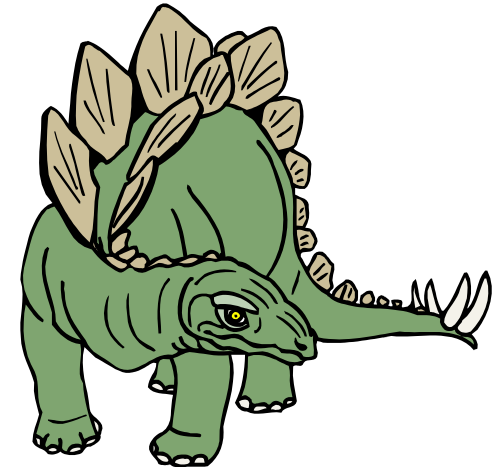# Steganography

The "art" of hiding data

# What is Steganography?

- The word "steganography" comes from Greek words: *steganos* "covered" and *graphie* "writing"
- *Steganography* is a science (and art) of hiding one message within another

Sacramento State - Cook

# What is Steganography

- The secret message is referred to as the *payload* (or carrier medium)

- The normal message, that contains the secret message, is the *carrier*

- Both parties know how the message was hidden and can secretly transfer messages

# World War II Example

> **Apparently  neutral's protest is thoroughly discounted and ignored. Isman hard hit. Blockade issue affects pretext for embargo on by-products, ejecting suets and vegetable oils.**

- During World War II, a German Spy sent a secret message using a *null cipher*
- The message was hidden in every second letter of the sentence

# World War II Example

**A**pparently **n**eutral's **p**rotest **i**s **t**horoughly **d**iscounted a**n**d **i**gnored. I**s**man h**a**rd h**i**t. **B**lockade i**s**sue a**f**fects **p**retext f**o**r **e**mbargo o**n** b**y**-products, e**j**ecting s**u**ets a**n**d **v**egetable o**i**ls.
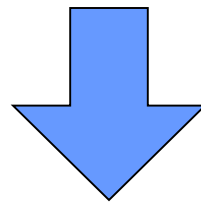


**Pershing sails from NY June 1**

# Steganography Today

- Nowadays, practically everything is stored in digital format
- People seldom realize how much data there is!
- Digital data is used everywhere
  - e-mail
  - online pictures – websites, eBay, etc…
  - music
  - video
  - communication between computers – MMORPGs

# Good Uses of Steganography

- Watermarks to detect forgeries
  - holding a $20 bill up to the light and seeing a watermark
  - ultraviolet marking on credit cards
- Fighting against government intrusion
  - some states are oppressive (e.g. Iran)
  - resistance groups can use it to talk
- Hiding confidential / valuable data

# Evil Uses of Steganography

- Concealing a plan for terroristic threats
  - al-Qaeda may have used steganography communicate before the 9-11 attacks
  - this is a huge threat to the government
- Hiding contraband
  - can allow perpetrators (such as child pornographers) to exchange information
  - stolen data – spying, etc…

# Images & Steganography

Pictures *look* good for secrets!

# Images are a Popular Choice

- Each pixel uses 3 (or more) bytes to represent the red-green-blue color

- This means:
  - each pixel can have 16,777,216 values
  - changing a red-green-blue value slightly cannot be picked up the human eye
  - … but computers can tell the difference

