

Digital Steganography: Hiding Extra Information Inside of Pictures and Sounds

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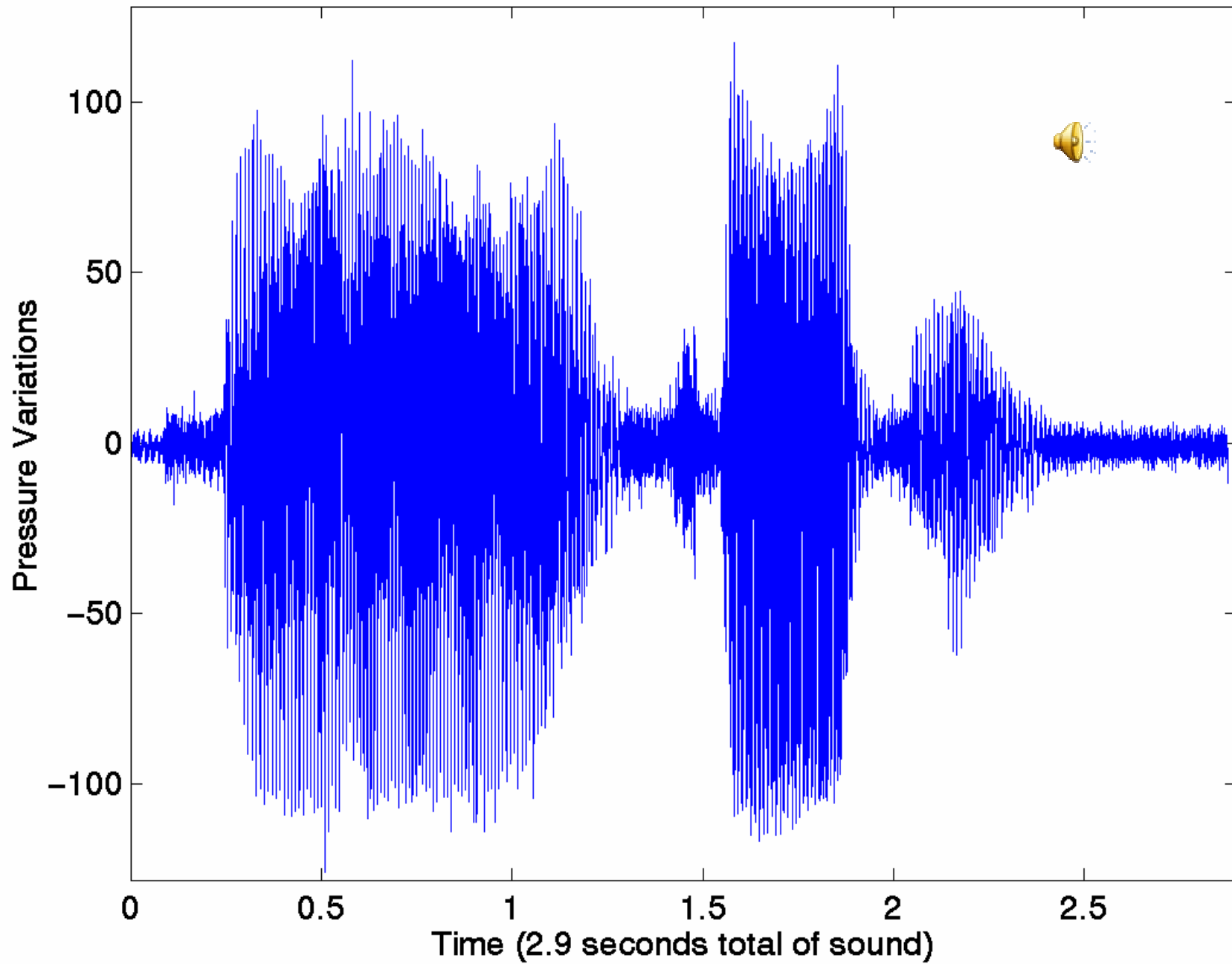
Washington University in St. Louis

