward-and-back rocking motion, insert the board into slot connector #4. (See section on slot portability.)

Step 4: Connect the speaker lead wires to an 8-ohm speaker. We recommend a 4 to 8 inch diameter speaker in a small vented box. Larger speakers give SAM, more chest” and smaller speakers tend to sound too tinny. Radio Shack part #40-1 227A is a good, inexpensive choice.

Step 5: (Optional) If you desire all the Apple sounds to be amplified through to SAM’s speaker, do the following: locate the small speaker inside the Apple near the ell side of the keyboard. A pair of wires runs to a connector under the right side of the keyboard. Unplug this connector and replace it with the duplicate connector coming from the S.A.M. board.

Step 6: Using a small screwdriver, turn the volume control on the S.A.M. board to its mid-position. Turn on the computer. Run a demo program from the S.A.M. diskette.

If S.A.M is working but the Apple sounds, such as beeps, do not come through, turn off the computer. Now unplug the substitute Apple speaker connector, turn it around 180° and plug it back in. Try it again; you actually have a 50/50 chance of it working the first time.

LOADING THE S.A.M. PROGRAMS

S.A.M. and RECITER are machine language programs stored as binary files on disk. To load them, say BLOAD SAM or BLOAD RECITER in immediate mode or within a program. RECITER requires S.A.M., so you must load both to use RECITER. The order in which the programs are loaded is unimportant.

RUNNING THE DEMO PROGRAMS

Once S.A.M. is binary-loaded into the computer, you are ready to run any of the BASIC demo programs such as SAYIT, DEMO, SPEECHES, AND GUESSNUM.
USING S.A.M. FROM APPLESOFT

SAM patches into Applesoft by the use of the reserved string variable named SA$ (easy to remember).
Two Applesoft statements are all that are required to make S.A.M. speak. The following statements inserted anywhere in an Applesoft program will cause S.A.M. to speak the phrase “I am a computer’.

```
100 SA$= “AY4 AEM AH KUMPYW3TER.”
110 CALL 38128
```

By using Applesoft’s string handling capabilities, it is possible to generate the SA$ string from sentence fragments, data statements, text tiles, etc. The GUESSNUM program listed in this manual illustrates some of these techniques.

TWO CAUTIONS

1. To avoid stepping on S.A.M. with your Applesoft program, a HIMEM:29024 should appear before any variables (especially strings) are defined in your program. Play it safe and make it the first statement executed after S.A.M. is BLOADed.

2. Never hit RESET while S.A.M. is speaking! Not only is it very rude, it also has detrimental effects: S.A.M. uses many zero-page memory addresses which are restored to normal after vocal output. Pressing RESET does not allow this to happen and consequently, the chances of your program surviving are rather slim. If you need to exit your program, use ctrl-C.
USING RECITER FROM APPELSOFT

Using RECITER from Applesoft is the same as using S.A.M. in his phonetic mode. However, this time the string SA$ is in plain English. Also the calling address is different.

100 SA$="I AM A COMPUTER."
110 CALL 38131

Use of punctuation with RECITER is discussed later, but note that a dash will be treated as a pause-making dash only if there is a non-letter (not A-Z) on both sides of it. Examples: the dash in "YOU ARE A RAT-FINK" will not pause, but the dash in "HELLO JIM - THIS IS ANN" will.

USE OF S.A.M. AND RECITER FROM MACHINE LANGUAGE

This is very similar to using S.A.M. from Applesoft except for one change: you must do your own string handling. A string of ASCII characters (the same ones you would use in Applesoft) is moved into locations $9500-$95FF. The first character must be in $9500 and the last character, an $8D return character, marks the string's end. Bytes after the $8D are not read by S.A.M. All characters must have their MSB on. Following the string definition, a JSR $94F6 is done and SAM. speaks. The use of RECITER is the same except that you do a JSR $94F9 instead.
THE RECITER PROGRAM

RECITER is an English text-to-speech program that converts ordinary text into phonemes that SAM can understand. You simply supply output strings of 256 characters or less to the program. RECITER takes care of the rest.

The program uses about 450 rules to convert English into SAM’s phonetic language. Included among these rules are some stress markers for situations where the stress choice is unambiguous. In addition, SAM’s usual punctuation rules still operate with some additional symbols “‘”, “::”, and “::”) being considered as periods. The net result is that even directly-translated English text has a fair amount of inflection.

RECITER also recognizes a number of special characters. Numbers are read aloud, and several others are pronounced as well. If a character is not understood by RECITER, it simply isn’t passed to S.A.M.

We recommend use of RECITER by any text-to-speech program, for that matter) only by applications where the user has no control of the text. For example, text already in a file, text received over a MODEM, and text supplied by users unfamiliar with the phonetic system. Where the highest quality speech with full inflection is desired, we urge you to use S.A.M.s phonetic system.

Don’t be discouraged, though. You will find that RECITER will do a better job of speaking from English text than other text-translator products.

THE SAYIT PROGRAM

SAYIT is a short BASIC program that allows you to test many of S.A.M. and RECITER’s features by directly inputting the string SAM$.

If both S.A.M. and RECITER have been loaded in, you may opt for English input when running the program.

Typing “ctrl-N” will allow you to input new pitch and speed values to lest these features. Once you have done so, the new pitch and speed will remain until you type “ctrl-N” again.
PHONETIC INPUT TO S.A.M.

I. THE PHONETIC SPELLING SYSTEM

S.A.M. is equipped with a version of the easy-to-learn, very readable International Phonetic Alphabet. There are about fifty phonemes which will let you spell all the words in English. Some sounds from foreign languages are not available in the system at this time.

Why use the phonetic system? There are two compelling reasons. 1.) In the phonetic system, all the words will be pronounced correctly; and 2.) You can put inflection into the speech however and wherever you want it.

If you have already tried the RECITER text-to-speech program, you know that it does a fair job of pronouncing English words. However, it does make mistakes. Some words sound a little strange and others are difficult to understand. The reasons for this are not hard to understand. English is a language of exceptions rather than rules; words that are spelled alike are pronounced differently (‘have’ vs. “gave”). A rule system like RECITER cannot pronounce all words correctly unless it stores an enormous dictionary that takes up vast amounts of memory. But the second flaw in text-to-speech conversion is more serious. Such a rule system cannot decide where the stress belongs in what is being said. The phonetic system in SAM., on the other hand, allows you to decide where to stress syllables within a word and where to stress words within a sentence.

So it is clear that the preferred way to make SAM. speak is with the phonetic alphabet. But how hard is it to use? It’s really easier than writing in English because you don’t have to know how to spell! You only have to know how to say the word in order to spell it phonetically.

Here is the complete list of phonemes, each presented with a sample word containing its sound. Note that there are many vowels, which is why they are all indicated by two letters rather than one.

