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# Alairas.Common

## BaseLineExtraction

```
public class Alairas.Common.BaseLineExtraction
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

### Methods

Type	Name	Summary
void	Run( Signature input)	
void	Transform( Signature signature)	

### Static Methods

Type	Name	Summary
	GetComponentLowerEnvelopes( Image<Rgba32>	Extracts lower envelope for

List<List<Point>>	image)	each component
Baseline	GetLineOfBestFit( List<Point> points)	Megkeresi a megadott pontokra legjobban illeszkedő egyenest. Képes még ennek az egyenesnek különböző hibamértékeinek kiszámítására, azonban jelenleg ezzel nem foglalkozom, hiszen ebben a speciális esetben szinte biztosan elég jól illeszkedő egyenest kapunk eredményül. Az algorimus kimenete nem egy egyenes, hanem egy egy vektor, mely az egyenes egy szakasza. Felteszem, hogy a pontok X koordináta szerint rendezettek, így az első és utolsó pont X koordinátája közötti szakaszt adom vissza az egyenesből. Azaz: Paraméterként egy előzőleg megtalált komponenst kap, kimenete pedig az adott komponens alapvonala.

## BasicMetadataExtraction

```
public class Alairas.Common.BasicMetadataExtraction
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

### Methods

Type	Name	Summary
void	Run( Signature input)	
void	Transform( Signature signature)	

### Static Properties

Type	Name	Summary
Double	Trim	

## SimpleRenderingTransformation

Renders an image of the signature based on the available online information (X,Y,Dpi)

```
public class Alairas.Common.SimpleRenderingTransformation
: PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

#### Methods

Type	Name	Summary
void	Run( Signature input)	
void	Transform( Signature signature)	

## SigStat.Common.Algorithms

### Dtw

Dynamic Time Warping algorithm test

```
public class SigStat.Common.Algorithms.Dtw
```

#### Properties

Type	Name	Summary
List<ValueTuple<Int32, Int32>>	ForwardPath	Gets the list of points representing the shortest path.

#### Methods

Type	Name	Summary
Double	Compute( Double[][] signature1, Double[][] signature2)	Generate shortest path between the two sequences.

### DtwPy

```
public static class SigStat.Common.Algorithms.DtwPy
```

#### Static Methods

Type	Name	Summary
Double	Dtw( IEnumerable<P> sequence1, IEnumerable<P> sequence2, Func<P, P, Double> distance)	
Double	EuclideanDistance( Double[] p1, Double[] p2)	

### HSCPThinningStep

HSCP thinning algorithm <http://www.ppgia.pucpr.br/~facon/Afinamento/1987holt.pdf>  
(<http://www.ppgia.pucpr.br/~facon/Afinamento/1987holt.pdf>)

```
public class SigStat.Common.Algorithms.HSCPThinningStep
```

Properties

Type	Name	Summary
Nullable<Boolean>	ResultChanged	Gets whether the last SigStat.Common.Algorithms.HSCPThinningStep.Scan(System.Boolean[0,0,0,0,0,0,0,0,0]) call was effective.

Methods

Type	Name	Summary
Boolean[,]	Scan( Boolean[, ] b)	Does one step of the thinning. Call it iteratively while ResultChanged.

## PatternMatching3x3

Binary 3x3 pattern matcher with rotating option.

```
public class SigStat.Common.Algorithms.PatternMatching3x3
```

Methods

Type	Name	Summary
Boolean	Match( Boolean[, ] input)	Match the 3x3 input with the 3x3 pattern.
Boolean	RotMatch( Boolean[, ] input)	Match the 3x3 input with the 3x3 pattern from all 4 directions.

## SigStat.Common.Helpers

### ConfigurationHelper

```
public class SigStat.Common.Helpers.ConfigurationHelper
```

Static Methods

Type	Name	Summary
Configuration	Load()	

## ILogger

Enables logging by exposing a SigStat.Common.Helpers.Logger property.

```
public interface SigStat.Common.Helpers.ILogger
```

## Properties

Type	Name	Summary
Logger	Logger	Gets or sets the attached <code>SigStat.Common.Helpers.Logger</code> object used to log messages.

## IProgress

Enables progress tracking by expsoing the `SigStat.Common.Helpers.IProgress.Progress` property and the `SigStat.Common.Helpers.IProgress.ProgressChanged` event.

```
public interface SigStat.Common.Helpers.IProgress
```

## Properties

Type	Name	Summary
Int32	Progress	Gets the current progress in percentage.

## Events

Type	Name	Summary
EventHandler<Int32>	ProgressChanged	Invoked whenever the <code>SigStat.Common.Helpers.IProgress.Progress</code> property is changed.

## LogEntry

Represents a single entry of the log, consisting of a timestamp, a level, a sender and the message.

```
public class SigStat.Common.Helpers.LogEntry
```

## Fields

Type	Name	Summary
LogLevel	Level	Log level of the entry.

## Methods

Type	Name	Summary
String	ToString()	Format the contained data to string, divided by tab characters. Use this to display the entry in the console.

## Logger

A easy-to-use class to log pipeline messages, complete with filtering levels and multi-thread support.