March 18, 2004

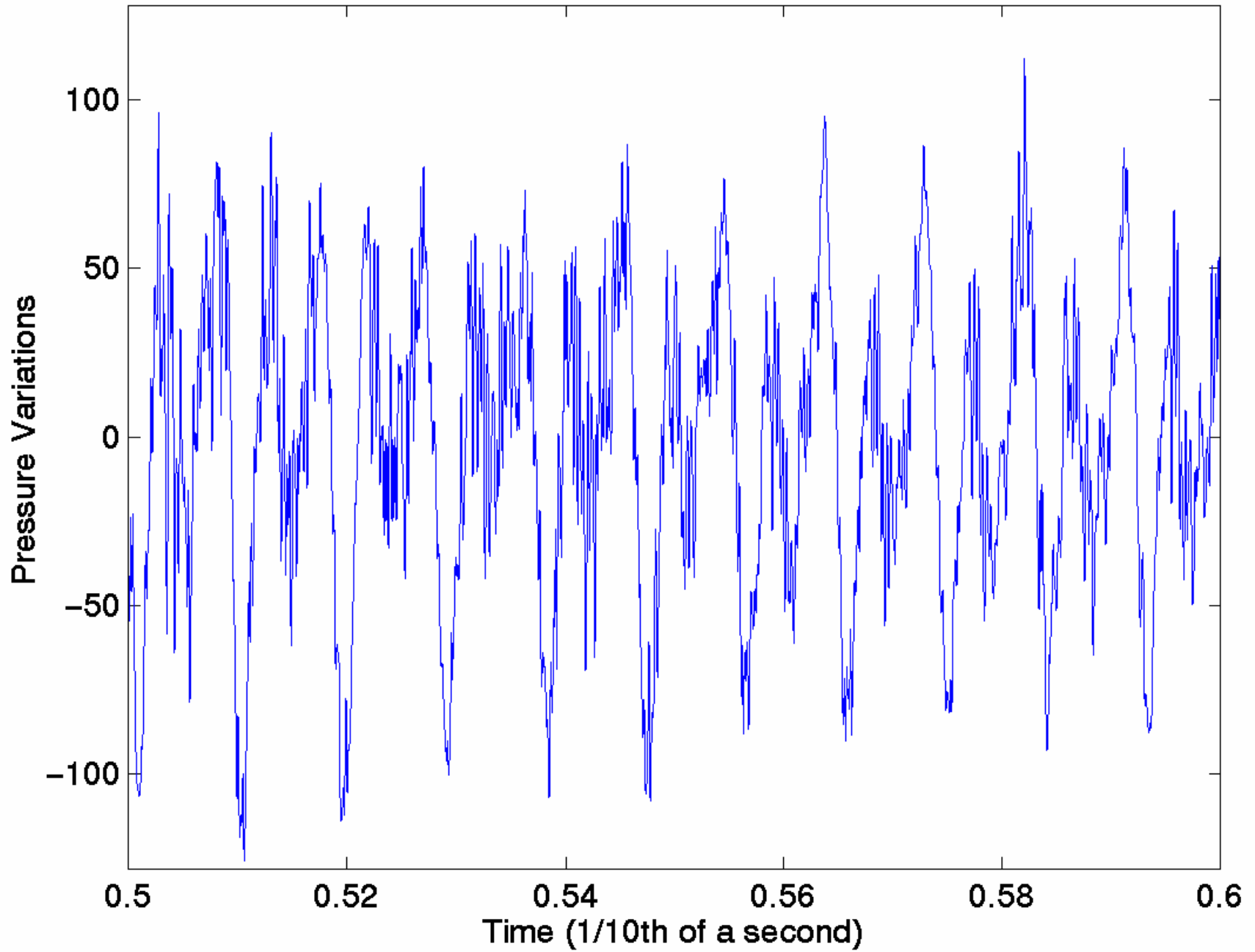
What does Digital Mean?