The phonemes are classified into two categories: vowels and consonants. Among the vowels are the simple vowel sounds such as the “i” in “sit”, the “o” in “slot”, and the "a" in "hat" These vowels do not change their quality through out their duration. The?e are also vowels called diphthongs such as the “i” in “site”, the “o” in “slow”, and the “a” in “hate”, as well as the “oi” in “oil” and the “ow” in “how”. These vowels start with one sound and end with another (e.g."oi" glides from an “oh” sound to an “ee” sound).

The consonants are also divided into two groups: voiced and unvoiced. The voiced consonants require you to use your vocal chords to produce the sound. Such sounds as “b”, “l”, “n”, and “z” sounds fall into this category. The unvoiced consonants, on the other hand, are produced entirely by rushing air and include such sounds as the “p’, “t”, “h”, and “sh” sounds.

-10-
# PHONETIC ALPHABET
## FOR S.A.M.

The example words have the sound of the phoneme, not necessarily the same letters.

## VOWELS

<table>
<thead>
<tr>
<th>Letter</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>IY</td>
<td>feel</td>
</tr>
<tr>
<td>IH</td>
<td>pin</td>
</tr>
<tr>
<td>EH</td>
<td>beg</td>
</tr>
<tr>
<td>AE</td>
<td>Sam</td>
</tr>
<tr>
<td>AA</td>
<td>pot</td>
</tr>
<tr>
<td>AH</td>
<td>budget</td>
</tr>
<tr>
<td>AO</td>
<td>talk</td>
</tr>
<tr>
<td>OH</td>
<td>cone</td>
</tr>
<tr>
<td>UH</td>
<td>book</td>
</tr>
<tr>
<td>UX</td>
<td>loot</td>
</tr>
<tr>
<td>ER</td>
<td>bird</td>
</tr>
<tr>
<td>AX</td>
<td>gallon</td>
</tr>
<tr>
<td>IX</td>
<td>digit</td>
</tr>
</tbody>
</table>

## DIPHTHONGS

<table>
<thead>
<tr>
<th>Letter</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>EY</td>
<td>made</td>
</tr>
<tr>
<td>AY</td>
<td>high</td>
</tr>
<tr>
<td>OY</td>
<td>boy</td>
</tr>
<tr>
<td>AW</td>
<td>how</td>
</tr>
<tr>
<td>OW</td>
<td>slow</td>
</tr>
<tr>
<td>UW</td>
<td>crew</td>
</tr>
</tbody>
</table>

## VOICED CONSONANTS

<table>
<thead>
<tr>
<th>Letter</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>red</td>
</tr>
<tr>
<td>L</td>
<td>allow</td>
</tr>
<tr>
<td>W</td>
<td>away</td>
</tr>
<tr>
<td>WH</td>
<td>whale</td>
</tr>
<tr>
<td>Y</td>
<td>you</td>
</tr>
<tr>
<td>M</td>
<td>Sam</td>
</tr>
<tr>
<td>N</td>
<td>man</td>
</tr>
<tr>
<td>NX</td>
<td>song</td>
</tr>
<tr>
<td>B</td>
<td>bad</td>
</tr>
<tr>
<td>D</td>
<td>dog</td>
</tr>
<tr>
<td>G</td>
<td>again</td>
</tr>
<tr>
<td>J</td>
<td>judge</td>
</tr>
<tr>
<td>Z</td>
<td>zoo</td>
</tr>
<tr>
<td>ZH</td>
<td>pleasure</td>
</tr>
<tr>
<td>V</td>
<td>seven</td>
</tr>
<tr>
<td>DH</td>
<td>then</td>
</tr>
</tbody>
</table>

## UNVOICED CONSONANTS

<table>
<thead>
<tr>
<th>Letter</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Sam</td>
</tr>
<tr>
<td>SH</td>
<td>fish</td>
</tr>
<tr>
<td>F</td>
<td>fish</td>
</tr>
<tr>
<td>TH</td>
<td>thin</td>
</tr>
<tr>
<td>P</td>
<td>poke</td>
</tr>
<tr>
<td>T</td>
<td>talk</td>
</tr>
<tr>
<td>K</td>
<td>cake</td>
</tr>
<tr>
<td>CH</td>
<td>speech</td>
</tr>
<tr>
<td>/H</td>
<td>ahead</td>
</tr>
</tbody>
</table>

The following symbols are used internally by some of S.A.M.'s rules, but they are also available to the user.

- **YX**: diphthong ending
- **WX**: diphthong ending
- **RX**: R after a vowel
- **LX**: L after a vowel
- **/X**: H before a non-front vowel or consonant "flap" as in pity
- **DX**: "flap" as in pity

## SPECIAL PHONEMES

<table>
<thead>
<tr>
<th>Letter</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>UL</td>
<td>settle (= AXL)</td>
</tr>
<tr>
<td>UM</td>
<td>astronomy (= AXM)</td>
</tr>
<tr>
<td>UN</td>
<td>function (= AXN)</td>
</tr>
<tr>
<td>Q</td>
<td>kitt-en (glottal stop)</td>
</tr>
</tbody>
</table>

Note: The symbol or the "H" sound is /H. A glottal stop is a forced stoppage of sound.
On the phoneme chart, you will notice six phonemes — YX, WX, RX, LX, /X, and DX — which are described as being used by S.A.M.'s rule system. However, they have been provided with letter codes so that you may experiment with these special sounds directly. YX and WX are weaker versions of Y and W. RX and LX are smooth gliding versions of R and L. /X is the “h” sound in “who”, and DX is the quick flap of the tongue on the upper palate as in the word “pity”.

We are now ready to transcribe ordinary speech into its phonetic representation. Let's use the following sentence as an example:

I do my calculations on the computer.

The first step is to say each word aloud and decide how many syllables are in the word. A syllable has one vowel phoneme and its associated consonants (if any). We then identify the proper vowel phoneme by comparing its sound to the sounds listed in the table. And do the same for the consonants. The resultant combination of phonemes is the phonetic representation of the syllable. We do this for each syllable in a word.

In our example, the first word — “I” — is a single phoneme, the diphthong "AY". The next word — “do” — is a single syllable comprised of the diphthong "UW" preceded by the voiced consonant “D”. The phonetic spelling is therefore "DUW". Similarly the third word — “my” — again uses the “AY” sound. This time preceded by an “M”. Resulting in "MAY".

The word “calculations” has four syllables. The first syllable transcribes as “KAEL” The “c” sound is pronounced as “k”. Unlike the “s” pronunciation in a word like “cell” (notice there is no “C” in the phoneme tablet. The next syllable — “cu” — transcribes as “KYUW”. Note here that the “Y” sound prevents this syllable from being pronounced as “coo”. The third syllable comes out as “LEY”. And the fourth becomes “SHAX NZ”. This word ends with a voiced sound “Z” and not the hissy “S” sound as in “list”. You will rapidly discover that many words contain the phonetic combinations “AXL”, “AXM”, and “AXN”. To enhance the readability of the phonetic spelling, the special symbols “UL”, “UM”, and “UN” can be substituted for these combinations. The “lions” syllable is now written as “SHUNZ”. So “calculations” becomes “KAELKYUWLEYSHUNZ”.