```
public class SigStat.Common.Helpers.Logger
```

Properties

Type	Name	Summary
List<LogEntry>	Entries	
LogLevel	FilteringLevel	
IReadOnlyDictionary<String, Object>	ObjectEntries	
Boolean	StoreEntries	Enable or disable the storing of log entries. This can come useful for filtering by certain type of entries.

Methods

Type	Name	Summary
void	Debug( Object sender, String message)	Enqueue a debug level log entry.
void	EnqueueEntry( LogLevel messageLevel, Object sender, String message)	Enqueue a new log entry with specified level. The entry is filtered through SigStat.Common.Helpers.Logger.FilteringLevel .
void	Error( Object sender, String message)	Enqueue an error level log entry.
void	Fatal( Object sender, String message)	Enqueue a fatal level log entry.
void	Info( Object sender, String message)	Enqueue an information level log entry.
void	Info( Object sender, String key, Object infoObject)	Enqueue an information level log entry.
void	Stop()	Stop accepting entries, flush the queue and stop the consuming thread.
void	Warn( Object sender, String message)	Enqueue a warning level log entry.

# LogLevel

Represents the level of log. Lowest level: Off. Highest level: Debug.

```
public enum SigStat.Common.Helpers.LogLevel
    : Enum, IComparable, IFormattable, IConvertible
```

Enum

Value	Name	Summary
-------	------	---------

0	Off	Completely turn off logging.
1	Fatal	Represents a fatal error level log.
2	Error	Represents an error level log.
3	Warn	Represents a warning level log.
4	Info	Represents an information level log.
5	Debug	Represents a debug level log.

# SigStat.Common.Loaders

## DataSetLoader

Abstract loader class to inherit from. Implements ILogger.

```
public abstract class SigStat.Common.Loaders.DataSetLoader
: IDatasetLoader, ILogger
```

### Properties

Type	Name	Summary
Logger	Logger	

### Methods

Type	Name	Summary
IEnumerable<Signer>	EnumerateSigners()	
IEnumerable<Signer>	EnumerateSigners( Predicate<Signer> signerFilter)	
void	Log( LogLevel level, String message)	

## IDatasetLoader

Exposes a function to enable loading collections of SigStat.Common.Signer s. Base abstract class: SigStat.Common.Loaders.DataSetLoader .

```
public interface SigStat.Common.Loaders.IDatasetLoader
```

### Methods

Type	Name	Summary
IEnumerable<Signer>	EnumerateSigners()	Loads the database and returns the collection of SigStat.Common.Signer s that match the .

IEnumerable<Signer>	EnumerateSigners( Predicate<Signer> signerFilter)	Loads the database and returns the collection of SigStat.Common.Signer s that match the .
---------------------	---	---

## ImageLoader

DataSetLoader for Image type databases. Similar format to Svc2004Loader, but finds png images.

```
public class SigStat.Common.Loaders.ImageLoader
    : DataSetLoader, IDatasetLoader, ILogger
```

### Methods

Type	Name	Summary
IEnumerable<Signer>	EnumerateSigners( Predicate<Signer> signerFilter)	

### Static Methods

Type	Name	Summary
void	LoadImage( Signature signature, String file)	Load one image.
Signature	LoadSignature( String file)	

## ImageSaver

Get the SigStat.Common.Features.Image of a SigStat.Common.Signature and save it as png file.

```
public static class SigStat.Common.Loaders.ImageSaver
```

### Static Methods

Type	Name	Summary
void	Save( Signature signature, String path)	Saves a png image file to the specified .

## Svc2004

Set of features containing raw data loaded from SVC2004-format database.

```
public static class SigStat.Common.Loaders.Svc2004
```

### Static Fields

Type	Name	Summary
FeatureDescriptor<List<Int32>>	Altitude	
FeatureDescriptor<List<Int32>>	Azimuth	

FeatureDescriptor<List<Int32>>	Button	
FeatureDescriptor<List<Int32>>	Pressure	
FeatureDescriptor<List<Int32>>	T	
FeatureDescriptor<List<Int32>>	X	
FeatureDescriptor<List<Int32>>	Y	

## Svc2004Loader

Loads SVC2004-format database from .zip

```
public class SigStat.Common.Loaders.Svc2004Loader
    : DataSetLoader, IDatasetLoader, ILogger
```

Properties

Type	Name	Summary
Predicate<Signer>	SignerFilter	

Methods

Type	Name	Summary
IEnumerable<Signer>	EnumerateSigners( Predicate<Signer> signerFilter)	

Static Methods

Type	Name	Summary
void	LoadSignature( Signature signature, String path, Boolean standardFeatures)	Loads one signature from specified file path.
void	LoadSignature( Signature signature, Stream stream, Boolean standardFeatures)	Loads one signature from specified file path.

## SigStat.Common

### ArrayExtension