- Representing signals (sounds and pictures, for example) with A LOT of numbers
 - A CD stores about 74 minutes of music with about 392 million numbers
 - A typical digital picture requires around a million numbers to represent

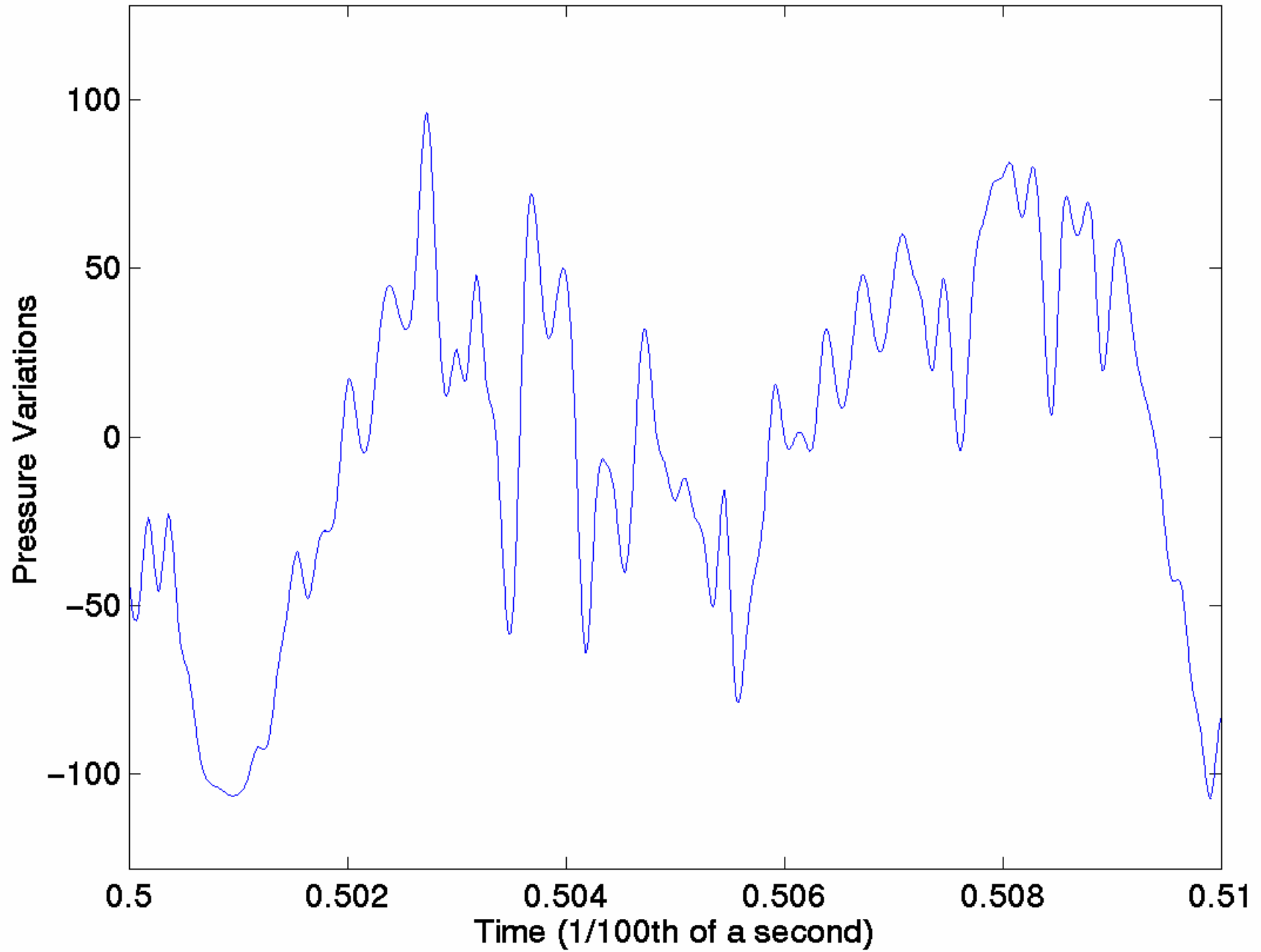
Sound Signal



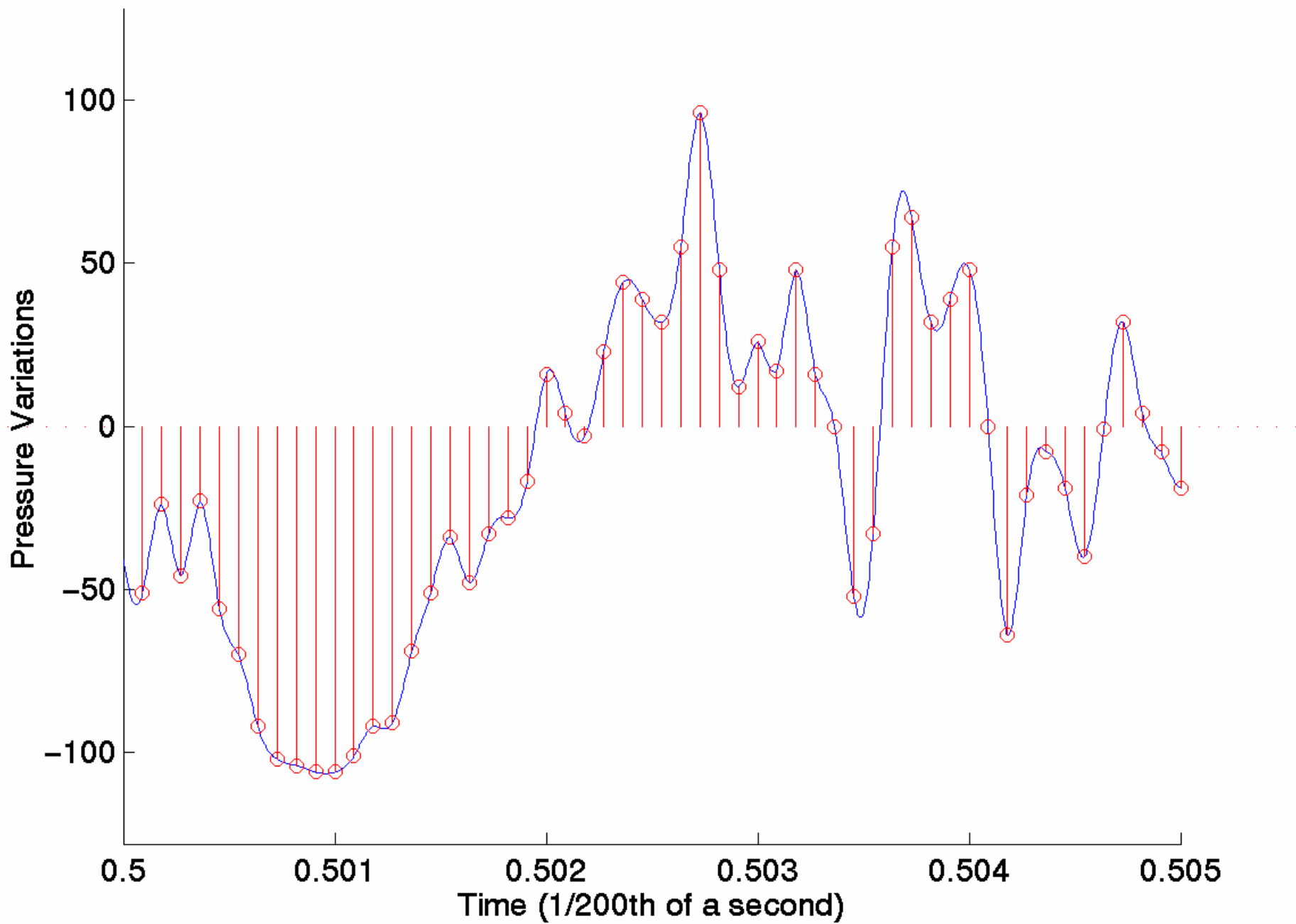
Sound Signal



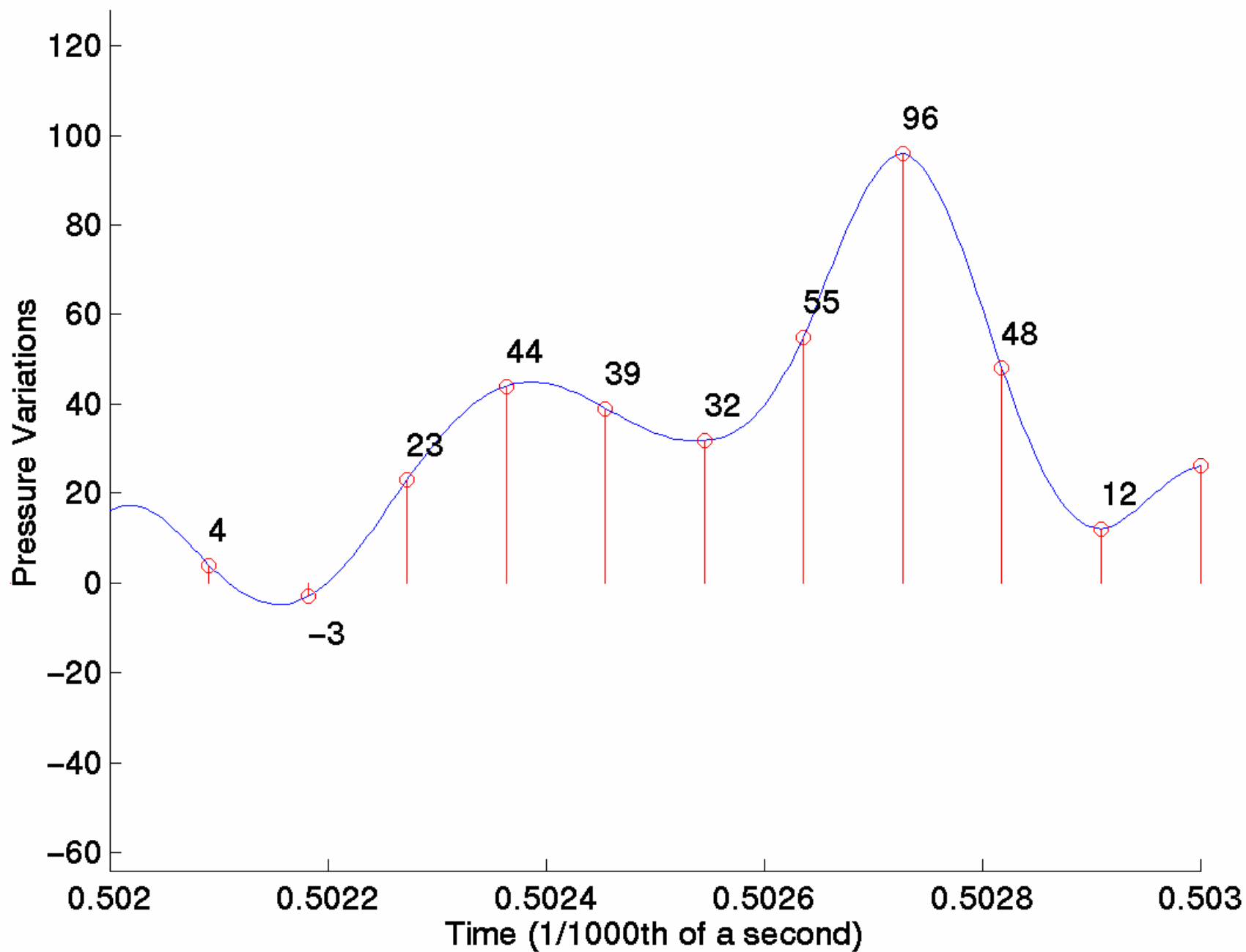
Sound Signal



Sound Signal and Samples



Sound Signal



0 -3 -1 0 0 2 -4 -4 -2 0 1 -2 0 -3 1 -1 0 -3 -1 1 -1 2 0 -3 3 2 4 4 7 -1 -5 -4 3 -2 -2 1
-2 -1 0 1 -1 0 -3 -4 -3 -2 2 -2 -2 -2 3 -1 -1 -1 0 0 -3 -3 0 -1 0 -3 -3 -2 4 1 0 -4 2 -1 -6 -5 0 -2 -2 0