# Completely Under the RADAR

# LSB Example

Data

| 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
Red

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
Green
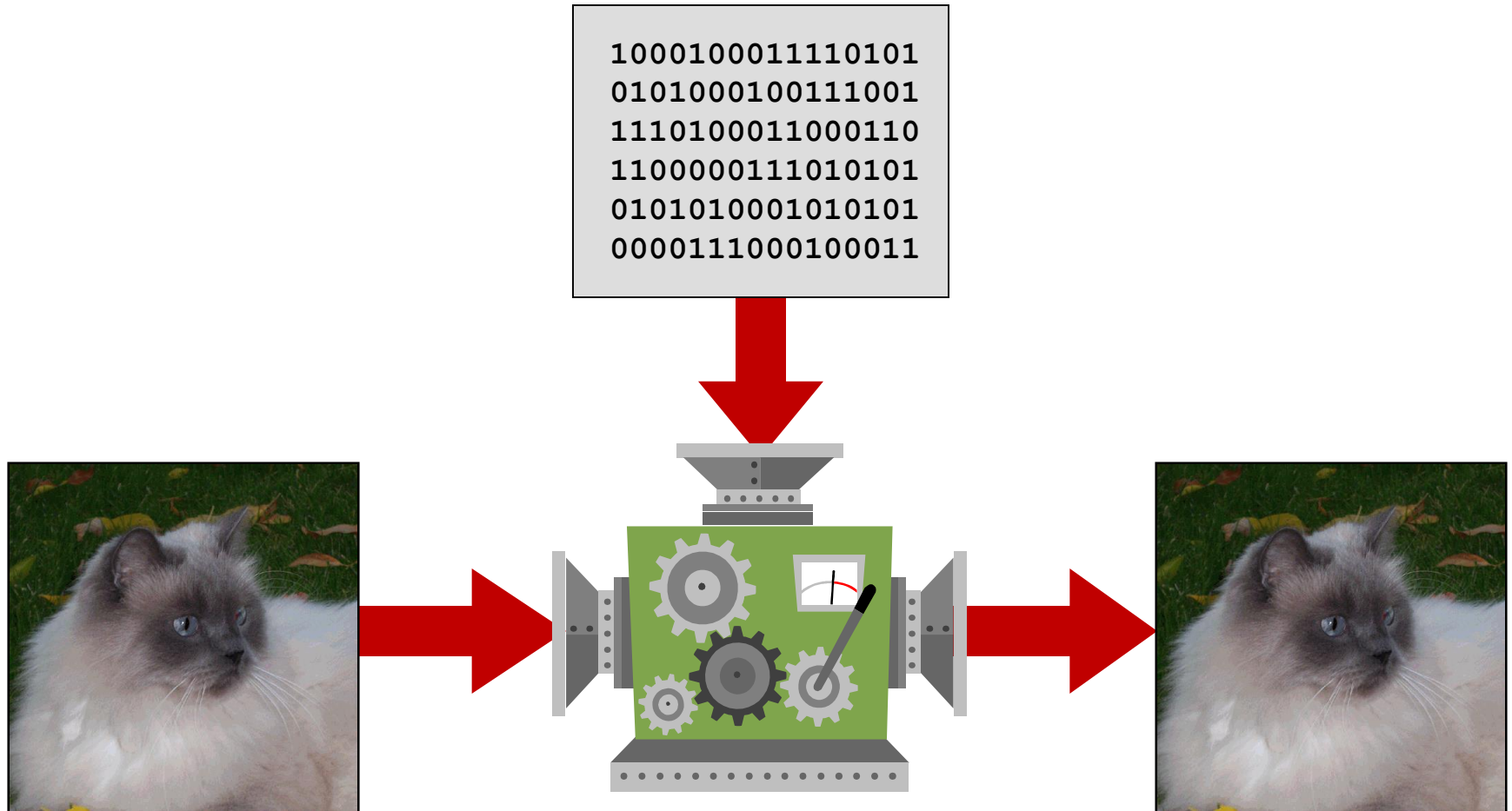
| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
Blue
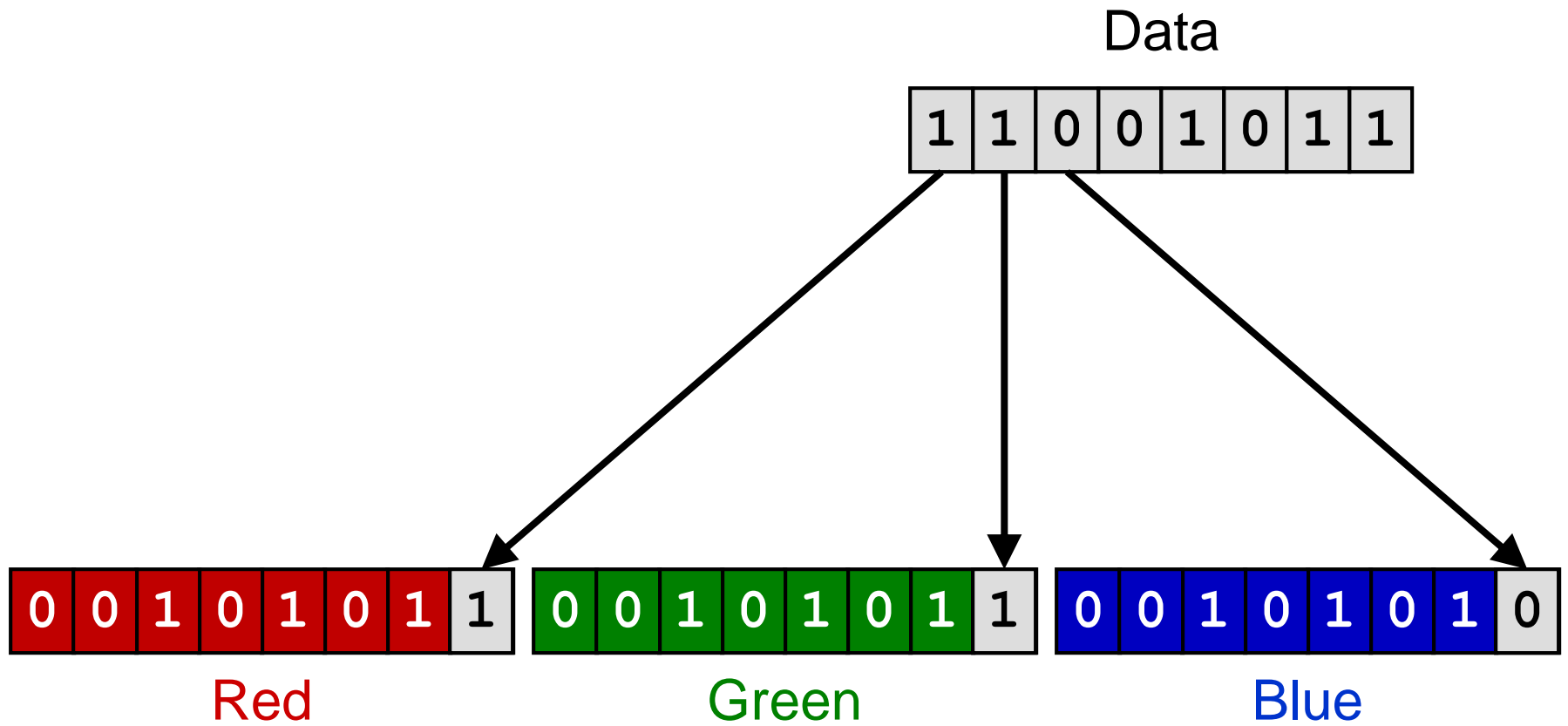
# Byte Can Be Stored in 3 Pixels

