

3.12.4 Probability models

3.12.4.1 ProbabilityModel DS

Information on extraction and use is not provided.

3.12.4.2 ProbabilityDistribution DS

3.12.4.2.1 ProbabilityDistribution DS examples

The following example shows the use of the `ProbabilityDistribution` DS for describing a probability distribution in terms of its statistics such as mean, variance, min, max, mode, median, and moment.

```
<Mpeg7>
  <DescriptionUnit xsi:type="ProbabilityDistributionType" confidence="1.0"
  dim="2">
    <Mean mpeg7:dim="2"> 0.25 0.5 </Mean>
    <Variance mpeg7:dim="2"> 0.1 0.9 </Variance>
    <Min mpeg7:dim="2"> 0.0 0.0 </Min>
    <Max mpeg7:dim="2"> 1.0 1.0 </Max>
    <Mode mpeg7:dim="2"> 0.5 0.5 </Mode>
    <Median mpeg7:dim="2"> 0.5 0.5 </Median>
    <Moment>
      <Value mpeg7:dim="2" order="3"> 0.2 0.3 </Value>
    </Moment>
  </DescriptionUnit>
</Mpeg7>
```

3.12.4.3 Discrete distribution description tools

3.12.4.3.1 Discrete distribution description tools examples

The following example illustrates the use of the `HistogramProbability` DS for describing an eight-dimensional histogram.

```
<Mpeg7>
  <DescriptionUnit xsi:type="HistogramProbabilityType" momentNormalized="1"
  dim="8">
    <Distribution mpeg7:dim="8"> 0.125 0.0 0.0 0.25 0.125 0.25 0.25 0.0
    </Distribution>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the `BinomialDistribution` DS for describing a one-dimensional binomial distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="BinomialDistributionType" dim="1">
    <SuccessProbability mpeg7:dim="1"> 0.5 </SuccessProbability>
    <NumOfTrials mpeg7:dim="1"> 16 </NumOfTrials>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the `BinomialDistribution` DS for describing a two-dimensional hypergeometric distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="HyperGeometricDistributionType" dim="2">
    <NumOfSuccesses mpeg7:dim="2"> 5 5 </NumOfSuccesses>
    <NumOfTrials mpeg7:dim="2"> 8 8 </NumOfTrials>
    <PopulationSize mpeg7:dim="2"> 16 16 </PopulationSize>
  </DescriptionUnit>
</Mpeg7>
```

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The following example illustrates the use of the PoissonDistribution DS for describing a three-dimensional Poisson distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="PoissonDistributionType" dim="3">
    <Lambda mpeg7:dim="3"> 0.4 0.3 0.75 </Lambda>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the GeometricDistribution DS for describing a one-dimensional geometric distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="GeometricDistributionType" dim="1">
    <SuccessProbability mpeg7:dim="1"> 0.75 </SuccessProbability>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the DiscreteUniformDistribution DS for describing a one-dimensional discrete uniform distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="DiscreteUniformDistributionType" dim="1">
    <Range mpeg7:dim="1"> 0.125 </Range>
    <Scale mpeg7:dim="1"> 2.0 </Scale>
    <Shift mpeg7:dim="1"> 8.0 </Shift>
  </DescriptionUnit>
</Mpeg7>
```

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3.12.4.4 Continuous distribution description tools

3.12.4.4.1 Continuous distribution description tools examples

The following example illustrates the use of the GaussianDistribution DS for describing a one-dimensional Gaussian distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="GaussianDistributionType" dim="1">
    <Mean mpeg7:dim="1"> 0.5 </Mean>
    <Variance mpeg7:dim="1"> 0.25 </Variance>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the ExponentialDistribution DS for describing a two-dimensional generalized Gaussian distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="GeneralizedGaussianDistributionType" dim="2">
    <Mean mpeg7:dim="2"> 0.5 0.35 </Mean>
    <Variance mpeg7:dim="2"> 0.25 0.75 </Variance>
    <Shape mpeg7:dim="2"> 2 2 </Shape>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the ExponentialDistribution DS for describing a two-dimensional exponential distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="ExponentialDistributionType" dim="2">
    <Theta mpeg7:dim="2"> 0.5 0.25 </Theta>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the GammaDistribution DS for describing a three-dimensional Gamma distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="GammaDistributionType" dim="3">
    <Theta mpeg7:dim="3"> 0.4 0.3 0.75 </Theta>
    <Shape mpeg7:dim="3"> 8 4 16 </Shape>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the ContinuousUniformDistribution DS for describing a one-dimensional continuous uniform distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="ContinuousUniformDistributionType" dim="1">
    <MaxRange mpeg7:dim="1"> 1.0 </MaxRange>
    <MinRange mpeg7:dim="1"> 0.0 </MinRange>
  </DescriptionUnit>
</Mpeg7>
```