-3 -1 -1 0 0 0 -4 -3 -2 -1 2 -4 -2 -1 2 0 -1 -2 -1 -1 -2 -4 0 1 3 -2 -2 0 5 -1 -4 -3 0 -1 -5 -7 3 -1 -3 -3
-2 -1 -1 0 -2 1 -4 -3 -2 -1 0 -3 -4 -1 2 -2 -3 -1 0 0 -2 -4 -1 0 1 -5 -3 -3 4 5 -5 -7 -1 2 -7 -6 6 1 -6 -1
-3 -1 0 -2 -3 0 -2 -4 -3 1 1 -4 -1 -1 2 -2 -2 -2 -1 -1 -4 -5 0 -1 0 -2 -1 -6 -4 4 1 -3 4 5 -12 -3 4 -4 -6 6
-2 -2 2 -1 -2 0 -4 -2 -4 0 2 -4 -2 -2 0 -1 -2 -1 1 0 -4 -3 -1 -1 -4 -1 3 -6 -6 0 -3 2 2 5 -7 -4 3 -6 -3 2
-2 -1 0 0 -2 0 -5 -4 -2 1 0 -6 -5 -2 1 -1 -5 0 -2 -1 -3 -6 -1 1 -5 1 3 -1 -7 -4 -4 -2 3 2 -8 -4 1 -7 -2 2
-3 -1 -1 -4 -4 1 -3 -4 -2 0 0 -3 -2 -2 2 -1 -3 -2 -1 2 -3 -2 -1 0 -1 2 2 2 -4 -4 -7 -1 5 2 -11 -4 -2 -5 -1 1