The next word “on” becomes “AAN”. And “the” becomes “DHAX”. By the way, if the word “the” precedes a word beginning with a vowel, it gets pronounced “thee” and is spelled “DH IY”. You should also notice that the “th” letter combination has two phonetic representations: unvoiced (TH) as in “thin”, or voiced (DH) as in “the”.

By now, the steps used in getting from ‘computer” to “KUMPYUWTER” should at ready be obvious. Try it.
Once you get used to the phonetic system it will seem very easy and obvious. Initially, there will be some spellings that seem tricky (did you know that "adventure" has a "CH" in it?). However, the rule is always to write the word the way you say it, not the way you spell it.

To help you learn the system fast, we have provided an English-to-phonetic spelling dictionary of almost 1500 words. Many common words are in the dictionary: some unusual ones are in it as well. If you are really stuck on how to spell a word that isn’t in the dictionary, think of another word that sounds like it and that one may be listed.

In any case, don’t hesitate to experiment with the phonetic spelling system. Let your ears be your guide. This system is easy to learn easy to use. easy to read, and you will be amazed at what you can do with it.

II. ADDING STRESS TO S.A.M.’S SPEECH

I’m the phonetic mode. S.A..M. is capable of speaking with a great deal of inflection and emphasis. This gives a much more natural and understandable quality to the speech than is otherwise possible.

The stress system for S.A.M. is particularly easy to use. There are eight stress markers that can be used simply by inserting a number(1-8) after the vowel to be stressed. For example, the monotonic pronunciation of the word “hello” produced by the phonetic spelling “/HEHLOW” becomes a much friendlier sounding greeting when spelled “/HEH3LOW”.

Why do you have to put in the stress markers? Simply because they can go anywhere and SAM. has no way of knowing where you want them to go. The following simple example will demonstrate this point to you. Use the SAYIT program on your SAM. disk to hear the following sample phrases.

We will have S.A.M. say

"Why should I walk to the store?"

in a number of different ways.

1. WAY2 SHUH7D AY WAO5K TUX DHAH STOH5R. (You want a reason to do it.)
2. WAY7 SHUH2D AY WAO7K TUX DHAH STOH5R. (You are reluctant to go.)
3. WAY5 SHUH7D AY2 WAO7K DHAH STOHR. (You want someone else to do it.)
4. WAY5 SHUHO AY7 WAO2K TUX7 DHAH STOHR. (You’d rather drive.)
5. WAY5 SHUHD AY WAO5K TUX DHAH STOH2OH7R. (You want to walk somewhere else.)

Each of these stress examples has a slightly different meaning. even though the words are all the same. Stress markers give you the ability to let S.A.M. be expressive.
What do the stress markers do? The number you type tells S.A.M. to raise (or lower) his pitch and elongate the associated vowel sound.

The number system works like this:

1 = very emotional stress
2 = very emphatic stress
3 = rather strong stress
4 = ordinary stress
5 = tight stress
6 = neutral (no pitch change) stress
7 = pitch-dropping stress
8 = extreme pitch-dropping stress

When should you use each of these? It all depends on how you want S.A.M. to sound. Say the words to yourself as expressively as you can and see where your voice rises and falls. Remember, the smaller the number, the more extreme the emphasis will be. Also, the stress markers will help get difficult words pronounced correctly. If some syllable is not enunciated sufficiently, put in a neutral stress marker.

A general rule is that the most important word or words in a sentence get the most stress and the rest of the words get little or no stress. However, words of more than one syllable should have stress marked on their accented syllables (most dictionaries show which these are it you are uncertain).

We will now assign stresses to our first example sentence about doing calculations on the computer. The first word “AY” is usually an important word (can you think of anyone more important?).. We will write it as “AY4", assigning ordinary stress. “DUW", the only verb, is also important. We’ll try "DUW4". “MAY” isn’t very strong (unless you want to draw attention to it) and it is a single syllable, so we will leave it alone. “KAELKYUWLEYSHUNZ” is polysyllabic so we must identify the accented syllables. It is also the most important word in the sentence so it will have the strongest stress. “LEY” has the primary stress and “KAEL” receives the secondary stress, so we will write "KAE4LKLYUWLEY3SHUNZ”. “AAN” and “DHAX” are short, unstressed words. “KUMPYUWTER” has a single accent on ‘PYUW” and gets written “KUMPYUW4TER”. So our original sentence gets written:

AY4 DUW4 MAY KAE4LKLYUWLEY3SHUNZ AAN DHAH KUMPYUW4TER.

Try typing it into the SAYIT program compared to the unstressed version.

How about really unusual stress? When you place extraordinary emphasis on a word, you do so by elongating its vowel sounds. SAM. can do the same thing. For example, a call for help can become "/HEH5EH4EH3EH2EH2EH3EH4EH5EHLP." You can always do this with the ordinary vowel sounds, but be careful with the diphthongs. They are complex sounds and if you repeat them, they will not do what you wa~t (e.g. “OYOYOYOYOYOY” sounds lust like it reads in English). To extend the diphthong sounds, you need to break them into component parts. So "OY” can be extended with “OHOHIYIYIY”, and “AY” can be extended with “AAAAIYIYIY”. You should experiment to find out just what you can do.
Unlike many other speech synthesis systems, S.A.M. allows you 10 Control consonant stresses directly. This is usually done to produce a special tonal pattern in a word. Sometimes you might want a pitch rise on the final phoneme occurring just before a comma. For example, try typing. “AY4 YUWZ SAE5M3, AE4ND RIYSAY4TER.” Notice how the pitch rises on the “M.” It is never necessary to specify stress for a consonant occurring immediately before a stressed vowel. This is handled automatically.

Try to become familiar with the stress marker system. It makes all the difference between an ordinary speech synthesizer and the very expressive SAM.

III. THE EFFECTS OF PUNCTUATION
S.A.M. understands tour punctuation marks. They are the hyphen, comma, period, and question mark.
The hyphen (-) serves to mark clause boundaries by inserting a short pause in the speech. It also has other uses to be discussed later. The comma marks phrase boundaries and inserts a pause approximately double that of the hyphen. The question-mark and period mark the end of sentences. The period inserts a pause and also causes the pitch to tall. The question-mark also inserts a pause, but it causes the pitch to rise. Notice that not all questions should end with a question-mark (rising pitch), only those that require a yes-or-no answer. (“Are we hiking today?” rises; “Why are we going to the woods?” tails at the end and should be marked with a period).

IV. FINAL NOTES ON PHONETIC IN PUT
S.A.M. is capable of speaking only 2.5 seconds of speech without a break (this is the size of his “breath”). If the string to be spoken exceeds this, S.A.M. will insert short breaks every 2.5 seconds. S.A.M. always breaks at punctuation marks in anticipation of the following phrase. So, if you don’t like where S.A.M. broke up a phrase, you can specify your own breaks with hyphens. An example of this is: “I use the telephone - to call out of town”.