The following example illustrates the use of the LognormalDistribution DS for describing a one-dimensional lognormal distribution.

```
<Mpeg7>
  <DescriptionUnit xsi:type="LognormalDistributionType" dim="1">
    <NormalMean mpeg7:dim="1"> 0.5 </NormalMean>
    <NormalVariance mpeg7:dim="1"> 0.35 </NormalVariance>
  </DescriptionUnit>
</Mpeg7>
```

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3.12.4.5 Finite state model description tools

3.12.4.5.1 Finite state model description tools examples

The following example shows the use of the StateTransitionModel DS for describing a state-transition model that has three states. In this example, assume that the observed weather has one of the following states: "precipitation", "cloudy", or "sunny". Furthermore, the state-transition probabilities indicate the probability of moving from one state to another. The initial probabilities specify the initial probability of each state. The state-transition model allows questions to be answered such as, what is the probability that the weather for eight consecutive days is "sun-sun-sun-rain-rain-sun-cloudy-sun", or given that the system is in a known state, i.e., "sunny", what is the expected number of consecutive days the system will remain in that state.

```
<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="StateTransitionModelType" numOfStates="3">
      <Initial mpeg7:dim="3"> 0.5 0.25 0.25 </Initial>
      <Transitions mpeg7:dim="3 3"> 0.4 0.3 0.3 0.2 0.6 0.2 0.1 0.1 0.8
    </Transitions>
    <State>
      <Label>
        <Name>Precipitation </Name>
      </Label>
    </State>
    <State>
      <Label>
        <Name>Cloudy </Name>
      </Label>
    </State>
    <State>
      <Label>
        <Name>Sunny </Name>
      </Label>
    </State>
  </Description>
</Mpeg7>
```

```

    </Model>
  </Description>
</Mpeg7>

```

The following example shows the use of the StateTransitionModel DS for describing a state-transition model of the events depicted a video of a soccer game. The model describes three states: "Pass", "Shot on goal" and "Goal score". The StateTransitionModel DS describes the states, the initial state probabilities, and the transition probabilities between the states.

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="StateTransitionModelType" numOfStates="3">
      <Initial mpeg7:dim="3"> 0.25 0.5 0.25 </Initial>
      <Transitions mpeg7:dim="3 3"> 0.2 0.2 0.6 0.1 0.8 0.1 0.3 0.3 0.4
    </Transitions>
    <State>
      <Label>
        <Name> Pass </Name>
      </Label>
    </State>
    <State>
      <Label>
        <Name>Shot on goal </Name>
      </Label>
    </State>
    <State>
      <Label>
        <Name>Goal score </Name>
      </Label>
    </State>
  </Model>
</Description>
</Mpeg7>

```

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<https://standards.iteh.ai/catalog/standards/sist/8e7f952b-fb51-4047-b713-bc9e24786bf3/iso-iec-tr-15938-8-2002>

The following example shows the use of DiscreteHiddenMarkovModelType for describing a discrete hidden markov model of events in a soccer game, such as "passes" and "goal scores".

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="DiscreteHiddenMarkovModelType" numOfStates="2">
      <Initial mpeg7:dim="2"> 0.5 0.5 </Initial>
      <Transitions mpeg7:dim="2 2"> 0.4 0.6 0.3 0.7 </Transitions>
      <State>
        <Label>
          <Name>Pass</Name>
        </Label>
      </State>
      <State>
        <Label>
          <Name>Goal score</Name>
        </Label>
      </State>
      <NumOfObservationsPerState>2</NumOfObservationsPerState>
      <Observation>Team A pass</Observation>
      <Observation>Team B pass</Observation>
      <ObservationDistribution xsi:type="HistogramProbabilityType"
        momentNormalized="1" dim="2">
        <Distribution mpeg7:dim="2">0.2 0.8</Distribution>
      </ObservationDistribution>
      <NumOfObservationsPerState>2</NumOfObservationsPerState>
      <Observation>Team A goal</Observation>
      <Observation>Team B goal</Observation>
      <ObservationDistribution xsi:type="HistogramProbabilityType"