-3 -2 -1 -1 -1 2 -4 -6 -1 1 2 -4 -3 -2 3 -4 -3 -2 -1 0 -5 -2 0 0 0 -1 3 3 1 -1 -5 -6 5 1 -6 -3 -3 -1 -2 -1
-4 -3 -1 -2 -1 3 -3 -4 -1 0 3 -3 -4 -1 2 -1 -2 -3 -1 -2 -3 -6 -1 -1 1 3 10 4 2 0 -3 -14 5 0 -3 -8 -3 3 2 -2
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-1 -3 -1 0 0 1 0 -5 -1 0 -1 -1 -2 1 1 -4 -4 0 -2 0 -3 -2 -2 0 0 -4 6 4 -9 -1 -2 -8 2 -4 -2 -3 6 10 -7 1
-2 -2 0 -1 0 2 -1 -3 -2 2 0 -2 -2 -1 -2 -4 -4 -2 -1 0 -4 -2 -2 0 -5 -7 2 6 -10 4 -2 -6 1 -4 -4 -4 6 9 -8 3
-2 0 -1 0 -3 3 -1 -3 -2 0 -1 -1 -3 0 0 -3 -2 -2 2 -1 -2 -1 -1 3 -1 -6 0 2 -7 0 -1 -6 1 -1 -1 -7 6 6 -9 1