S.A.M. uses the spaces between words to make his sentence-breaking decisions. If a single word requires more than 2.5 seconds to say, S.A.M. will not be able to insert his own breaks and will therefore be unable to say the word.

In summary, the procedures outlined above may seem complex, but this is because they were presented in fine detail. In reality, the steps become automatic and you will soon be able to type in phonetics almost as fast as you can type English text.
THE USE OF PITCH AND SPEED CONTROLS

SAM. is capable of speaking in a wide range of tones and at many different rates. Both pitch and speed controls are accessed by single POKES to memory locations.

The following chart shows the effects of different values in the pitch and speed registers.*

**PITCH**

POKE PITCH. N

<table>
<thead>
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<td>80-90</td>
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<tr>
<td>90-255</td>
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default = 64

**SPEED**

POKE SPEED. M

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<thead>
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<td>0-20</td>
<td>impractical</td>
</tr>
<tr>
<td>20-40</td>
<td>very fast</td>
</tr>
<tr>
<td>40-60</td>
<td>fast</td>
</tr>
<tr>
<td>60-70</td>
<td>fast conversational</td>
</tr>
<tr>
<td>70-75</td>
<td>normal conversational</td>
</tr>
<tr>
<td>75-90</td>
<td>narrative</td>
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<tr>
<td>90-100</td>
<td>slow</td>
</tr>
<tr>
<td>100-225</td>
<td>very slow</td>
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default = 72

*see the memory reference chart for these locations*
WHAT AM I HEARING?

In recent years, many new speech synthesizers have appeared in the marketplace. The techniques they use vary widely depending on the intended application. Most synthesizers found in consumer products, such as talking televisions or microwave ovens, use a speech compression technique of one sort or another. These techniques require a person to speak the needed words or entire sentences. The speech waveform is then compressed using a mathematical algorithm and, as a result, can then be stored in a memory chip without taking up a lot of room. The synthesizer’s job is to then take this compressed speech information and expand it back into the original waveform. Some of these systems work quite well, retaining the speaker’s intonation and sometimes even his or her identity. The processes used in such synthesizers differ greatly from those used in unlimited vocabulary synthesizers like S.A.M.

Let’s follow the evolution of an unlimited vocabulary speech synthesizer. First, we must define the task. Simply, we want to create a system that will synthesize any English utterance. One way to begin would be to record every possible utterance on tape and just play back the right one whenever we need it. This would take up more tape or computer memory than could ever exist, so this method is obviously not too practical.

The next method might be to record all the English words and play them back in a specific order to create sentences. This is certainly practical. It would take up a large amount of memory, but it would work. However, we have lost something in this process. The words now sound disjointed because we have "spliced" the sentence together. Also, the stress or inflection pattern of the sentence is either wrong or nonexistent. If we wanted an accurate stress pattern, we would need to record every word in a number of different styles, at different pitches, etc.

Such a system needs too much memory. So, let’s break things down even further and try to store as little as possible in memory. Instead of storing sentences or words or even syllables, we could store phonemes. Phonemes are the atoms of spoken language, the individual speech sounds. It turns out that English has a little over forty of them. Wow — this takes up practically no memory at all! We could specify the phonemes in the order we need to create words and sentences and really have ourselves a system. So, we go and record the phonemes and play them back to say the sentence, “I am a computer.” Why can we barely understand it? It seems we have broken things down a bit too far. When we chop the words down to this level and then try to reassemble them, everything that blends one sound into another is lost and the results are nothing less than horrible.
But all is not lost. Our efforts are not wasted because we have the acoustic-phonetician to come to our rescue. These people deal in the study of speech sounds and they can tell us just how to repair our phoneme-based system. First, instead of recording the actual speech waveform, we only store the frequency spectrums. By doing this, we save memory and pick up other advantages. Second, we learn that we need to store some data about timing. These are numbers pertaining to the duration of each phoneme under different circumstances, and also some data on transition times so we can know how to blend a phoneme into its neighbors. Third, we devise a system of rules to deal with all this data and, much to our amazement, our computer is babbling in no time.

The advantages in synthesizing speech in this way are tremendous. We use very little memory for all the data and the rules to use that data, and we also gain the ability to specify inflection, timing, and intonation. This is because we have not stored actual speech sounds, only their spectrums. (You can think of this as a printer needing only four colors of ink to reproduce all the colors in a picture.)

Now, in actuality, we do not store all the spectrums, but only those that are targets. Each phoneme has associated with it a target spectrum which can be specified with very little data. The target may be thought of as a frozen’ speech sound, the sound you would be making if your mouth was frozen exactly in the middle of pronouncing the phoneme. The timing rules tell the synthesizer how to move from target to target in a manner that imitates the timing of a human talker.

S.A.M. is this type of synthesizer implemented entirely in software. It has the tables of phoneme spectra and timing, together with the rules for using this data to blend the sounds together into any English utterance we may have in mind. We have traded some quality from the method using all the recorded words, but what we have gained is versatility, practicality, and the ability to do it all in realtime, with very little memory usage, on an inexpensive microcomputer.
<table>
<thead>
<tr>
<th>ENGLISH-TO-PHONETIC SPELLING DICTIONARY</th>
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</thead>
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burglar = BER4GULER
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byte = BAY4T

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call = KAO4L
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cant = KAE4NT
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captain = KAE4PTIXN
capture = KAE4PCHER
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careful = KEH4RFUHL
carry = KEH4RIY
cartridge = KAA4RTRIXJ
case = KEY4S
cashier KAE4SHIY4R
cassette KAXSEH4T
catalog KAE4TULAOG
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celestial = SULEH4SCHIYUL
Celsius = SEH4LSIYAXS
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chauvenism = SHOH4VIXNIRZUM

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cheese = CHIY4Z
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church = CHER4CH
cinema = SIH4NUMAH
circle = SER4KUL
circuit = SER4KIXT
circumstance = SER4KUMSTAENS
citizen = SIH4TIXSUN
city = SIH4TIY
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clear = KLIY4R
close = KLOW4Z
coaxial = KOHAE4KSIYUL
coffee = KAO4 FIY
cohorent = KOW/HEH4RIXNT
cold = KOW4LD
college = KAA4LIXJ
color = KAI4LER
comfortable = KAH4MFTERBUL
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company = KAHM4PUNIY
complain = KUMPLEY4N
complex = KUMPLEH4KS
component = KAHMPOH4NUNT
computer = KUMPYUW4TER
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conscience = KAA4NSHUNTS
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control = KUNTROH4L
conversation = KAA5NVERSEY4SHUN
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corporation = KOH5RPEREY4SHUN
correction = KOHREH4KSHUN
count = KAW4NT
country = KAH4NTRLY
cousin = KAH4ZIXN
create = KRIYEY4T
critical = KRIIH4TIXKUL
culture = KAH4LCHEER
curious = KYY4RIYAXS

danger = DEY4NJER
data = DEY4TAH
decay = DIXKEY4
gasoline = GAE4SULIYN
home = /HOW4M