```

```

        momentNormalized="1" dim="2">
        <Distribution mpeg7:dim="2">0.4 0.6</Distribution>
    </ObservationDistribution>
</Model>
</Description>
</Mpeg7>

```

The following example shows the use of the ContinuousHiddenMarkovModel DS for describing a continuous hidden Markov model of audio sound effects. Each continuous hidden Markov model has 5 states and represents a sound effect class. The parameters of the continuous density state model can be estimated via training, for example, using the Baum-Welch algorithm. After training, the continuous HMM model consists of a 5x5 state transition matrix, a 5x1 initial state density matrix, and 5 multi-dimensional Gaussian distributions defined in terms of the mean and variance parameters. Each multi-dimensional Gaussian distribution has six dimensions corresponding to audio features comprised of 5 channels of Independent Component Analysis (ICA) data and 1 channel of spectral envelope data.

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="ContinuousHiddenMarkovModelType" numOfStates="5">
      <Initial mpeg7:dim="5"> 0.1 0.2 0.1 0.4 0.2 </Initial>
      <Transitions mpeg7:dim="5 5">
        0.2 0.2 0.6 0.0 0.0
        0.1 0.2 0.1 0.3 0.3
        0.4 0.2 0.1 0.1 0.2
        0.2 0.1 0.4 0.2 0.1
        0.0 0.2 0.1 0.3 0.4
      </Transitions>
      <State>
        <Label>
          <Name> State 1 </Name>
        </Label>
      </State>
      <State>
        <Label>
          <Name> State 2 </Name>
        </Label>
      </State>
      <State>
        <Label>
          <Name> State 3 </Name>
        </Label>
      </State>
      <State>
        <Label>
          <Name> State 4 </Name>
        </Label>
      </State>
      <State>
        <Label>
          <Name> State 5 </Name>
        </Label>
      </State>
      <DescriptorModel>
        <Descriptor xsi:type="BeatType">
          <BeatData> 1 2 3 4 5 6 </BeatData>
        </Descriptor>
        <Field xsi:type="XPathFieldType">BeatData</Field>
      </DescriptorModel>
      <ObservationDistribution xsi:type="GaussianDistributionType" dim="6">
        <Mean mpeg7:dim="6"> 0.5 0.5 0.25 0.3 0.5 0.3 </Mean>
        <Variance mpeg7:dim="6"> 0.25 0.75 0.5 0.45 0.75 0.3</Variance>
      </ObservationDistribution>
      <ObservationDistribution xsi:type="GaussianDistributionType" dim="6">

```