```
public static class SigStat.Common.ArrayExtension
```

Static Methods

Type	Name	Summary
T[]	Clone(this T[] array)	
T[][]	CreateNested( Int32 length1, Int32 length2)	

T[]	ForEach(this T[] array, Action<T> action)	Performs a given action on all items of the array and returns the original array.
IEnumerable<T>	GetColumn(this T[,] array, Int32 colIndex)	
T[,]	GetPart(this T[,] source, Int32 startIndex1, Int32 startIndex2, Int32 length1, Int32 length2)	
IEnumerable<T>	GetRow(this T[,] array, Int32 rowIndex)	
Tuple<Int32, Int32>	IndexOf(this Int32[,] array, Int32 value)	
Tuple<Int32, Int32>	IndexOf(this Double[,] array, Double value)	
Int32	IndexOf(this T[] array, T value)	
Int32	Max(this Int32[,] array)	
Byte	Max(this Byte[,] array)	
Double	Max(this Double[,] array)	
void	SetColumn(this T[,] array, Int32 x, T value)	
void	SetRow(this T[,] array, Int32 y, T value)	
T[,]	SetValues(this T[,] array, T value)	
T[]	Shuffle(this T[] array)	

## Baseline

```
public class SigStat.Common.Baseline
```

### Properties

Type	Name	Summary
PointF	End	
PointF	Start	

### Methods

Type	Name	Summary
String	ToString()	

## Configuration

```
public class SigStat.Common.Configuration
```

#### Properties

Type	Name	Summary
String	DatabaseFolder	
Lazy<Configuration>	Default	

## DataSet

---

```
public class SigStat.Common.DataSet
```

#### Properties

Type	Name	Summary
List<Signer>	Signers	

## FeatureAttribute

---

```
public class SigStat.Common.FeatureAttribute  
    : Attribute, _Attribute
```

#### Properties

Type	Name	Summary
String	FeatureKey	

## FeatureDescriptor

---

Represents a feature with name and type.

```
public class SigStat.Common.FeatureDescriptor
```

#### Properties

Type	Name	Summary
Type	FeatureType	Gets or sets the type of the feature.
Boolean	IsCollection	Gets whether the type of the feature is List.
String	Key	Gets the unique key of the feature.
String	Name	Gets or sets a human readable name of the feature.

#### Methods

--	--	--

Type	Name	Summary
String	ToString()	Returns a string represenatation of the FeatureDescriptor

Static Fields

Type	Name	Summary
Dictionary<String, FeatureDescriptor>	descriptors	The static dictionary of all descriptors.

Static Methods

Type	Name	Summary
FeatureDescriptor	Get( String key)	Gets the SigStat.Common.FeatureDescriptor specified by . Throws System.Collections.Generic.KeyNotFoundException exception if there is no descriptor registered with the given key.
FeatureDescriptor<T>	Get( String key)	Gets the SigStat.Common.FeatureDescriptor specified by . Throws System.Collections.Generic.KeyNotFoundException exception if there is no descriptor registered with the given key.
Boolean	IsRegistered( String featureKey)	
FeatureDescriptor	Register( String featureKey, Type type)	

## FeatureDescriptor<T>

Represents a feature with the type type

```
public class SigStat.Common.FeatureDescriptor<T>
    : FeatureDescriptor
```

Static Methods

Type	Name	Summary
FeatureDescriptor<T>	Get( String key)	Gets the SigStat.Common.FeatureDescriptor 1 specified by ` . If the key is not registered yet, a new SigStat.Common.FeatureDescriptor 1` is automatically created with the given key and type.

## Features

Standard set of features.

`public static class SigStat.Common.Features`

Static Fields

Type	Name	Summary
<code>ReadOnlyList&lt;FeatureDescriptor&gt;</code>	All	
<code>FeatureDescriptor&lt;List&lt;Double&gt;&gt;</code>	Altitude	
<code>FeatureDescriptor&lt;List&lt;Double&gt;&gt;</code>	Azimuth	
<code>FeatureDescriptor&lt;RectangleF&gt;</code>	Bounds	
<code>FeatureDescriptor&lt;List&lt;Boolean&gt;&gt;</code>	Button	
<code>FeatureDescriptor&lt;Point&gt;</code>	Cog	
<code>FeatureDescriptor&lt;Int32&gt;</code>	Dpi	
<code>FeatureDescriptor&lt;Image&lt;Rgba32&gt;&gt;</code>	Image	
<code>FeatureDescriptor&lt;List&lt;Double&gt;&gt;</code>	Pressure	
<code>FeatureDescriptor&lt;List&lt;Double&gt;&gt;</code>	T	
<code>FeatureDescriptor&lt;Rectangle&gt;</code>	TrimmedBounds	
<code>FeatureDescriptor&lt;List&lt;Double&gt;&gt;</code>	X	
<code>FeatureDescriptor&lt;List&lt;Double&gt;&gt;</code>	Y	

# IClassification

Allows implementing a pipeline classifier item capable of logging, progress tracking and IO rewiring.

`public interface SigStat.Common.IClassification`  
`: ILogger, IProgress, IPipelineIO`

Methods

Type	Name	Summary
Double	<code>Pair( Signature signature1, Signature signature2)</code>	Executes the classification by pairing the parameters. This function gets called by the pipeline.

# IClassificationMethods

Extension methods for `SigStat.Common.IClassification` for convenient IO rewiring.

`public static class SigStat.Common.IClassificationMethods`

Static Methods

Type	Name	Summary
------	------	---------



IClassification	Input(this IClassification caller, FeatureDescriptor[] inputFeatures)	Sets the InputFeatures in a convenient way.
IClassification	Output(this IClassification caller, FeatureDescriptor[] outputFeatures)	Sets the OutputFeatures in a convenient way.

## ITransformation

Allows implementing a pipeline transform item capable of logging, progress tracking and IO rewiring.