Data

| 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|



| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|

| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|
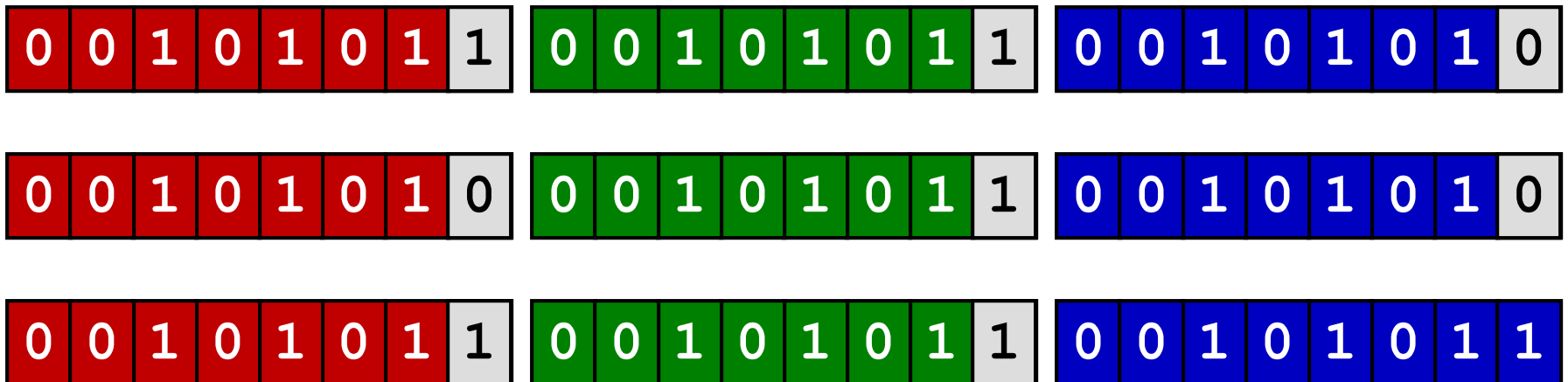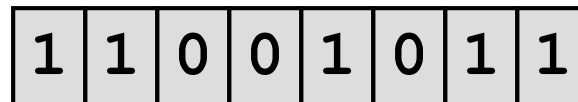
# Least-Significant-Bit Encoding