```

    <Mean mpeg7:dim="6"> 0.25 0.4 0.25 0.3 0.2 0.1 </Mean>
    <Variance mpeg7:dim="6"> 0.5 0.25 0.5 0.45 0.5 0.2</Variance>
  </ObservationDistribution>
  <ObservationDistribution xsi:type="GaussianDistributionType" dim="6">
    <Mean mpeg7:dim="6"> 0.2 0.5 0.35 0.3 0.5 0.5 </Mean>
    <Variance mpeg7:dim="6"> 0.5 0.5 0.5 0.5 0.75 0.5</Variance>
  </ObservationDistribution>
  <ObservationDistribution xsi:type="GaussianDistributionType" dim="6">
    <Mean mpeg7:dim="6"> 0.5 0.3 0.25 0.2 0.5 0.6 </Mean>
    <Variance mpeg7:dim="6"> 0.5 0.1 0.5 0.25 0.75 0.4</Variance>
  </ObservationDistribution>
  <ObservationDistribution xsi:type="GaussianDistributionType" dim="6">
    <Mean mpeg7:dim="6"> 0.5 0.15 0.25 0.3 0.5 0.35 </Mean>
    <Variance mpeg7:dim="6"> 0.5 0.75 0.5 0.5 0.75 0.35</Variance>
  </ObservationDistribution>
</Model>
</Description>
</Mpeg7>

```

3.12.4.5.2 FiniteStateModel DS use

State-transition models can be extracted from the events along the temporal dimension of a video sequence. For example, a temporal sequence of scenes in video can be characterized by a state-transition model that describes the probabilities of transitions between scenes.

The state-transition models can be matched using the following matching metrics to determine the similarity of the underlying multimedia content being modeled:

Euclidean distance: calculates the sum of squared differences between transition probabilities.

$$dissimilar\ score = \sum_i \sum_j (A_{ij} - B_{ij})^2$$

Quadratic distance: calculates the sum of weighted quadratic distance between transition probabilities.

$$dissimilar\ score = \sum_i \sum_j \sum_k \sum_l \frac{(A_{ij} - B_{ij})(A_{kl} - B_{kl})}{(1 + abs(i - k) + abc(j - l))}$$

Weighted transition frequency: calculates the weighted sum of ratios of transition probabilities.

$$fA_{ij} = A_{ij} + A_{ji} \quad rA_{ij} = \frac{A_{ij}}{A_{ji}}$$

$$match\ score = \sum_i \sum_{j>i} \sqrt{fA_{ij} \cdot fB_{ij}} \cdot \min\left(\frac{fA_{ij}}{fB_{ij}}, \frac{fB_{ij}}{fA_{ij}}\right) \cdot \min\left(\frac{rA_{ij}}{rB_{ij}}, \frac{rB_{ij}}{rA_{ij}}\right)$$

Euclidean distance of aggregated state transitions: calculates the sum of the squared differences of aggregated transitions.

$$dissimilar\ score = \sum_i \left(\sum_j A_{ij} - \sum_j B_{ij} \right)^2 - \sum_j \left(\sum_i A_{ij} - \sum_i B_{ij} \right)^2$$

3.12.5 Analytic models

3.12.5.1.1 AnalyticModel DS examples

The example below illustrates the use of the ModelState DS to describe a an analytic model that represents a state in a finite state model. The description gives three labels for the state and gives information about the confidence and reliability of the state analytic model.

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">

```

```

<Model xsi:type="ModelStateType" confidence="0.9" reliability="0.75">
  <Label relevance="0.5" confidence="0.9" reliability="0.75">
    <Name> Shot on goal </Name>
  </Label>
  <Label relevance="1.0" confidence="0.75" reliability="0.75">
    <Name> Ball block </Name>
  </Label>
  <Label relevance="0.25" confidence="0.5" reliability="0.75">
    <Name> Shot wide </Name>
  </Label>
</Model>
</Description>
</Mpeg7>

```

3.12.5.2 CollectionModel DS

3.12.5.2.1 CollectionModel DS examples

The following example illustrates the use of the CollectionModel DS for describing a collection model consisting of a content collection of four images. In this example, the semantic concept is being described by the collection of images. For example, the collection of images describe the concept of "soccer shots on goal". In this example, the description gives a confidence of 0.75 and a reliability of 0.5.

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="CollectionModelType" confidence="0.75" reliability="0.5"
      function="described">
      <Label>
        <Name>Soccer shots on goal</Name>
      </Label>
      <Collection xsi:type="ContentCollectionType">
        <Content xsi:type="ImageType">
          <Image>
            <MediaLocator xsi:type="ImageLocatorType">
              <MediaUri>soccer1.jpg</MediaUri>
            </MediaLocator>
          </Image>
        </Content>
        <Content xsi:type="ImageType">
          <Image>
            <MediaLocator xsi:type="ImageLocatorType">
              <MediaUri>soccer2.jpg</MediaUri>
            </MediaLocator>
          </Image>
        </Content>
        <Content xsi:type="ImageType">
          <Image>
            <MediaLocator xsi:type="ImageLocatorType">
              <MediaUri>soccer3.jpg</MediaUri>
            </MediaLocator>
          </Image>
        </Content>
        <Content xsi:type="ImageType">
          <Image>
            <MediaLocator xsi:type="ImageLocatorType">
              <MediaUri>soccer4.jpg</MediaUri>
            </MediaLocator>
          </Image>
        </Content>
      </Collection>
    </Model>
  </Description>
</Mpeg7>

```

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The following example illustrates the use of the CollectionModel DS for describing a model of a collection of two color descriptions. In this example, the semantic concept "Sunsets" has the function of describing the collection of descriptors.

```
<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="CollectionModelType" confidence="0.75" reliability="0.5"
      function="describing">
      <Label>
        <Name> Sunsets </Name>
      </Label>
      <Collection xsi:type="DescriptorCollectionType">
        <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
          numOfBitplanesDiscarded="0">
          <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
        </Descriptor>
        <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
          numOfBitplanesDiscarded="0">
          <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
        </Descriptor>
      </Collection>
    </Model>
  </Description>
</Mpeg7>
```

The following example illustrates the use of the CollectionModel DS for describing a collection of four concepts. The concept collection has a semantic label: "soccer stadium objects", that is, the semantic concept has the function of describing the collection of concepts. In this example, the confidence is 0.75 and reliability is 0.5.