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-3 -1 0 1 -1 0 -1 -4 -1 1 -3 -1 -1 3 0 -2 -2 -3 0 -1 -4 -1 -2 -2 -5 -3 -5 6 -8 5 -6 -2 3 -2 5 -4 2 4 -1 -4
-4 -1 1 -1 -1 -2 0 -4 1 1 -4 -3 -3 0 -1 -4 -4 -3 0 -1 -2 -2 -3 -1 2 -4 -3 4 -9 6 -7 -2 0 1 5 -2 0 5 0 -4
-2 -1 1 -1 1 1 -3 -2 0 1 -4 -4 -1 2 1 -3 -2 -2 -1 -1 -4 -1 -2 -2 0 -6 -1 0 -1 4 -6 -2 -3 2 5 -1 0 8 -2 -3
-2 -3 3 -1 2 0 -1 -3 -2 0 -3 -2 -2 2 1 -3 -4 -3 -1 1 -4 0 -2 -2 4 -8 -4 -4 2 4 -6 -5 -1 5 1 -3 2 0 -3 -5
-3 -1 1 -1 0 -1 0 -3 -2 0 -3 -1 -2 0 2 -4 -2 -1 0 1 -2 2 -2 -1 2 -12 -6 -5 0 0 -1 -3 -3 4 1 -1 1 -7 -3 -4
-1 -1 1 -1 0 0 -1 -2 -1 2 -4 -3 -2 0 2 -1 -3 -1 -1 -2 -2 1 -1 1 -3 -11 -7 -7 4 -1 0 4 -2 0 3 -2 4 -6 -1 -2