```
public interface SigStat.Common.ITransformation
    : ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	Executes the transform on the parameter. This function gets called by the pipeline.

## ITransformationMethods

Extension methods for SigStat.Common.ITransformation for convenient IO rewiring.

```
public static class SigStat.Common.ITransformationMethods
```

Static Methods

Type	Name	Summary
ITransformation	Input(this ITransformation caller, FeatureDescriptor[] inputFeatures)	Sets the InputFeatures in a convenient way.
ITransformation	Output(this ITransformation caller, FeatureDescriptor[] outputFeatures)	Sets the OutputFeatures in a convenient way.

## Loop

```
public class SigStat.Common.Loop
```

Properties

Type	Name	Summary
RectangleF	Bounds	
PointF	Center	
List<PointF>	Points	

Methods

--	--	--

Type	Name	Summary
String	ToString()	

# MathHelper

```
public static class SigStat.Common.MathHelper
```

## Static Methods

Type	Name	Summary
Double	Min( Double d1, Double d2, Double d3)	Returns the smallest of the three double parameters

# Matrix

```
public static class SigStat.Common.Matrix
```

## Static Methods

Type	Name	Summary
E[,]	Evaluate( T[,] matrix, ItemEvaluator<E, T> evaluator)	
T[,]	FromTableRows( IEnumerable<DataRow> rows, Int32 ignoreColumns, Int32 ignoreRows)	Egy DataRow gyűjteményt átalakít egy kétdimenziós tömbbé. Az átalakítás során ignoreColumns oszlopot és ignoreRows sort figyelmen kívül hagy.
Point	GetCog( Double[,] weightMartix)	
IEnumerable<Point>	GetNeighbourPixels(this Point p)	
IEnumerable<Point>	GetNeighbours(this Point p, Point start, Int32 offset)	
Double	GetSum( Double[,] matrix, Int32 x1, Int32 y1, Int32 x2, Int32 y2)	
Double	GetSumCol( Double[,] matrix, Int32 col)	
Double	GetSumRow( Double[,] matrix, Int32 row)	
Boolean[,]	Invert(this Boolean[,] array)	returns a copy of the array with inverted values
Byte[,]	Neighbours( T[,] matrix, T emptyValue)	returns a same sized matrix with each item showing the neighbour

		count for the given position.
T[]	SetValues(this T[] array, T value)	
T[]	SetValues(this T[] array, Func<T, T> transformation)	

## Origin

Represents our knowledge on the origin of a signature.

```
public enum SigStat.Common.Origin
    : Enum, IComparable, IFormattable, IConvertible
```

Enum

Value	Name	Summary
0	Unknown	Use this in practice before a signature is verified.
1	Genuine	The SigStat.Common.Signature 's origin is verified to be from SigStat.Common.Signature.Signer
2	Forged	The SigStat.Common.Signature is a forgery.

## PipelineBase

TODO: Ideiglenes osztaly, C# 8.0 ban ezt atalakitani default implementacios interface be. IProgress, ILogger, IPipelineIO default implementacioja.

```
public abstract class SigStat.Common.PipelineBase
```

Properties

Type	Name	Summary
List<FeatureDescriptor>	InputFeatures	
Logger	Logger	
List<FeatureDescriptor>	OutputFeatures	
Int32	Progress	

Events

Type	Name	Summary
EventHandler<Int32>	ProgressChanged	

Methods

Type	Name	Summary

void	Log( LogLevel level, String message)	Enqueues a new log entry to be consumed by the attached SigStat.Common.Helpers.Logger . Use this when developing new pipeline items.
void	OnProgressChanged( Int32 v)	Used to raise base class event in derived classes. See explanation: Event docs link.

## Signature

Represents a signature as a collection of features, containing the data that flows in the pipeline.

```
public class SigStat.Common.Signature
```

### Properties

Type	Name	Summary
String	ID	An identifier for the Signature. Keep it unique to be useful for logs.
Object	Item	Gets or sets the specified feature.
Object	Item	Gets or sets the specified feature.
Origin	Origin	Represents our knowledge on the origin of the signature. SigStat.Common.Origin.Unknown may be used in practice before it is verified.
Signer	Signer	A reference to the SigStat.Common.Signer who this signature belongs to. (The origin is not constrained to be genuine.)

