The fastest and worstest AV1 encoder

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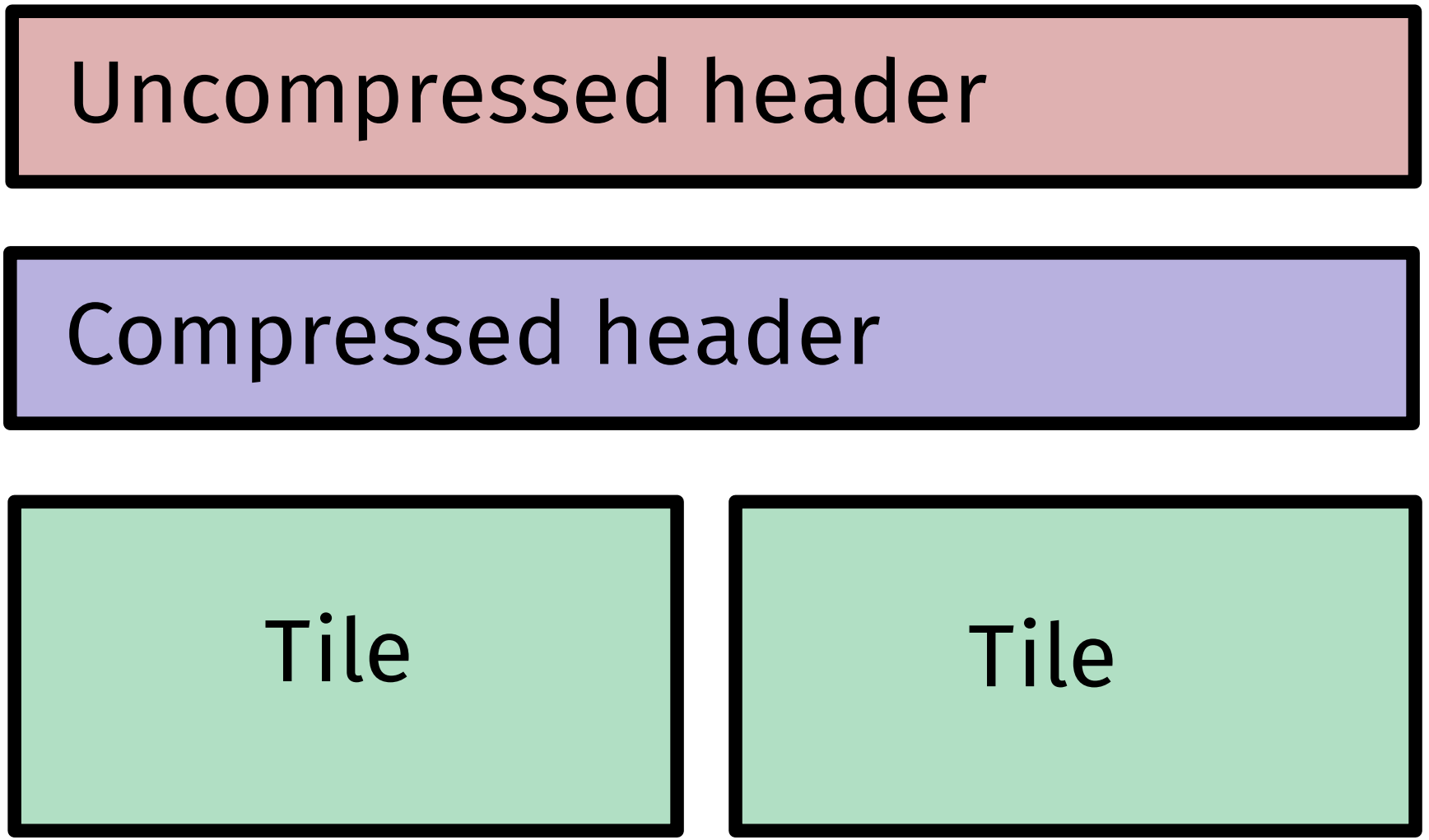
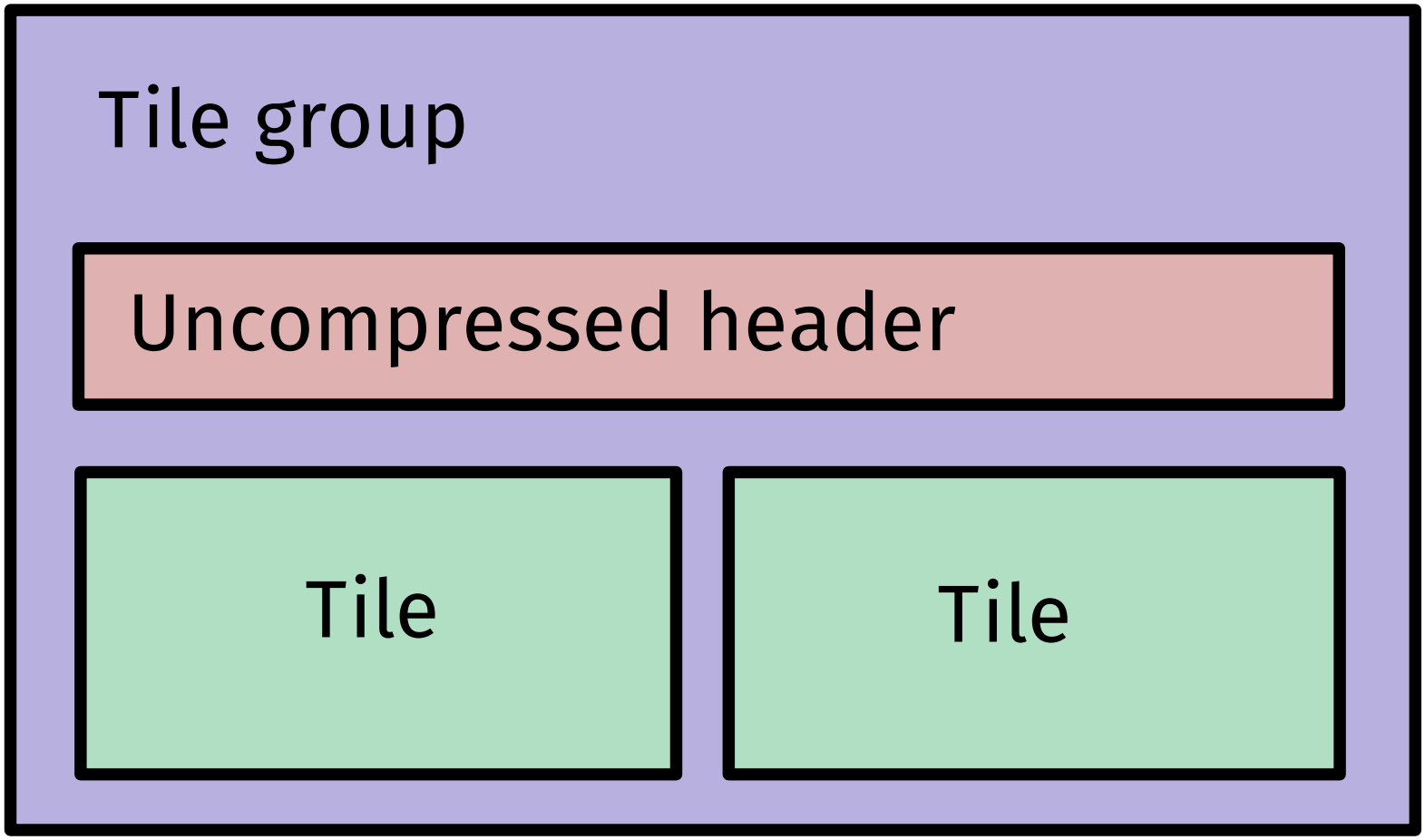
but why