```
<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="CollectionModelType" confidence="0.75" reliability="0.5"
      function="describing">
      <Label>
        <Name> Soccer stadium objects </Name>
      </Label>
      <Collection xsi:type="ConceptCollectionType">
        <Concept xsi:type="ObjectType">
          <Label>
            <Name> Ball </Name>
          </Label>
        </Concept>
        <Concept xsi:type="ObjectType">
          <Label>
            <Name> Goal </Name>
          </Label>
        </Concept>
        <Concept xsi:type="ObjectType">
          <Label>
            <Name> Seats </Name>
          </Label>
        </Concept>
        <Concept xsi:type="ObjectType">
          <Label>
            <Name> Water </Name>
          </Label>
        </Concept>
      </Collection>
    </Model>
  </Description>
</Mpeg7>
```


3.12.5.3 DescriptorModel DS

3.12.5.3.1 DescriptorModel DS examples

The following example illustrates the use of the DescriptorModel DS for describing a descriptor model of the ScalableColor descriptor. The DescriptorModel DS specifies that the descriptor model is formed from the Coefficients element of the ScalableColor D (defined in ISO/IEC 15938-3). For example, in the DescriptorModel for ScalableColorType, the value of numOfCoefficients="16" is constant in the descriptor model.

```
<mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="DescriptorModelType">
      <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
        numOfBitplanesDiscarded="0">
        <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
      </Descriptor>
      <Field>Coeff</Field>
    </Model>
  </Description>
</Mpeg7>
```

The following example illustrates the use of the DescriptorModel DS for describing a descriptor model of the ContourShape descriptor. The DescriptorModel DS specifies that the descriptor model is formed from the concatenation of six elements of the ContourShape D (defined in ISO/IEC 15938-3). All other elements and attributes not mentioned in the field statements are assumed to be constant in the descriptor models, taking the values specified in the example Descriptors.

```
<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="DescriptorModelType">
      <Descriptor xsi:type="ContourShapeType">
        <GlobalCurvature> 3 5 </GlobalCurvature>
        <PrototypeCurvature> 4 7 </PrototypeCurvature>
        <HighestPeakY>2</HighestPeakY>
        <Peak peakX="4" peakY="2"/>
        <Peak peakX="3" peakY="5"/>
        <Peak peakX="7" peakY="1"/>
      </Descriptor>
      <Field>GlobalCurvature</Field>
      <Field>PrototypeCurvature</Field>
      <Field>HighestPeakY</Field>
      <Field>Peak</Field>
    </Model>
  </Description>
</Mpeg7>
```

3.12.5.4 ProbabilityModelClass DS

3.12.5.4.1 ProbabilityModelClass DS examples

The following example illustrates the use of the ProbabilityModelClass DS for describing a probability model class that characterizes a class of "Nature scene" images by representing the statistics associated with the color features of the images of that class. For example, the specification below indicates that the Coefficients element of the ScalableColor D (defined in ISO/IEC 15938-3) for the Nature scene images has a centroid or mean value of (0.5, 0.5, ...) and a variance of (0.25, 0.75, ...).

```
<mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="ProbabilityModelClassType" confidence="0.75"
      reliability="0.5">
      <Label>
        <Name>Nature scenes</Name>
      </Label>
    </Model>
  </Description>
</Mpeg7>
```