get = GEH4T
honest = AA4NIXST

gate = GEY4T
humor = /HYUW4MER

genius = JIY4NYAXS
human = /HYUW4MUN

general = JEH4NERUL
husband = /HAH4ZBUND

horoscope = /HOH4RAXSKOWP
hyper = /HAY4PER

generate = JEH4NEREYT
hypothbsis = /HAYPM4THAXSIHS

gas = GAE4S
important = IHMPOH4RTUNT

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in = IH4N

gey = GEY4T
inch = IHN4CH

get = GEH4T
income = IH4NKUM

gift = GIH4FT
inconvenient = IHNKUNVIY4NYUNT

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indeed = IHNDIY4O

gnome = NOW4M
index = IH4NOEHKS

guant = GAE4RIXNTIY
indifferent = IXDIY4RIYER

gyroscope = JAY4RAXSKOWP
industry = IH4NDAHSTRIY

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include = IHNKLUX4DIXD

increase = IHNKRIY4S
inconvenience = IHN5KUNVIY4NYUNT

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injection = IHNJEH4KT
knowledge = IH4NFORM4SHUN

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inflation = IHNFLEY4SHUN

hexadecimal = /HEH5KSIXDEH4SUMUL
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information = IHN5FERMEY4SHUN

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invader = IHNV4Y4DER
invent = IHNV4EH4NT
involve = IHNVAA4LV
iron = AY4ERN
irrational = IHRAE4SHUNUL
isolate = AY4SULEYT
issue = IH4SHUW
item = AY4TUM

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jacket = JAE4KIY4XT
jam = JAE4M
jargon = JM4RGUIY4N
jazz = JAE4Z
jiffy = JIH4FIY
job = JAA4B
join = JOY4N
joke = JOW4K
judge = JAH4J
jump = JAH4MP
junction = JAH4NXKSHUN
junior = JUW4NYER
just = JAH4ST
jail = JEH4L
jewelry = JUW4LRU4Y
journey = JER4NIY
jungle = JAH4NXGUL
junk = JAH4NXK

-K-

keep = KIY4P
key = KIY4
keyboard = KIY4BOHRD
kilobyte = KIH4LAXBAYT
kind = KAY4ND
kingdom = KIH4NXGDUM
knight = NAY4T
knowledge = NAA4LIXJ

-L-

label = LEY4BUL
lady = LEY4DIY
language = LAE4NXGWIJ
large = LAA4RJ
laser = LEY4ZER
last = LAE4ST
late = LEY4T
laugh = LAY4F
launch = LAO4NGH
law = LAO4
layer = LEY4ER
lead = LIY4D
lease = LIY4S
lecture = LEH4KCHER
left = LEH4FT
legal = LIY4GUL
legend = LEH4JXIY4ND
leisure = LIY4ZHER
length = LEH4NTH
letter = LEH4TER
level = LEH4VUL
liberal = LIH4BERUL
life = LAY4F
lift = LIH4FT
light = LAY4T
like = LAY4K
limit = LIH4MIXT
linear = LIH4NIYER
liquid = LIH4KWIXD
list = LIH4ST
listen = LIH4SIXN
literature = LIH4TERIXCHER
little = LIH4UL
load = LOW4D
local = LOW4KUL
location = LOW4KEY4SHUN
lock = LAO4K
logarithm = LAO4GERJH5DHUM
logical = LAA4JHKUL
long = LAO4NX
look = LUH4K
loop = LUW4P
lose = LOW4Z
love = LAH4V
low = LOW4
loyal = LOY4UL
luminescence = LUW4MIXNEH5SIXNS
lunatic = LUW4NAXTIH6K
luxury = LAH4GZHERIY

-M-

machine = MAXSHIY4N
madam = MAE4DIY
made = MEY4D
magazine = MAEGAXZIY4N
magic = MAE4JIHK
magnet = MAE4GNIIXT
magnitude = MAE4GNIHTUX5D
mess = MAE5LFAH4NXKSHUN
man = MAE4N
mail = MEY4L
main = MEY4N
major = MEY4KER
make = MEY4K
malfunction = MAE5LFAH4NXKSHUN
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manager = MAE4NIXJER
maneuver = MUNUW4VER
manipulate = MUNIHI4PYI4HLEYT
manual = MAE4NYUWUL
manufacture = MAE5LSUXFA4KCH ER
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marriage = MEH4RIXJ
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micro = MAY4KROW6
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mind = MAY4ND
mineral = MIH4NERUL
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moon = MUW4N
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multiply = MA44LTIX6PLAY
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muscle = MAH4SUL
music = MYUW4ZIXK
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myself = MAYSEH4LF
mystery = MIH4STERIY

-N-
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narrate = NAE4REYT
narrow = NAE4ROW
natural = NAE4CHERUL
nature = NEY4CHER
navigate = NAE4VIXGEYT
near = NIY4R
need = NIY4D
negative = NEH5GAXTIH6V
negotiate = NIXGOW4SH1YEYT
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outside = AWTSAY4D
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paper = PEY4PER
parabol = PERAE4BULAH
paradox = PAE4RAXDA6KS
parallel = PAE4RULEH6L
caragraph = PAE4RAXGRAEF
dardon = PAA4RDUN
parent = PEH4RUNT
parity = PAE4RIXTIY
park = PAA4RK
part = PAA4RT
particle = PAA4RTIXKUL
particular = PAARTIH4KYUHLER
pass = PAE4S
patch = PAE4TCH
pathetic = PAHTHEH4TIXK
pattern = PAE4TERN
pause = PAO4Z
pay = PEY4
payroll PEY4ROW6L
peculiar = PIIXKYUW4LYER
penalty = PEH4NULTIY4
penetrate = PEH4NAXTREY6T
perception = PERSE4PSHUN
perfect = PER4FIXKT
period = PIH4RIYIXD
permanent = PER4MUNIXNT
permission = PERMIH4SHUN
person = PER4SUN
personality = PER4SUNAE5LIX1
perspective = PERSPE4KTIXV
pet = PEH4T
phantom = FAE4NTUM
phase = FEY4Z
phiemon = FUNAA4MIXNU
philosophy = FULAA4SAH Fly
phoneme = FOW4NIYM
photo = FOW4TOW
physical = FIH4ZIXKUL
physics = FIH4ZIXKS
piano = PYAE4NOW
pick = PIH4K
picture = PIH4KCHER
pilot = PAY4LIXT
pin = PIH4N
pirate = PAY4RIXT
pistol = PIH4STUL
pitch = PIH4TCH
pity = PIH4TIY
place = PLEY4S
plan = PLAE4N
planet = PLAE4NIXT
plastic = PLAE4STIXK
plausible = PLAO4ZAXBUL
play = PLEY4
please = PLIY4Z
pleasure = PLEH4ZHER
plectrum = PLEH4KTRUM
plenty = PLEH4NTIY
plot = PLM4T
plug = PLAH4G
plus = PLAH4S
poetry = POW4IXTRIY
point = POY4NT
poke = POW4K
police = PULIY4S
policy = PAA4LIXSIY
polynomial = PAA5LIXNOH4MIYUL
pop = PAA4P
popular = PM4PYULER
population = PAA4PYULEY4SHUN
port = POH4RT
portable = POH4RTAXBUL
positive = PM4ZIXTIX6V
position = PAXZIH4SHUN
power = PAW4ER
practice = PRAE4KTIHS
precise = PRIXSAY4S
prefer = PRIXFER4
preliminary = PREIXLIH4MIXNEHRIY
prepare = PRIXPEH4R
present = PREH4ZIXNT
press = PREH4S
pressure = PREH4SHER
prevent = PRIXVEH4NT
primary = PRAY4MEHRIY
primitive = PRIH4MIXTIX6V
prince = PRIH4NS
princess = PRIH4NSEHS
print = PRIH4NT
private = PRAY4VIXT
probably = PRM4BAXBLIY
problem = PRAA4BLUM
proceed = PROHSIY4D
process = PRAA4SEHS
produce = PRAXDUW4S
professional = PRAXFEH4SHUNUL
professor = PRAHFEH4SER
profit = PRAA4FIXT
program = PROW4GRAEM
project = PRM4JEHKT
promise = PRAA4MIHS
pronounce = PRUNAW4NS
proper = PRAA4PER
proportional = PRAXPOH4RSHUNUL
protect = PRAXTEH4KT
proud = PRAW4D
psychiatrist = SAYKAY4AXTRIX6ST
public = PAH4BLIXK
publish = PAH4BLIHS
pull = PUH4L
pulse = PAH4LS
pure = PYUW4R
push = PUH4SH
put = PUH4T