- Started as a reimplementation of AV1 in order to find bitstream and specification bugs
- Could do an encoder or decoder:
  - Decoder (especially fuzzed) more useful to find mismatches
  - Encoder doesn’t need all features implemented to work
- Algorithmic improvements over libaom

VP9 frame at a glance



AV1 frame at a glance



The compressed header is gone!

- In VP9, probabilities were stored in the compressed header and remained constant for the frame.
  - Encode without writing the bitstream, but count the probabilities for each symbol
  - Write probabilities in compressed header
  - Write actual bitstream using probabilities in the compressed header

Tile

DC	DC	DC	H_PRED
1	1	1	01

Compressed header

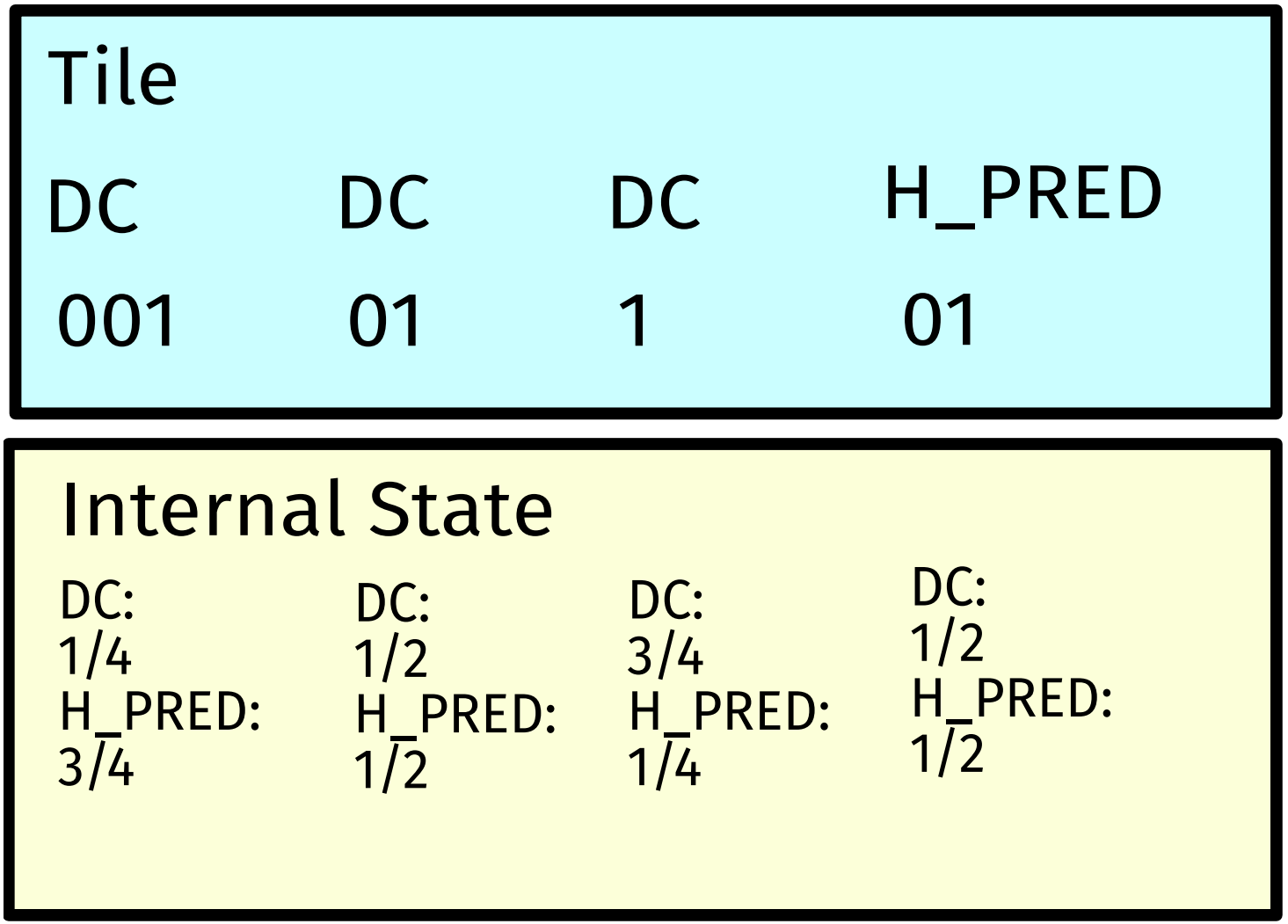
DC = 3/4
H_PRED = 1/4

Downsides

- Probabilities during RDO aren’t the real probabilities because you haven’t counted yet
- Have to buffer coefficients or tokens in memory