```

    <DescriptorModel>
      <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
        numOfBitplanesDiscarded="0">
        <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
      </Descriptor>
    </DescriptorModel>
    <Field>Coeff</Field>
  </ProbabilityModel xsi:type="ProbabilityDistributionType"
confidence="1.0"
  dim="16">
    <Mean mpeg7:dim="16"> 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 </Mean>
    <Variance mpeg7:dim="16"> 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 5
  </Variance>
</ProbabilityModel>
</Model>
</Description>
</Mpeg7>

```

The following example illustrates the use of the ProbabilityModelClass DS for describing a probability model that characterizes checker patterns using a probability model of EdgeHistogram D (see ISO/IEC 15938-3).

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="ProbabilityModelClassType" confidence="0.75"
      reliability="0.5">
      <Label relevance="0.75">
        <Name>Checker patterns</Name>
      </Label>
      <DescriptorModel>
        <Descriptor xsi:type="EdgeHistogramType">
          <BinCounts> 3 5 2 5 . . . 6 </BinCounts>
        </Descriptor>
        <Field>BinCounts</Field>
      </DescriptorModel>
      <ProbabilityModel xsi:type="ProbabilityDistributionType"
confidence="0.75"
        dim="80">
        <Mean mpeg7:dim="80"> 5 3 9 4 . . . 5 </Mean>
        <Variance mpeg7:dim="80"> 4.5 5.0 8.0 7.5 . . . 5.2 </Variance>
      </ProbabilityModel>
    </Model>
  </Description>
</Mpeg7>

```

The following example illustrates the use of the ProbabilityModelClass DS for describing a probability model that characterizes oval shapes using a probability model of RegionShape D (see ISO/IEC 15938-3).

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="ProbabilityModelClassType" confidence="0.75"
      reliability="0.5">
      <Label relevance="0.75">
        <Name> Ovals </Name>
      </Label>
      <DescriptorModel>
        <Descriptor xsi:type="RegionShapeType">
          <MagnitudeOfART> 3 5 2 5 . . . 6 </MagnitudeOfART>
        </Descriptor>
        <Field>MagnitudeOfART</Field>
      </DescriptorModel>
      <ProbabilityModel xsi:type="ProbabilityDistributionType"
confidence="1.0"

```

```

        dim="35">
        <Mean dim="35"> 4 8 6 9 . . . 5 </Mean>
        <Variance dim="35"> 1.3 2.5 5.0 4.5 . . . 3.2 </Variance>
    </ProbabilityModel>
</Model>
</Description>
</Mpeg7>

```

The following example illustrates the use of the `ProbabilityModelClass DS` for describing a probability model that characterizes silhouettes using a probability model of `ContourShape D` (see ISO/IEC 15938-3).

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="ProbabilityModelClassType" confidence="0.75"
      reliability="0.5">
      <Label relevance="0.75">
        <Name> Silhouettes </Name>
      </Label>
      <DescriptorModel>
        <Descriptor xsi:type="ContourShapeType">
          <GlobalCurvature> 3 5 </GlobalCurvature>
          <PrototypeCurvature> 4 7 </PrototypeCurvature>
          <HighestPeakY>2</HighestPeakY>
          <Peak peakX="4" peakY="2"/>
          <Peak peakX="3" peakY="5"/>
          <Peak peakX="7" peakY="1"/>
        </Descriptor>
        <Field>GlobalCurvature</Field>
        <Field>PrototypeCurvature</Field>
        <Field>HighestPeakY</Field>
        <Field>Peak</Field>
      </DescriptorModel>
      <ProbabilityModel xsi:type="ProbabilityDistributionType"
confidence="1.0"
dim="11">
        <Mean mpeg7:dim="11"> 3 9 7 4 6 9 1 2 6 8 9</Mean>
        <Variance mpeg7:dim="11"> 3.4 5.4 9.1 1.8 2.3 6.5 7.9 1.2 3.4 3.3
1.0
        </Variance>
      </ProbabilityModel>
    </Model>
  </Description>
</Mpeg7>

```

3.12.6 Cluster models

3.12.6.1.1 ClusterModel DS examples

The following example illustrates the use of the `ClusterModel DS` for describing a cluster model consisting of a set of examples of two scalable color descriptions. The cluster models have a semantic label: "Nature scenes". The example describes also the probability model of the `ScalableColor D` (see ISO/IEC 15938-3).

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="ClusterModelType" confidence="0.75" reliability="0.5">
      <Label>
        <Name> Nature scenes </Name>
      </Label>
      <Collection xsi:type="DescriptorCollectionType">
        <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
          numOfBitplanesDiscarded="0">
          <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>

```