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-1 -1 -1 -2 -1 -3 0 0 0 1 -3 -3 -2 -1 2 -4 -3 0 -2 -1 -3 -1 -2 3 0 7 -3 2 -6 -8 0 4 0 -2 5 4 -6 1 -2 -6
-3 -1 2 -1 -1 -1 0 0 0 1 -4 -3 -1 -1 1 -2 -3 -4 0 -2 -3 2 -1 0 -2 6 -1 1 -9 -8 2 3 -3 -1 3 -4 -4 2 -1 -7
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-2 -2 -1 -1 1 -2 -1 -2 -1 1 -3 -2 -3 4 0 -4 -4 -2 0 -1 -5 -3 1 1 2 -1 -4 3 4 -3 2 -2 -1 -4 -4 -5 -7 -3 4 -10
-3 -3 1 -1 3 -5 -1 -1 1 0 -4 -2 -4 2 -1 -2 -3 -1 1 -1 -4 -3 0 0 -7 0 -6 3 3 7 5 -1 -2 -2 -6 3 -6 -2 0 -7
-2 -2 1 -1 3 -1 -2 -2 0 -1 -2 -1 -1 2 -1 -1 -3 0 2 -1 -4 -1 -1 -2 -1 -2 -5 3 3 6 5 2 -1 0 -5 2 -4 -2 2 -9