### Methods

Type	Name	Summary
List<Double[]>	GetAggregateFeature( List<FeatureDescriptor> fs)	Aggregate multiple features into a single feature. Example: X, Y features -> Z feature. Use this for example as input for a machine learning algorithm input.
T	GetFeature( String featureKey)	Gets the specified feature
T	GetFeature( FeatureDescriptor<T> featureDescriptor)	Gets the specified feature
T	GetFeature( FeatureDescriptor featureDescriptor)	Gets the specified feature
IEnumerable<FeatureDescriptor>	GetFeatureDescriptors()	Gets a collection of FeatureDescriptors that are used in this signature
Boolean	HasFeature( FeatureDescriptor featureDescriptor)	Returns true if the signature contains the specified feature
Boolean	HasFeature( String featureKey)	Returns true if the signature contains the specified feature

void	SetFeature( FeatureDescriptor featureDescriptor, T feature)	Sets the specified feature
void	SetFeature( String featureKey, T feature)	Sets the specified feature
String	ToString()	Returns a string representation of the signature

## Signer

Represents a person as a `SigStat.Common.Signer.ID` and a list of `SigStat.Common.Signer.Signatures`.

```
public class SigStat.Common.Signer
```

### Properties

Type	Name	Summary
String	ID	An identifier for the Signer. Keep it unique to be useful for logs.
List<Signature>	Signatures	List of signatures that belong to the signer. (Their origin is not constrained to be genuine.)

## Vector

```
public class SigStat.Common.Vector
```

### Properties

Type	Name	Summary
Double	Angle	
Double	B	
Rectangle	BoundingBox	
Rectangle	Bounds	
Point	COG	
Point	End	
Double	Length	
Point	Location	
Double	M	
Point	Start	
Int32	Vx	
Int32	Vy	
Int32	X	

Int32	X2	
Int32	Y	
Int32	Y2	

Methods

Type	Name	Summary
void	Add( Point p)	
Vector	Clone()	
Boolean	Equals( Object obj)	Két vektor akkor egyenlő, ha ugyanabból a pontból indulnak ki és ugyanabban az irányba mutatnak és hosszuk is megegyezik.
IEnumerator<VectorPoint>	GetEnumerator()	
Int32	GetHashCode()	
Double	GetLength()	
Vector	GetNormal()	Elofrgatja a vektort 90 fokkal a kezdőpontja körül az óramutató járásával megegyező irányba
Vector	GetNormal( Double length)	Elofrgatja a vektort 90 fokkal a kezdőpontja körül az óramutató járásával megegyező irányba
String	ToMatlabString()	
String	ToString()	

# SigStat.Common.Model

## ApproximateLimit

Used to approximate the classification limit in the training process.

```
public class SigStat.Common.Model.ApproximateLimit
```

Methods

Type	Name	Summary
Double	Calculate( List<Signature> sigs)	Calculate the limit by pairing each signature. Limit = AverageCost + StdDeviation.

## BenchmarkResults

Contains the benchmark results of every SigStat.Common.Signer and the summarized final results.

```
public struct SigStat.Common.Model.BenchmarkResults
```

#### Fields

Type	Name	Summary
Result	FinalResult	Summarized, final result of the benchmark execution.
List<Result>	SignerResults	List that contains the <code>SigStat.Common.Model.Result</code> s for each <code>SigStat.Common.Signer</code>

## Result

Contains the benchmark results of a single `SigStat.Common.Signer`

```
public class SigStat.Common.Model.Result
```

#### Fields

Type	Name	Summary
Double	Aer	Average Error Rate
Double	Far	False Acceptance Rate
Double	Frr	False Rejection Rate
String	Signer	Identifier of the <code>SigStat.Common.Model.Result.Signer</code>

## Sampler

Takes samples from a set of `SigStat.Common.Signature` s by given sampling strategies. Use this to fine-tune the `SigStat.Common.Model.VerifierBenchmark`

```
public class SigStat.Common.Model.Sampler
```

#### Methods

Type	Name	Summary
void	Init( <code>Signer</code> s)	Initialize the Sampler with a Signer's Signatures.
void	Init( <code>List&lt;Signature&gt;</code> s)	Initialize the Sampler with a Signer's Signatures.
<code>List&lt;Signature&gt;</code>	SampleForgeryTests()	Samples a batch of forged signatures to test on.
<code>List&lt;Signature&gt;</code>	SampleGenuineTests()	Samples a batch of genuine signatures to test on.
<code>List&lt;Signature&gt;</code>	SampleReferences()	Samples a batch of genuine reference signatures to train on.

#### Static Properties

--	--	--

Type	Name	Summary
Sampler	BasicSampler	Default sampler for SVC2004 database. 10 references, 10 genuine tests, 10 forged tests

## ThresholdResult

```
public class SigStat.Common.Model.ThresholdResult
    : Result
```

## Verifier

Uses pipelines to transform, train on, and classify `SigStat.Common.Signature` objects.

```
public class SigStat.Common.Model.Verifier
    : ILogger, IProgress
```

### Properties

Type	Name	Summary
IClassification	ClassifierPipeline	Gets or sets the classifier pipeline. Hands over the Logger object.
Logger	Logger	Gets or sets the attached <code>SigStat.Common.Helpers.Logger</code> object used to log messages. Hands it over to the pipelines.
Int32	Progress	
ITransformation	TransformPipeline	Gets or sets the transform pipeline. Hands over the Logger object.

