MODEL-BASED TRANSRATING OF H.264 INTRA CODED FRAMES
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Transrating of coded video
- **Transrating**: bit rate reduction of pre-encoded video.
- **Method**: transform coefficients quantization.
- **Applications**: television broadcast, internet streaming

**Transrating architectures**
- **Trivial solution**: re-encoding
  - **High computational complexity due to full encoding**
- **Lowest complexity**: open-loop
  - **Drift error**
- **Reuse of input coding modes**
  - **Compromise of quality vs. computational complexity**
- **Intra-frame transrating architectures**
  - **Partial Decoder**: Partial Encoder
    - **Encode up to the residual transform coefficients**
    - **Non-linear operations cause a drift error that cannot be fully compensated**
  - **Full Decoder**: Guided Encoder
    - **No drift error**
    - **Guided encoding, based on the input intra prediction modes with optional modes modification.**

Model-based uniform requantization
- **Uniform requantization**
  - A sufficiently high bit budget is typical (intra-frames).
  - Spatial prediction → block dependencies
- **Model-based**
  - Transform coefficients requantization → evaluation of rates at many step sizes → high complexity.
  - Reduce the complexity by model-based evaluation.
  - Use a robust rate model in the ρ domain (fraction of zeroed coefficients). (He and Mitra, 2002)

### Statistical ρ(Q2) estimator

1. **Modeling stages (closed-loop scheme just for modeling)**
   1. Extract the distribution of Y from the input:
      \[ p_1(y) = \sum_{m=0}^{M} p_m \delta(y - mQ) \]
   2. Model the distribution of the correction signal C
      - Characterization: segment into homogenous data parts
      - Γ probability distribution
      - Estimation of Γ distribution parameter
      - Use 1+2. to model the distribution of W:
      \[ \Pr(W \leq w) = \sum_{m=0}^{M} p_m \int_{-\infty}^{w} p_{C|Y}(c|y = mQ) dc \]
   3. Estimate \( \hat{\rho}(Q_2) = \Pr(W \leq Th(Q_2)) \)

### Correction signal modeling (I)

**Characterization of C**

- **Segment the correction signal into groups according to the following criteria**
  1. Spatial prediction modes (e.g. DC, vertical, horizontal, various diagonal)
  2. Affected / unaffected transform coefficients:
     - DC prediction
     - Vertical prediction
     - Horizontal prediction
     - Other spatial prediction

**Benefits**
- Increased precision
- Complexity reduction – use open-loop estimator for unaffected coefficients

### Correction signal modeling (II)

**Γ probability distribution**

- **Definition**:
  \[ p_c(c) = \frac{1}{2\sqrt{\pi B |c|}} \exp(-\beta |c|) \]
  where smaller β → wider distribution
- **ML estimator**:
  \[ \hat{\beta} = 0.5 N \sum_{i=1}^{N} |c_i| \]

**Results**
- **ρ-Q2 estimator performance**
  - The proposed Γ distribution estimator has an average relative error of less than 1.7%.

### Correction signal modeling (III)

**Estimation of Γ distribution parameter**

**Parameters depend on input**

**Conclusion**
- **Novel statistical-based ρ-Q2 model** for transrating of H.264 intra-coded frames.
  - The model provides average rate deviation of 3%, as compared to 10.8% average deviation, obtained using an open-loop estimator.