Digitized Sound

- 3 seconds of Homer is about 30,000 numbers
- What can we do with these numbers?
 - Store them (CD, hard disk drive)
 - Transmit them over the internet
 - CHANGE SOME OF THEM!

Code Table for Letters

a	1
b	2
c	3
d	4
e	5
f	6
g	7
h	8
i	9
j	10
k	11
l	12
m	13

n	14
o	15
p	16
q	17
r	18
s	19
t	20
u	21
v	22
w	23
x	24
y	25
z	26
space	27

Secret Message

- meet me behind the restaurant at midnight

- 13 5 5 20 27 13 5 27 2 5

8 9 14 4 27 20 8 5 27 18

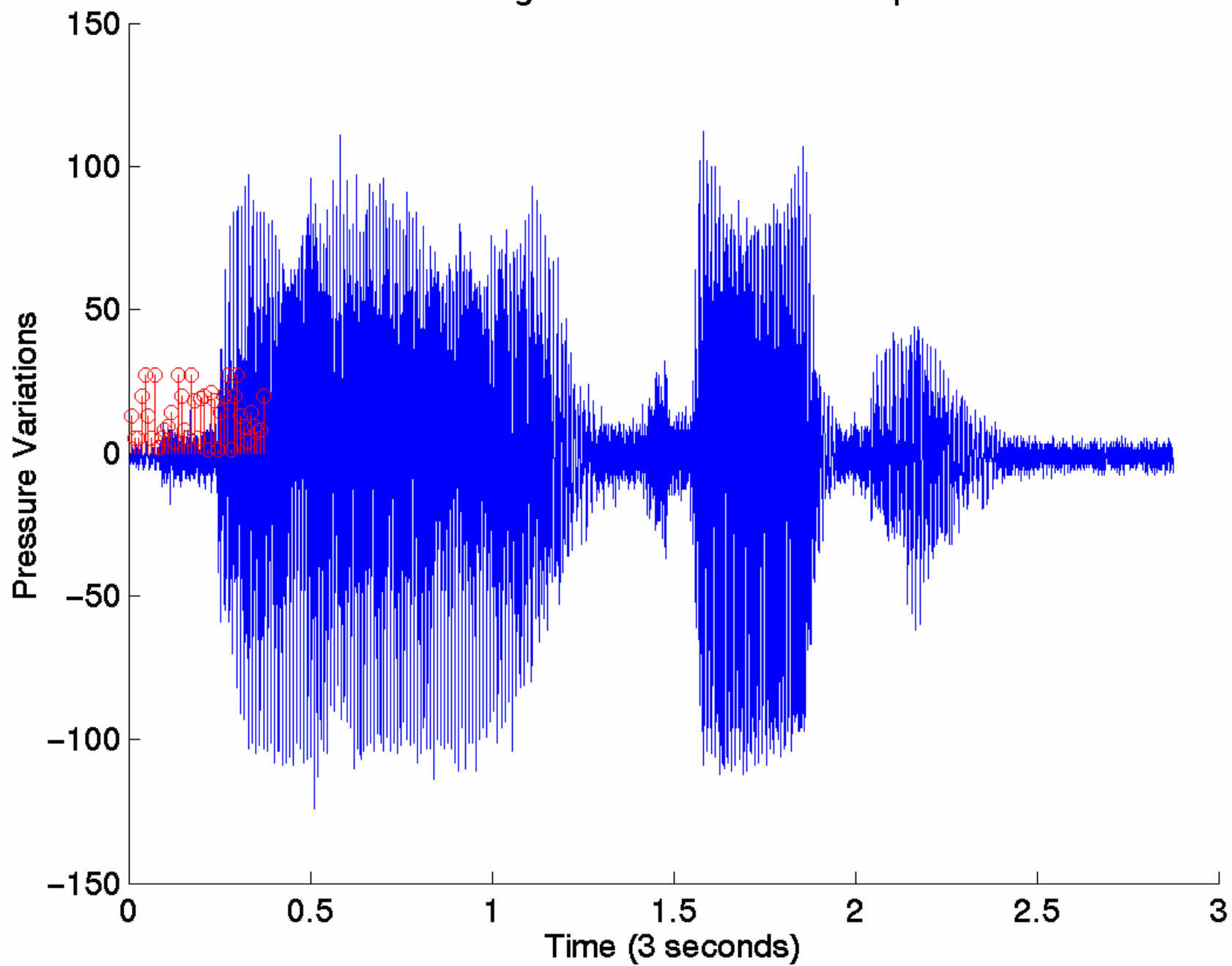
5 19 20 1 21 18 1 14 20 27

1 20 27 13 9 4 14 9 7 8 20

Hide the Message in the Sound

- Change every 100th number in the digital representation of the sound into the message numbers
- We only have to change 41 numbers out of 30,000
 - Will Homer sound different?
 - Can you tell that there is a hidden message by listening to the sound?

Sound Signal with MODIFIED Samples



Sound Signal and MODIFIED Samples