### Events

Type	Name	Summary
EventHandler<Int32>	ProgressChanged	

### Methods

Type	Name	Summary
void	Log( LogLevel level, String message)	Enqueues a new log entry to be consumed by the attached <code>SigStat.Common.Helpers.Logger</code> . Use this when developing new pipeline items.
void	LoggerChanged( Logger oldLogger, Logger newLogger)	
Boolean	Test( Signature sig)	Verifies the genuinity of .
void	Train( Signer signer)	Trains the verifier with <code>SigStat.Common.Signer.Signatures</code> having <code>SigStat.Common.Origin.Genuine</code> property.



void	Train( List<Signature> sigs)	Trains the verifier with SigStat.Common.Signer.Signatures having SigStat.Common.Origin.Genuine property.
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Static Properties

Type	Name	Summary
Verifier	BasicVerifier	Basic SigStat.Common.Model.Verifier model with DTW classification of tangent features.

# VerifierBenchmark

Benchmarking class to test error rates of a SigStat.Common.Model.Verifier

```
public class SigStat.Common.Model.VerifierBenchmark
    : ILogger, IProgress
```

Properties

Type	Name	Summary
IDatasetLoader	Loader	
Logger	Logger	Gets or sets the attached SigStat.Common.Helpers.Logger object used to log messages. Hands it over to the verifier.
Int32	Progress	
Sampler	Sampler	
Verifier	Verifier	Gets or sets the SigStat.Common.Model.Verifier to be benchmarked.

Events

Type	Name	Summary
EventHandler<Int32>	ProgressChanged	

Methods

Type	Name	Summary
BenchmarkResults	Execute()	Synchronously execute the benchmarking process.
BenchmarkResults	ExecuteParallel()	Parallel execute the benchmarking process.
void	Log( LogLevel level, String message)	

Static Methods

Type	Name	Summary

Task<Int32>	ExecuteAsync()	Asynchronously execute the benchmarking process.
-------------	----------------	--

# SigStat.Common.Pipeline

## IClassificationModel

Analyzes signatures based on their similiarity to the trained model

```
public interface SigStat.Common.Pipeline.IClassificationModel
```

Methods

Type	Name	Summary
Double	Test( Signature signature)	Returns a double value in the range [0..1], representing the probability of the given signature belonging to the trained model. 0: non-match0.5: inconclusive1: match

## IClassifier

Trains classification models based on reference signatures

```
public interface SigStat.Common.Pipeline.IClassifier
```

Methods

Type	Name	Summary
IClassificationModel	Train( List<Signature> signatures)	Trains a model based on the signatures and returns the trained model

## IPipelineIO

Gives ability to get or set (rewire) a pipeline item's default input and output features.

```
public interface SigStat.Common.Pipeline.IPipelineIO
```

Properties

Type	Name	Summary
List<FeatureDescriptor>	InputFeatures	List of features to be used as input.
List<FeatureDescriptor>	OutputFeatures	List of features to be used as output.

## ParallelTransformPipeline

Runs pipeline items in parallel. Default Pipeline Output: Range of all the Item outputs.

```
public class SigStat.Common.Pipeline.ParallelTransformPipeline
    : PipelineBase, IEnumerable, ITransformation, ILogger, IProgress, IPipelineIO
```

## Properties

Type	Name	Summary
List<ITransformation>	Items	
Logger	Logger	Passes Logger to child items as well.
Int32	Progress	Gets the minimum progress of all the child items.

## Methods

Type	Name	Summary
void	Add( ITransformation newItem)	Add new transform to the list. Pass SigStat.Common.Pipeline.ParallelTransformPipeline.Logger and set up Progress event.
IEnumerator	GetEnumerator()	
void	Transform( Signature signature)	Executes transform SigStat.Common.Pipeline.ParallelTransformPipeline.Items parallel. Passes input features for each. Output is a range of all the Item outputs.

# SequentialTransformPipeline

Runs pipeline items in a sequence. Default Pipeline Output: Output of the last Item in the sequence.

```
public class SigStat.Common.Pipeline.SequentialTransformPipeline
    : PipelineBase, IEnumerable, ITransformation, ILogger, IProgress, IPipelineIO
```

## Properties

Type	Name	Summary
List<ITransformation>	Items	
Logger	Logger	Passes Logger to child items as well.