-Q-

quality = KWAA4LIXTIY
quantity = KWAA4NTIXTIY
question = KWEH4SCHUN
quick = KWIH4K
quiet = KWAY4IXT
quit = KWI~4T
quiz = KWIH4Z
quote = KWOW4SHUNT
quotient = KWOW4SHUNT

race = REY4S
radar = REY4DAAR
radiation = REY5DIYEY4SHUN
radio = REY4O1YOW
radius = REY4DIYAHS
rain = REY4N
random = RAE4NDUM
range = REY4NJ
rate = REY4T
rather = RA4DHER
ratio = REY4SHIYOW
reach = R1Y4CH
take = TEY4K
talent = TAE4LIX6NT
tall = TAO4L
talk = TAO4K
tap = TAE4P
tape = TEY4P
target = TAA4RGI4XT
task = TEY4SK
tax = TAE4KS
teach = TIY4CH
team = TIY4M
technical = TEH4KNI4XKUL
technology = TEHKNA4LAXJIIY
telephone = TEH4LAX6FOWN
television = TEH4TAX6VI4XZHUN
temper = TEH4M PER
tender = TEH4NDER
tense = TEH4NS
tension = TEH4NsHuN
term = TER4M
terminal = TER4MIXNUL
terrestrial = TER6EH4STRIY6UL
terrible = TEH4RAXBUL
territory = TEH4RAXTOH6RIY
terror = TEH4RER6
test = TEH4ST
testimony = TEH4STUMOHNIY
text = TEH4KST
than = DHA4E4N
than = DHA4E4N
thank = THAE4N4XK
that = DHA4E4T
the = DHA4H4
theater = THIY4AHTER
then = DHE4H4N
theorem = THIY4RUM
theory = THIY4RIY
thermometer = THERMM4MIXTER
thesis = THIY4SIXS
they = DHE4Y
thin = TRI4H4N
thing = THIH4NX
think = THIH4NXL
this = DHI4HS
thought = THAO4T
threshold = THREH4SH/HOWLD
through = THR4UW4
ticket = TIH4KIXT
tight = TAY4T
time = TAY4M
tiny = TAY4NIY
tired = TAY4ERD
title = TAY4TUL
together = TUXGEH4DHER
tolerance = TAA4LERIXNS
tone = TOW4N
tool = TUW4L
top = TAA4P
toss = TAO4S
touch = TAH4CH
tough = TAH4F
tournament = TERR4UMIXNT
toward = TOH4RD
toward = TOW4RD
town = TAW4N
toy = TOY4
trace = TREY4S
track = TRAE4K
trade = TERY4D
tradition = TRAXDIH4SHUN
tax = TAE4KS
tough = TAH4F
teach = TIY4CH
tournament = TER4NUMIXNT
toward = TOH4RD
toward = TOW4RD
town = TAW4N
toy = TOY4
turn = TER4N
tutor = TUW4TER
twist = TWHI4ST
type = TAY4P
typewriter = TAY4PRAYTER

video = VIH4OIYOW
village = VIH4LIAXJ
vinyl = VAY4NUL
violation = VAY4AXLEY5SHUN
virtue = VER4CHUW
visible = VIH4ZIXBUL
visit = VIH4ZIXT
vital = VAY4TUL
vocabulary = VOHKAE4BYULEHRIY
vocal = VOW4KUL
voice = VOY4S
volt = VOW4LT
volume = VAA4LYUWM
voluntary = VAA4LUNTEH5RIY
vote = VOW4T
vowel = VAW4UL
voyage = VOY4IXJ
video = VIH4DIYOW

ugly = AH4GLIY
ultimate = AH4LTA5X6MIXT
uncle = AH4NKUL
under = AH4NDER
understand = AH5NDERSTAE4ND
uniform = YUW4NIYFQHRM
union = YUW4NYUN
unit = YUW4NIXT
universal = YUW5NIYVER4SUL
unless = AHNLEH4S
up = AH4P
upset = AHPSEH4T
urge = EH4RJ
use = YUW4S
utility = YUWTIH4LIXTIY

water = WEY4FER
wage = WEY4J
wait = WEY4T
wake = WEY4K
walk = WAO4K
wall = WAO4L
war = WOH4R
warm = WOH4RM
warp = WOH4RP
warranty = WOH5RIXNTIY4
wash = WAA4SH
wash = WAA4SH
date = WAA4S
watch = WAA4CH
water = WAO4TER
watt = WAA4T
wave = WEY4V
way = WEY4
weak = WIY4K
wealth = WEH4LTH
wear = WEH4R
wedding = WEH4DIHNX
week = WIY4K
weight = WEY4
welcome = WEH4LKUM
well = WEH4L
were = WER4
what = WHAH4T
wheel = WHIY4L
when = WHEH4N
which = WHIH4CH
while = WHAY4L
whisper = WHIH4SPER
white = WHAY4T
who = /HUW4
whole = /HOW4L
wide = WAY4D
wild = WAY4LD
will = WIH4L
win = WIH4N
window = WIH4NDOW
wing = WIH4NX
winter = WIH4NTER
wise = WAY4Z
wish = WIH4SH
with = WIH4TH
wizard = WIH4ZERD
woman = WUH4MUN
women = WIH4MIXN
wonder = WAH4NDER
word = WER4D
Wordrace = WER2D REYS
work = WER4K
world = WUH4RLD
worry = WER4IY
would = WUH4D
wrap = RAE4P
write = RAY4T
wrong = RAO4NX