AV1

- Probabilities updated every symbol
- Exact rate known simply by coding the symbol
- RDO can be done by coding the symbol, then rewinding
- Once a superblock is encoded, it never has to be touched again (except for loop filter)


Tile
DC
DC
DC
H_PRED
001
01
1
01
Internal State
DC:
1/4
H_PRED:
3/4
DC:
1/2
H_PRED:
1/2
DC:
3/4
H_PRED:
1/4
DC:
1/2
H_PRED:
1/2

Downsides

- Internal state needs to be saved and restored when doing RDO (make a decision, undo it)
- State is intentionally kept small, but still 100kB+
- Need clever way of only saving and restoring the required parts

It’s in Rust

- Read Kostya’s blog post for details

Rust: Not So Great for Codec Implementing

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Overall, Rust is not that bad and I’ll keep developing NihAV using it but keep in mind it’s still far from being perfect (maybe about as far as C but in a different direction).

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Rust: Not So Great for Codec Implementing

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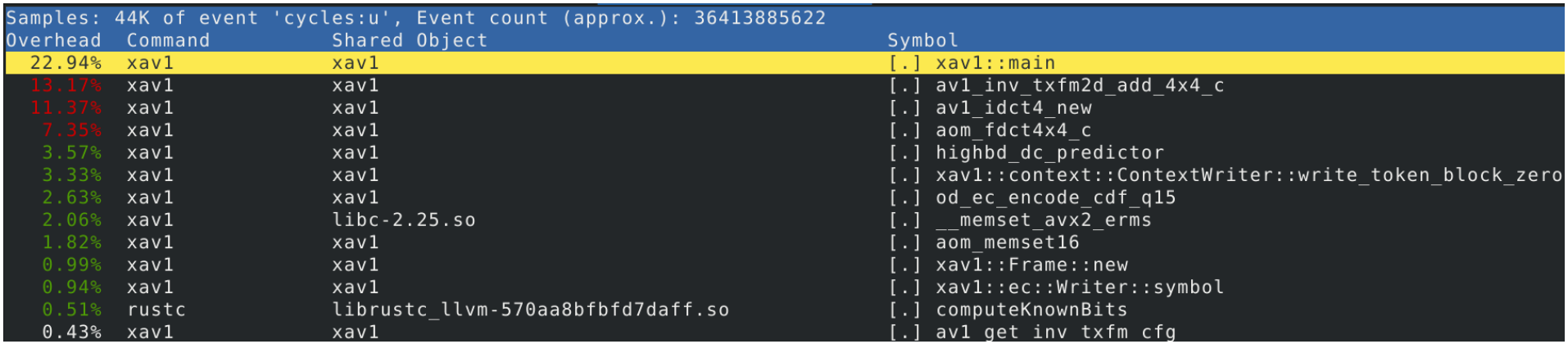
Overall, Rust is not that bad


Samples: 44K of event 'cycles:u', Event count (approx.): 36413885622
Overhead Command Shared Object Symbol
22.94% xav1 xav1 [.] xav1::main
13.17% xav1 xav1 [.] av1_inv_txfm2d_add_4x4_c
11.37% xav1 xav1 [.] av1_idct4_new
7.35% xav1 xav1 [.] aom_fdct4x4_c
3.57% xav1 xav1 [.] highbd_dc_predictor
3.33% xav1 xav1 [.] xav1::context::ContextWriter::write_token_block_zero
2.63% xav1 xav1 [.] od_ec_encode_cdf_q15
2.06% xav1 libc-2.25.so [.] __memset_avx2_erms
1.82% xav1 xav1 [.] aom_memset16
0.99% xav1 xav1 [.] xav1::Frame::new
0.94% xav1 xav1 [.] xav1::ec::Writer::symbol
0.51% rustc librustc_llvm-570aa8bfbfd7daff.so [.] computeKnownBits
0.43% xav1 xav1 [.] av1_get_inv_txfm_cfg

Some parts are still from libaom :(

- Transforms
  - Not final, not worth spending time on
- Predictions
- daala_ec
- Tables, etc

It’s in git

- https://github.com/tdaede/rav1e.git

Limitations

- Requires particular libaom git commit and configuration
- Intra only, 4x4 transforms
- Coefficient coder can’t code large values