- Advantages
  - simple
  - high capacity – 3 *or more* bits per pixel
  - low perceptibility – data hides in color "noise"
- Disadvantages
  - not very robust – lossy compression will easily destroy the data
  - … as a result, this technique is used on lossless images such as BMP and PNG

# Demonstration….

Let's Look at Some Secret Messages

# Other Simple Techniques

Very basic, and very hard to detect

# Text Position

- Secret messages can also be hidden in what appears to be innocuous data
- For instance: data can be hidden in text formatting in subtle ways
  - line spacing
  - word or character spacing
  - minor changes to shapes of characters
- For humans, we might not be able to see the difference… but computers can!

# Are These the Same?

Sacramento

Sacramento

Sacramento State - Cook

# Nope….

Sacramento

Sacramento

Sacramento State - Cook

# Whitespace: Word Spacing

- The number of spaces between words can contain the message

- e.g. single space $\rightarrow$ 0, two spaces $\rightarrow$ 1

- Text will be <span style="color:red">visually</span> altered!

- The file size will also increase

# Whitespace: End Line

- Spaces can be added to the end of each line (after the text)

- e.g. no space → 0, single → 1

- Visual appearance of the text...
  - will not be altered
  - but the capacity is far smaller

# End Line Example

- The following example shows data stored at the end of each line

- A space is added for a **1**, or left blank for a **0**

- The gray boxes are columns that contain no characters

```
In a society under
the forms of which
the stronger faction
can readily unite
and oppress the
weaker, anarchy may
as truly be said to
reign...
```

James Madison
Federalist Paper 51

# End Line Example - Original

| I | n |   | a |   | s | o | c | i | e | t | y |   | u | n | d | e | r |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| t | h | e |   | f | o | r | m | s |   | o | f |   | w | h | i | c | h |   |   |   |
| t | h | e |   | s | t | r | o | n | g | e | r |   | f | a | c | t | i | o | n |   |
| c | a | n |   | r | e | a | d | i | l | y |   | u | n | i | t | e |   |   |   |   |
| a | n | d |   | o | p | p | r | e | s | s |   | t | h | e |   |   |   |   |   |   |
| w | e | a | k | e | r | , |   | a | n | a | r | c | h | y |   | m | a | y |   |   |
| a | s |   | t | r | u | l | y |   | b | e |   | s | a | i | d |   | t | o |   |   |
| r | e | i | g | n | . | . | . |   |   |   |   |   |   |   |   |   |   |   |   |   |

James Madison – Federalist Paper 51

# End Line Example - Modified

| I | n |   | a |   | s | o | c | i | e | t | y |   | u | n | d | e | r |   |   |   | **1** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| t | h | e |   | f | o | r | m | s |   | o | f |   | w | h | i | c | h |   |   |   | **0** |
| t | h | e |   | s | t | r | o | n | g | e | r |   | f | a | c | t | i | o | n |   | **0** |
| c | a | n |   | r | e | a | d | i | l | y |   | u | n | i | t | e |   |   |   |   | **1** |
| a | n | d |   | o | p | p | r | e | s | s |   | t | h | e |   |   |   |   |   |   | **1** |
| w | e | a | k | e | r | , |   | a | n | a | r | c | h | y |   | m | a | y |   |   | **0** |
| a | s |   | t | r | u | l | y |   | b | e |   | s | a | i | d |   | t | o |   |   | **1** |
| r | e | i | g | n | . | . | . |   |   |   |   |   |   |   |   |   |   |   |   |   | **0** |

James Madison – Federalist Paper 51

# It is Invisible to the Reader

In a society under
the forms of which
the stronger faction
can readily unite
and oppress the
weaker, anarchy may
as truly be said to
reign...