```

        </Descriptor>
        <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
            numOfBitplanesDiscarded="0">
            <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
        </Descriptor>
    </Collection>
    <DescriptorModel>
        <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
            numOfBitplanesDiscarded="0">
            <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
        </Descriptor>
        <Field>Coeff</Field>
    </DescriptorModel>
    <ProbabilityModel xsi:type="ProbabilityDistributionType"
confidence="1.0"
        dim="16">
        <Mean mpeg7:dim="16"> 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 </Mean>
        <Variance mpeg7:dim="16"> 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 5
    </Variance>
    </ProbabilityModel>
    </Model>
    </Description>
</Mpeg7>

```

3.12.7 Classification models

Information on extraction and use is not provided.

3.12.7.1 ClusterClassificationModel DS

3.12.7.1.1 ClusterClassificationModel examples

The following example illustrates the use of the ClusterClassificationModel DS for describing a cluster classification model related to soccer scenes from a soccer game. In this example, the ClusterClassificationModel is comprised of two ClusterModels. The first ClusterModel describes a cluster of two images that form the class with label "Soccer shots on goal". The second ClusterModel describes a cluster of two images that form the class with label "Goal scores".

```

<Mpeg7>
    <Description xsi:type="ModelDescriptionType">
        <Model xsi:type="ClusterClassificationModelType" confidence="0.9"
            reliability="0.8" complete="true" redundant="false">
            <ClusterModel confidence="0.75" reliability="0.5">
                <Label>
                    <Name> Soccer shots on goal </Name>
                </Label>
                <Collection xsi:type="ContentCollectionType">
                    <Content xsi:type="ImageType">
                        <Image>
                            <MediaLocator xsi:type="ImageLocatorType">
                                <MediaUri>soccer1.jpg</MediaUri>
                            </MediaLocator>
                        </Image>
                    </Content>
                    <Content xsi:type="ImageType">
                        <Image>
                            <MediaLocator xsi:type="ImageLocatorType">
                                <MediaUri>soccer2.jpg</MediaUri>
                            </MediaLocator>
                        </Image>
                    </Content>
                </Collection>
            </ClusterModel>
            <ClusterModel confidence="0.9" reliability="0.75">
                <Label>

```

```

        <Name> Goal scores </Name>
    </Label>
    <Collection xsi:type="ContentCollectionType">
        <Content xsi:type="ImageType">
            <Image>
                <MediaLocator xsi:type="ImageLocatorType">
                    <MediaUri>soccer3.jpg</MediaUri>
                </MediaLocator>
            </Image>
        </Content>
        <Content xsi:type="ImageType">
            <Image>
                <MediaLocator xsi:type="ImageLocatorType">
                    <MediaUri>soccer4.jpg</MediaUri>
                </MediaLocator>
            </Image>
        </Content>
    </Collection>
</ClusterModel>
</Model>
</Description>
</Mpeg7>

```

The following example illustrates the use of the ClusterClassificationModel DS for describing a cluster classification model related to images depicting nature scenes. The ClusterClassificationModel is comprised of two ClusterModels. The first ClusterModel describes a collection of two scalable color descriptions that forms the class with label "Sunsets". The second ClusterModel describes a collection of two scalable color descriptions that forms the class with label "Nature scenes".

(standards.itech.ai)

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="ClusterClassificationModelType" confidence="0.95"
      reliability="0.75" complete="true" redundant="false">
      <ClusterModel confidence="0.8" reliability="0.75">
        <Label relevance="0.75">
          <Name>Sunsets</Name>
        </Label>
        <Collection xsi:type="DescriptorCollectionType">
          <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
            numOfBitplanesDiscarded="0">
            <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
          </Descriptor>
          <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
            numOfBitplanesDiscarded="0">
            <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
          </Descriptor>
        </Collection>
      </ClusterModel>
      <ClusterModel confidence="0.75" reliability="0.5">
        <Label>
          <Name>Nature scenes</Name>
        </Label>
        <Collection xsi:type="DescriptorCollectionType">
          <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
            numOfBitplanesDiscarded="0">
            <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
          </Descriptor>
          <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
            numOfBitplanesDiscarded="0">
            <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
          </Descriptor>
        </Collection>
      </ClusterModel>
    </Model>
  </Description>
</Mpeg7>

