

Class exercise: Coding with scaled integers

COMP 40

October 11, 2010

Group

Keeper of the record:
Other group members:

Coding coefficients of the Discrete Cosine Transform

Your homework requires you to convert luminance of a 2×2 block of pixels using the Discrete Cosine Transform, which produces coefficients a , b , c , and d . In principle, b , c , and d range over the interval $[-0.5, +0.5]$, but in practice almost all values fall into the range $[-0.3, +0.3]$. You must exploit this property or your compressed images will have ugly artifacts.

Your job is to code the real numbers b , c , and d as signed, scaled, 5-bit integers. Let us assume that a signed 5-bit integer can represent exactly the set of integers $\{n \mid -15 \leq n \leq +15\}$. (This assumption is almost but not quite the truth.) Please write C functions `encode` and `decode` with these prototypes:

```
int encode(float x);
float decode(int n);
```

Your functions should satisfy four algebraic laws and an \forall - \exists property:

<code>encode(decode(n)) = n</code>	when $ n \leq 15$
<code>decode(encode(x)) $\approx x$</code>	when $-0.3 \leq x \leq 0.3$
<code>encode(x) = encode(+0.3)</code>	when $x > +0.3$
<code>encode(x) = encode(-0.3)</code>	when $x < -0.3$
$\forall n : n \leq 15 : \exists x : x \leq 0.3 : \text{encode}(x) = n$	(all bits are used for the interval $[-0.3, +0.3]$)

where $x \approx y$ is defined to mean $|x - y| \leq \frac{1}{30}$.

1. Write the code.
2. Explain how you would test it.

Please return your work to the course staff.