## Methods

Type	Name	Summary
void	Add( ITransformation newItem)	Add new transform to the list. Pass SigStat.Common.Pipeline.SequentialTransformPipeline.Logger and set up Progress event.
IEnumerator	GetEnumerator()	
		Executes transform

void	Transform( Signature signature)	SigStat.Common.Pipeline.SequentialTransformPipeline.Items in sequence. Passes input features for each. Output is the output of the last Item in the sequence.
------	---------------------------------	---

# SigStat.Common.PipelineItems.Classifiers

## DTWClassifier

Classifies Signatures with the SigStat.Common.Algorithms.Dtw algorithm.

```
public class SigStat.Common.PipelineItems.Classifiers.DTWClassifier
    : PipelineBase, IClassification, ILogger, IProgress, IPipelineIO, IEnumerable
```

### Methods

Type	Name	Summary
void	Add( FeatureDescriptor f)	
IEnumerator	GetEnumerator()	
Double	Pair( Signature signature1, Signature signature2)	Aggregates the input features and executes the SigStat.Common.Algorithms.Dtw algorithm.

## WeightedClassifier

Classifies Signatures by weighing other Classifier results.

```
public class SigStat.Common.PipelineItems.Classifiers.WeightedClassifier
    : PipelineBase, IEnumerable, IClassification, ILogger, IProgress, IPipelineIO
```

### Fields

Type	Name	Summary
List<ValueTuple<IClassification, Double>>	Items	List of classifiers and belonging weights.

### Properties

Type	Name	Summary
Logger	Logger	Gets or sets the Logger. Passes it to child Items as well.

### Methods

Type	Name	Summary
void	Add( ValueTuple<IClassification, Double> newItem)	Add a new classifier with given weight to the list of items.
IEnumerator	GetEnumerator()	

Double	Pair( Signature signature1, Signature signature2)	Execute each classifier in the list and weigh returned costs.
--------	---	---

# SigStat.Common.PipelineItems.Markers

## LogMarker

Logs the Pipeline Input. Useful for logging TimeMarker results. Default Pipeline Output: -

```
public class SigStat.Common.PipelineItems.Markers.LogMarker
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## TimeMarkerStart

Starts a timer to measure completion time of following transforms. Default Pipeline Output: ( System.DateTime )  
DefaultTimer

```
public class SigStat.Common.PipelineItems.Markers.TimeMarkerStart
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## TimeMarkerStop

Stops a timer to measure completion time of previous transforms. Default Pipeline Output: ( System.DateTime )  
DefaultTimer

```
public class SigStat.Common.PipelineItems.Markers.TimeMarkerStop
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# SigStat.Common.Transforms

## AddConst

Adds a constant value to a feature. Works with collection features too. Default Pipeline Output: Pipeline Input

```
public class SigStat.Common.Transforms.AddConst
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## AddVector

Adds a vector feature's elements to other features. Default Pipeline Output: Pipeline Input

```
public class SigStat.Common.Transforms.AddVector
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## ApproximateOnlineFeatures

init Pressure, Altitude, Azimuth features with default values. Default Pipeline Output: Features.Pressure, Features.Altitude, Features.Azimuth

```
public class SigStat.Common.Transforms.ApproximateOnlineFeatures
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## Binarization

Generates a binary raster version of the input image with the iterative threshold method. Pipeline Input type: Image{Rgb32}Default Pipeline Output: (bool[,]) Binarized

```
public class SigStat.Common.Transforms.Binarization
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# BinaryRasterizer

---

Converts standard features to a binary raster. Default Pipeline Input: Standard

SigStat.Common.Features Default Pipeline Output: (bool[,]) Binarized

```
public class SigStat.Common.Transforms.BinaryRasterizer
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## CentroidExtraction

---

Extracts the Centroid (aka. Center Of Gravity) of the input features. Default Pipeline Output: (List{double})

Centroid.

```
public class SigStat.Common.Transforms.CentroidExtraction
    : PipelineBase, IEnumerable, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Add( FeatureDescriptor<List<Double>> newitem)	
IEnumerator	GetEnumerator()	
void	Transform( Signature signature)	

## CentroidTranslate

---

Sequential pipeline to translate X and Y SigStat.Common.Features to Centroid. The following Transforms are

called: SigStat.Common.Transforms.CentroidExtraction , SigStat.Common.Transforms.Multiply (-1),

SigStat.Common.Transforms.Translate Default Pipeline Input: SigStat.Common.Features.X ,

SigStat.Common.Features.Y Default Pipeline Output: (List{double}) Centroid

```
public class SigStat.Common.Transforms.CentroidTranslate
    : SequentialTransformPipeline, IEnumerable, ITransformation, ILogger, IProgress, IPipelineIO
```

## ComponentExtraction

---

Extracts unsorted components by tracing through the binary Skeleton raster. Default Pipeline Input: (bool[,])

Skeleton, (List{Point}) EndPoints, (List{Point}) CrossingPointsDefault Pipeline Output: (List{List{PointF}})

Components

```
public class SigStat.Common.Transforms.ComponentExtraction
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# ComponentSorter

Sorts Component order by comparing each starting X value, and finding nearest components. Default Pipeline Input: (bool[,]) ComponentsDefault Pipeline Output: (bool[,]) Components

```
public class SigStat.Common.Transforms.ComponentSorter
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# ComponentsToFeatures

Extracts standard SigStat.Common.Features from sorted Components. Default Pipeline Input: (List{List{PointF}}) ComponentsDefault Pipeline Output: X, Y, Button SigStat.Common.Features