Zerox = ZIH4RAAKS
X-ray = EH4KSREY
xylophone = ZAY4LAXFOWN
— Y —
yacht = YAA4T
yard = YAA4RD
yawn = YAO4N
year = YIH4R
yellow = YEH4LOW
yes = YEH4S
you = YUW4
your = YOH4R
youth = YUX4TH
— Z —
zany = ZEY4NIY
zero = ZIY4ROW

zig-zag = ZIH3GZAEG
zip = ZIH4P
zodiac = ZOW4DIY6AEK
zone = ZOW4N

- DAYS OF THE WEEK -
Monday = MAH4NDEY
Tuesday = TUW4ZDEY
Wednesday = WEH4NZDEY
Thursday = THER4ZDEY
Friday = FRAY4DEY
Saturday = SAE4TERDEY
Sunday = SAH4NDEY

- MONTHS OF THE YEAR -
January = JAE4NYUXEHRIY
February = FEH4BRUXEH6RIY
March = MAA4RCH
April = EY4PRIXL
May = MEY4
June = JUW4N
July = JUHLAY4
August = AO4GAXST
September = SEHPTEH4MBER
October = AAKTOW4BER
November = NOHVEH4MBER
December = DIHSEH4MBER

-NUMBERS-
one = WAH4N
two = TUW4
three = THR4IY4
four = FOH4R
five = FAY4V
six = SIH4KS
seven = SEH4VIXN
eight = EY4T
nine = NAY4N
ten = TEH4N
eleven = IXLEH4VIXN
twelve = TWEH4LV
Lhirteen = THER4TIY6N
twenty = TWEH4NTIY
thirty = THER4TIY
hundred = /HAH4NDRIXD
thousand = THAW4ZUND
million = MIH4LYUN

-32-
- STATES AND PROVINCES -

United States = YUWNAY4TIXD STEY4TS
Alabama = AE4LAXBAE6MAX
Alaska = AHLAE4SKAH
Arizona = EH4.RAXZOW5NAH
Arkansas = AA4RKUNSAO
California = KAE5LaxFOH4RNYAH
Colorado = KA5LAXRAA4DOW
Connecticut = KAHNEH4TIXKAHT
DelaTware = DEH4LAXWEH6R
Florida = FLOH4R1IDXAH
Georgia = JOH4RJAH
Hawaii = /HAHWAY4IY
Illinois = IHLUNOY4
Indiana = I5NIYAE4NAH
Iowa = AY4AHWAH
Kansas = KAE4NIZIXS
Kentucky= KEHNTAH4KIY
Louisiana = LUXIY4ZIYAE5NAH
Maine = MEY4N
Maryland = MEH4RULIXND
Massachusetts = MAE5SAXCHUW4SIXTS
Michigan = MIH4SAXGUN
Minnesota = MIH5NAXSOVVATA~
Mississippi = MIH5SIXSIH~IF'
Missouri = MIHZUH4RIY
Montana = MAANTAE4NAH
Nebraska = NAXBRAE4SKAH
Nevada = NAXVAE4DAH
New Hampshire = NUW6/HAE4MPSHER
New Jersey = NUWJER4ZIY
New Mexico = NUWMEH4KSIXKOW
New York = NUWYOH4RK
North Carolina = NOH4RTH
KEH5RULAY4NAH
North Dakota= NOH4RTH DAHKOW4TAH
Ohio=OW/HAY4OW
Oklahoma = OWKLAX6/HOW4MAH
Oregon = OH4RIXGUN
Pennsylvania = PEH5NSULVEY4NYAH
Rhode Island = ROW5D AY4LUND
South Carolina = SAW4TH
KEH5RULAY4NAH
South Dakota= SAW4TH DAKKOW4TAH
Tennessee= TEH5NAXSIY4
Texas = TEH4K5AXS
Utah = YUW4TAO6
Vermont = VERMAA4NT
Virginia = VERJIH4NYAH
Washington = WAA4SHIHNIXTAHN

West Virginia = WEH5ST VERJIH4NYAH
Wisconsin = WIH5KAA4NSUN
Wyoming = WAYOW4MIHNX

Provinces of Canada =
Alberta = AELBER4TAH
British Columbia =
BR5H4TIXSH KAHLAH4MBIYAH
Manitoba = MAE5NIXTOW4RAH
New Brunswick = NUWBRAH4NZWIXK
Newfoundland = NUW4FIXNLIXND
Nova Scotia = NOH4VAXSKOW4S!AH
Ontario = AANTEH4RIYOW
Prince Edward Island =
PRIH5NS EH4DWERD AY4LUND
Quebec = KUHBEH4K
Saskatchewan = SAESKAE4CHAXWAAN

- UNITS —

units = YUW4NIXTS
inches = IH4NCHIXZ
feet = FIY41
yards = YM4RDZ
miles = MAY4LZ
centimeters = SEH4NTIXMIY6TERZ
kilometers = KIXLAA4MIXTERZ
acres = EY4KERZ
ounces = AW4NSIXZ
pounds = PAW4NDZ
tons = TAH4NZ
grams = GRAE4MZ
teaspoons = TIY4SPUWNZ
cups = KAH4PS
pints = PAY4NTS
gallons = GAE4LUNZ
liters = LIY4TERZ
degrees = DAXGRIY4Z
FINDING PHONEME SPELLING ERRORS

If you have made a phonetic spelling mistake that causes S.A.M. to be unable to break your string down into phonemes, he will beep twice at you and come back to Applesoft without speaking. The location of the bad letter in the string is stored for you to examine. You may PEEK at this location in a program to see where the first error in spelling was and then make the required change.

Here is a sample error-checking and display program:

100 SA$="MAY VOY4C IHZ BIHZAA5R.”
110 CALL 38128
120 IF PEEK(38143)<255 THEN GOSUB 1000:REM ERROR CHECK

1000 REM ERROR DISPLAY—ERROR APPEARS IN INVERSE
1010 N = PEEK(38143): REM ERROR BYTE
1020 IF N = 1 GOTO 1040
1030 PRINT LEFT$(SA$, N-i)
1040 INVERSE: PRINT MID$(SA$, N, 1); INVERSE: PRINT MID$(SA$, N, 1);
1050 NORMAL: IF LEN (SA$)= N THEN PRINT: RETURN
1060 PRINT RIGHT$(SA$, LEN (SA$)-N)
1070 RETURN

The inverse character marks the spot where SAM. could no longer continue reading the string.