```

```

    </ClusterModel>
  </Model>
</Description>
</Mpeg7>

```

3.12.7.2 ProbabilityClassificationModel DS

3.12.7.2.1 ProbabilityClassificationModel DS examples

The following example illustrates the use of the ProbabilityClassificationModel DS for describing a probability classification model for sunset and nature images. The ProbabilityClassificationModel DS is comprised of two instances of ProbabilityModelClass DS. The first ProbabilityModelClass DS instance specifies a class of scalable color descriptors that forms with label "Sunsets". The second ProbabilityModelClass DS instance specifies a class of scalable color descriptors with label "Nature scenes".

```

<Mpeg7>
  <Description xsi:type="ModelDescriptionType">
    <Model xsi:type="ProbabilityClassificationModelType" confidence="0.95"
      reliability="0.75" complete="true" redundant="false">
      <ProbabilityModelClass confidence="0.9" reliability="0.5">
        <Label>
          <Name>Sunsets</Name>
        </Label>
        <DescriptorModel>
          <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
            numOfBitplanesDiscarded="0">
            <Coeff> 4 5 6 7 8 9 0 1 2 3 4 5 6 1 2 3</Coeff>
          </Descriptor>
          <Field>Coeff</Field>
        </DescriptorModel>
        <ProbabilityModel xsi:type="ProbabilityDistributionType"
          confidence="1.0" dim="16">
          <Mean mpeg7:dim="16"> 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 </Mean>
          <Variance mpeg7:dim="16"> 5 6 7 8 9 0 1 2 3 4 5 6 5 2 3 4
          </Variance>
        </ProbabilityModel>
      </ProbabilityModelClass>
      <ProbabilityModelClass confidence="0.9" reliability="0.8">
        <Label>
          <Name>Nature scenes</Name>
        </Label>
        <DescriptorModel>
          <Descriptor xsi:type="ScalableColorType" numOfCoeff="16"
            numOfBitplanesDiscarded="0">
            <Coeff> 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 </Coeff>
          </Descriptor>
          <Field>Coeff</Field>
        </DescriptorModel>
        <ProbabilityModel xsi:type="ProbabilityDistributionType"
          confidence="1.0" dim="16">
          <Mean mpeg7:dim="16"> 3 4 5 0 1 2 3 4 5 6 7 8 9 0 1 2 </Mean>
          <Variance mpeg7:dim="16"> 5 6 5 2 3 4 5 6 7 8 9 0 1 2 3 4
          </Variance>
        </ProbabilityModel>
      </ProbabilityModelClass>
    </Model>
  </Description>
</Mpeg7>

```

3.13 User interaction tools

3.13.1 Introduction

This clause specifies the following description tools related to user interaction with multimedia content.

Table 15 - Overview of User Interaction Tools.

<i>Tool</i>	<i>Functionality</i>
User Preferences	Tools for describing user preferences pertaining to multimedia content, enabling effective user interaction and personalization of content access and consumption. See clause 3.13.2.
Usage History	Tools for describing usage history of users of multimedia content, enabling effective user interaction and personalization of content access and consumption. See clause 3.13.3.

3.13.2 User preferences

The User Preferences tools are used to specify user's preferences pertaining to filtering, searching and browsing of multimedia content and can be used for personalized viewing and listening. Filtering and search preferences describe, for example, favorite titles, genres, actors and sources of content. This information can be used to find preferred multimedia content by matching it with information in multimedia content descriptions. Browsing preferences, for example, describe preferred views of favorite content, where preferences may be dependent on usage conditions such as available bandwidth or the time the user has to consume the information. This allows the user to navigate and access different views of the content in a personalized manner.

3.13.2.1 UserPreferences DS

3.13.2.1.1 UserPreferences DS examples

An example `UserPreferences` description containing several preferences pertaining to filtering and searching of content is as follows. Note that XML comments indicate description elements that are discussed in more detail in later subclauses.

```

<Mpeg7>
  <Description xsi:type="UserDescriptionType">
    <UserPreferences>
      <UserIdentifier>
        <!-- User preferences identification elements -->
      </UserIdentifier>
      <FilteringAndSearchPreferences>
        <CreationPreferences>
          <Creator>
            <Role href="urn:mpeg:mpeg7:cs:RoleCS:2001:ACTOR"/>
            <Agent xsi:type="PersonType">
              <Name>
                <GivenName>Harrison</GivenName>
                <FamilyName>Ford</FamilyName>
              </Name>
            </Agent>
          </Creator>
          <DatePeriod>
            <TimePoint>1995-01-01</TimePoint>
            <Duration>P1825D</Duration>
          </DatePeriod>
        </CreationPreferences>
        <ClassificationPreferences>
          <Genre><Name>News</Name></Genre>
          <Genre><Name>Sports</Name></Genre>
          <Genre><Name>Documentary</Name></Genre>
        </ClassificationPreferences>
      </FilteringAndSearchPreferences>
      <BrowsingPreferences>

```