```
public class SigStat.Common.Transforms.ComponentsToFeatures
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# EndpointExtraction

Extracts EndPoints and CrossingPoints from Skeleton. Default Pipeline Input: (bool[,]) SkeletonDefault Pipeline Output: (List{Point}) EndPoints, (List{Point}) CrossingPoints

```
public class SigStat.Common.Transforms.EndpointExtraction
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# Extrema



Extracts minimum and maximum values of given feature. Default Pipeline Output: (List{double}) Min, (List{double}) Max

```
public class SigStat.Common.Transforms.Extrema
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## HSCPThinning

Iteratively thins the input binary raster with the SigStat.Common.Algorithms.HSCPThinningStep algorithm. Pipeline Input type: bool[,]Default Pipeline Output: (bool[,]) HSCPThinningResult

```
public class SigStat.Common.Transforms.HSCPThinning
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## ImageGenerator

Generates an image feature out of a binary raster. Optionally, saves the image to a png file. Useful for debugging pipeline steps. Pipeline Input type: bool[,]Default Pipeline Output: (bool[,]) Input, (Image{Rgba32}) InputImage

```
public class SigStat.Common.Transforms.ImageGenerator
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## Map

Maps values of a feature to a specified range. Pipeline Input type: List{double}Default Pipeline Output: (List{double}) MapResult

```
public class SigStat.Common.Transforms.Map
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

--	--	--

Type	Name	Summary
void	Transform( Signature signature)	

## Multiply

Multiplies the values of a feature with a given constant. Pipeline Input type: List{double}Default Pipeline Output: (List{double}) Input

```
public class SigStat.Common.Transforms.Multiply
    : PipelineBase, IEnumerable, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Add( FeatureDescriptor newItem)	
IEnumerator	GetEnumerator()	
void	Transform( Signature signature)	

## Normalize

Maps values of a feature to 0.0 - 1.0 range. Pipeline Input type: List{double}Default Pipeline Output: (List{double}) NormalizationResult

```
public class SigStat.Common.Transforms.Normalize
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## OnePixelThinning

Iteratively thins the input binary raster with the SigStat.Common.Algorithms.OnePixelThinningStep algorithm. Pipeline Input type: bool[,]Default Pipeline Output: (bool[,]) OnePixelThinningResult

```
public class SigStat.Common.Transforms.OnePixelThinning
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## PrepareForThinning

```
public class SigStat.Common.Transforms.PrepareForThinning
: PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# RealisticImageGenerator

Generates a realistic looking image of the Signature based on standard features. Uses blue ink and white paper. It does NOT save the image to file. Default Pipeline Input: X, Y, Button, Pressure, Azimuth, Altitude  
SigStat.Common.Features Default Pipeline Output: SigStat.Common.Features.Image

```
public class SigStat.Common.Transforms.RealisticImageGenerator
: PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# Resize

Resizes the image to a specified width and height

```
public class SigStat.Common.Transforms.Resize
: PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Properties

Type	Name	Summary
Nullable<Int32>	Height	The new height. Leave it as null, if you do not want to explicitly specify a given height
Func<Image<Rgba32>, Size>	ResizeFunction	Set a resize function if you want to dynamically calculate the new width and height of the image
Nullable<Int32>	Width	The new width. Leave it as null, if you do not want to explicitly specify a given width

Methods

Type	Name	Summary
void	Transform( Signature signature)	

# TangentExtraction

Extracts tangent values of the standard X, Y SigStat.Common.Features Default Pipeline Input: X, Y  
SigStat.Common.Features Default Pipeline Output: (List{double}) Tangent

```
public class SigStat.Common.Transforms.TangentExtraction
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	

## TimeReset

Sequential pipeline to reset time values to begin at 0. The following Transforms are called: Extrema, Multiply, AddVector. Default Pipeline Input: SigStat.Common.Features.T Default Pipeline Output: SigStat.Common.Features.T

```
public class SigStat.Common.Transforms.TimeReset
    : SequentialTransformPipeline, IEnumerable, ITransformation, ILogger, IProgress, IPipelineIO
```

## Translate

Sequential pipeline to translate X and Y SigStat.Common.Features by specified vector (constant or feature). The following Transforms are called: SigStat.Common.Transforms.AddConst twice, or SigStat.Common.Transforms.AddVector . Default Pipeline Input: SigStat.Common.Features.X , SigStat.Common.Features.Y Default Pipeline Output: SigStat.Common.Features.X , SigStat.Common.Features.Y

```
public class SigStat.Common.Transforms.Translate
    : SequentialTransformPipeline, IEnumerable, ITransformation, ILogger, IProgress, IPipelineIO
```

## Trim

Trims unnecessary empty space from a binary raster. Pipeline Input type: bool[,.]Default Pipeline Output: (bool[,]) Trimmed

```
public class SigStat.Common.Transforms.Trim
    : PipelineBase, ITransformation, ILogger, IProgress, IPipelineIO
```

Methods

Type	Name	Summary
void	Transform( Signature signature)	