TECHNICAL NOTES

USES OF S.A.M.’S D/A CONVERTER BOARD

The board included with S.A.M. is a general purpose, 8-bit digital-to-analog converter connected to an audio amplifier. To output a value to the converter, a STA, STX, or STY $CONO instruction is executed in a machine language program. N = B + the slot number of the board. (The use of the board from BASIC is not practical because BASIC runs far too slowly.) By rapidly outputting different values to the converter, an audio waveform may be defined. Using SAM’s board, machine language programmers have the opportunity to create and output any sound imaginable.
SLOT PORTABILITY

When S.A.M. is loaded, the slot number he outputs to is always #4. If your slot #4 is in use by some other card, you may change the slot number by doing a POKE 38140,N in your program, where N is the slot number.

<table>
<thead>
<tr>
<th>IMPORTANT ADDRESSES</th>
<th>Decimal</th>
<th>Hex</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.A.M. from Applesoft</td>
<td>38128</td>
<td>$94F0</td>
</tr>
<tr>
<td>RECITER from Applesoft</td>
<td>38131</td>
<td>$94F3</td>
</tr>
<tr>
<td>S.A.M. from machine language</td>
<td>38134</td>
<td>$94F6</td>
</tr>
<tr>
<td>RECITER from machine language</td>
<td>38137</td>
<td>$94F9</td>
</tr>
<tr>
<td>SLOT</td>
<td>38140</td>
<td>$94FC</td>
</tr>
<tr>
<td>PITCH</td>
<td>38141</td>
<td>$94FD</td>
</tr>
<tr>
<td>SPEED</td>
<td>38142</td>
<td>$94FE</td>
</tr>
<tr>
<td>ERROR</td>
<td>38143</td>
<td>$94FF</td>
</tr>
<tr>
<td>ASCII STRING</td>
<td>38144</td>
<td>$9500-FF</td>
</tr>
<tr>
<td>HIMEM S.A.M.</td>
<td>29024</td>
<td>$7160</td>
</tr>
<tr>
<td>HIMEM RECITER</td>
<td>22688</td>
<td>$58A0</td>
</tr>
</tbody>
</table>

MEMORY MAP

<table>
<thead>
<tr>
<th>Hex</th>
<th>Decimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>$9600</td>
<td>38400</td>
</tr>
<tr>
<td>$7160</td>
<td>29024</td>
</tr>
<tr>
<td>$6000</td>
<td>24576</td>
</tr>
<tr>
<td>$58A0</td>
<td>22688</td>
</tr>
<tr>
<td>$4000</td>
<td>16384</td>
</tr>
</tbody>
</table>

Notice: Reciter partially overlaps HI-RES page 2
LISTING OF GUESSNUM

1 REM -- GUESSNUM --
10 HIMEM: 16600
20 A = 38128: REM SAM’S ADOR
30 HOME :N = INT (99 * RND (1)) + 1
40 SA$ = “GEH3S DHAX NAH4M8ER BIXTWIY5N WAH4N Q AEND WAHN6 /HAH4NDRIHD
:CALL A
50 HTAB I9: INPUT G
60 IF G > 99 THEN SA$ = "DHAESTS MOHER DHAEN WAI-t~ /HAH4NORIHD." : CALL A
GOTO 56
70 IF 0 C 1 THEN SA$ = "DHAE5TS MOHER DHAEN WAH6N." : CALL A: GOTO 50
80 C$ = ""
90 IF G < 10 THEN 8$ = " ": GOTO 310
100 ON G - 9 GOTO 120,130,140,150,160,170,180,190,260, 210
110 GOTO 220
120 B$ = "TEH4N": GOTO 430
130 B$ = "IHLEH4VIXN: GOTO 430
140 B$ = "TWEH4LV": GOTO 430
150 B$ = "THER4TIY6N": GOTO 430
160 B$ = "FOH4RTIY6N": GOTO 430
170 B$ = "FIH4RTIY6N": GOTO 430
190 B$ = "SIH4KSTIY6N": GOTO 430
190 B$ = "SEH4VUNTIY6N": GOTO 430
280 B$ = "EY4TIY6N": GOTO 430
210 B$ = "NAY4NT1Y6N": GOTO 430
220 ON INT (G / 10) — 1 GOTO 230,240,250,260,270,280,290,300
230 B$ = "THEH4NTIY": GOTO 310
240 B$ = "THER4NTIY": GOTO 310
250 B$ = "FOH4RT1Y": GOTO 310
260 B$ = "FIH4RT1Y": GOTO 310
270 B$ = "SIH4KST1Y": GOTO 310
280 B$ = "SEH4VUNTIY": GOTO 310
290 B$ = "EY4TIY": GOTO 320
300 B$ = "NAY4NTIY"
310 R = G — 10 * INT (G / 10)
320 IF R = 0 GOTO 430
330 ON R GOTO 340,350,360,370,380,390,480,410, 420
340 C$ = "WAH5N": GOTO 430
350 C$ = "TUW5": GOTO 430
360 C$ = "THRIY5": GOTO 430
370 C$ = "FOH5R": GOTO 430
380 C$ = "FAY5V": GOTO 430
390 C$ = "S1H5KS": GOTO 430
400 C$ = "SEH5VUN": GOTO 430
410 C$ = "EYST": GOTO 430
420 C$ = "NAYSN"
430 IF G > (N + 25) THEN R$ = " IHZ MAH3CH TUW5 /HAY6. ": GOTO 500
440 IF G > (N + 5) THEN R$ = " IHZ TUW3 /HAY6. ": GOTO 500
450 IF G > N THEN R$ = " IHZ AH LIH3TUL TUW4 /HAY6. ": GOTO 500
460 IF G > (N — 25) THEN R$ = " IHZ MAH3CH TUW4 LAXOW.": GOTO 500
470 IF G > (N — 5) THEN R$ = 1HZ TUW3 LAXOW.": GOTO 500
480 IF G > N THEN R$ = " IHZ AH LIH3TUL TUW4 LAXOW..": GOTO 500
490 IF G = N THEN R$ = "”? YUW3 AAR RAY2IHT."
500 SA$ = B$ + C$ + R$: CALL A
510 IF G <> N GOTO 50
520 FOR I = 1 TO 1000: NEXT : GOTO 30
### Seldom-Used Phoneme Combinations

<table>
<thead>
<tr>
<th>Phoneme Combination</th>
<th>You probably want:</th>
<th>Unless it splits syllables like:</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS</td>
<td>GZ e.g. bags</td>
<td>bugspray</td>
</tr>
<tr>
<td>BS</td>
<td>BZ e.g. slobs</td>
<td>obscene</td>
</tr>
<tr>
<td>DS</td>
<td>DZ e.g. suds</td>
<td>Hudson</td>
</tr>
<tr>
<td>PZ</td>
<td>PS e.g. slaps</td>
<td></td>
</tr>
<tr>
<td>TZ</td>
<td>TS e.g. curtsy</td>
<td></td>
</tr>
<tr>
<td>KZ</td>
<td>KS e.g. fix</td>
<td></td>
</tr>
<tr>
<td>NG</td>
<td>NXG e.g. singing</td>
<td>ingrate</td>
</tr>
<tr>
<td>NK</td>
<td>NXK e.g. bank.</td>
<td>Sunkist</td>
</tr>
</tbody>
</table>