Athena

0.1

Generated by Doxygen 1.8.14

Contents

Chapter 1

Hierarchical Index

1.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 2

Class Index

2.1 Class List

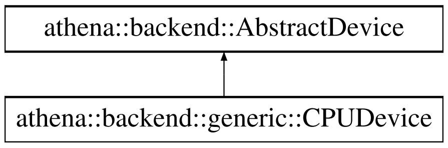
Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 3

Class Documentation

3.1 athena::backend::AbstractDevice Class Reference

Inheritance diagram for athena::backend::AbstractDevice:


athena::backend::AbstractDevice
athena::backend::generic::CPUDevice

Public Member Functions

- unsigned long **getMaxThreadMemSize** ()
- void **setMaxThreadMemSize** (unsigned long size=0)
- virtual AbstractMemoryManager $*$ **getMemoryManager** ()=0

Protected Attributes

- unsigned long **maxThreadMemorySize**
- unsigned long **maxThreads**
- unsigned long **memorySize**

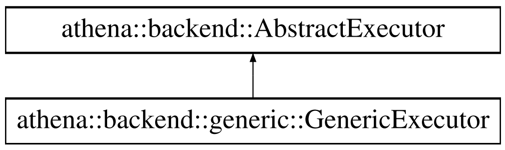
The documentation for this class was generated from the following files:

- backend/AbstractDevice.h
- backend/AbstractDevice.cpp

3.2 athena::backend::AbstractExecutor Class Reference

```
#include <AbstractExecutor.h>
```

Inheritance diagram for athena::backend::AbstractExecutor:


athena::backend::AbstractExecutor
athena::backend::generic::GenericExecutor

Public Member Functions

- virtual void execute ()=0
- virtual AbstractMemoryManager $*$ getMemoryManager ()=0
- void setBytecode (std::vector$<$ vm_word $>$ &bytecode)

Protected Attributes

- std::vector$<$ vm_word $>$ **bytecode**

3.2.1 Detailed Description

An Executor is a Virtual Machine that runs Athena `bytecode`. AbstractExecutor is the base class for all executors.

3.2.2 Member Function Documentation

3.2.2.1 execute()

```
virtual void athena::backend::AbstractExecutor::execute ( )  [pure virtual]
```

Executes current bytecode. After execution threads state must be reset. However, memory state (Memory manager and its data) must persist.

Implemented in athena::backend::generic::GenericExecutor.

3.2.2.2 getMemoryManager()

```
virtual AbstractMemoryManager* athena::backend::AbstractExecutor::getMemoryManager ( )  [pure
virtual]
```

Returns

Memory Manager for current device

Implemented in athena::backend::generic::GenericExecutor.

3.2.2.3 setBytecode()

```
void athena::backend::AbstractExecutor::setBytecode (
             std::vector< vm_word > & bytecode )
```

Sets new bytecode

Parameters

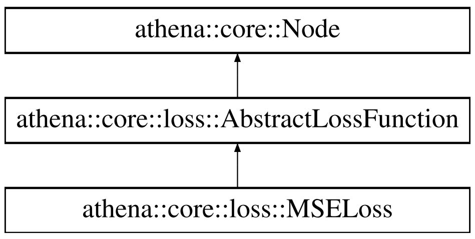
bytecode	Bytecode

The documentation for this class was generated from the following files:

- backend/AbstractExecutor.h
- backend/AbstractExecutor.cpp

3.3 athena::core::loss::AbstractLossFunction Class Reference

Inheritance diagram for athena::core::loss::AbstractLossFunction:


athena::core::Node
athena::core::loss::AbstractLossFunction
athena::core::loss::MSELoss

Public Member Functions

- **AbstractLossFunction** (OpKernel ∗)

Additional Inherited Members

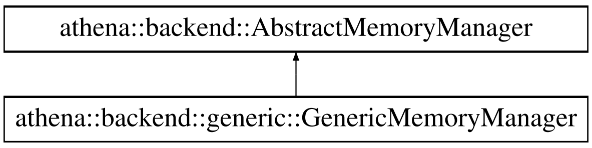
The documentation for this class was generated from the following files:

- core/loss/AbstractLossFunction.h
- core/loss/AbstractLossFunction.cpp

3.4 athena::backend::AbstractMemoryManager Class Reference

```
#include <AbstractMemoryManager.h>
```

Inheritance diagram for athena::backend::AbstractMemoryManager:


athena::backend::AbstractMemoryManager
athena::backend::generic::GenericMemoryManager

Public Member Functions

- void resetTable ()
- void addTensor (athena::core::Tensor ∗tensor)
- virtual void ∗ getPhysicalAddress (vm_word virtualAddress)=0
- void **load** (athena::core::Tensor ∗tensor)
- void **load** (vm_word address)
- virtual void load (vm_word address, unsigned long length)=0
- virtual void unlock (vm_word address)=0
- virtual void deleteFromMem (vm_word address)=0
- athena::core::Tensor ∗ **getTensor** (vm_word address)

Protected Attributes

- std::list< athena::core::Tensor ∗> **tensors**

3.4.1 Detailed Description

This class is an interface for physical memory managers. They provide conversion between virtual addresses and physical ones. A typical strategy for memory manager is to allocate as much memory as possible and then provide tensors with it. This class also encapsulates table of athena::core::Tensor objects. One can think of it as of variables table in a compiler.

3.4.2 Member Function Documentation

3.4.2.1 addTensor()

```
void athena::backend::AbstractMemoryManager::addTensor (
            athena::core::Tensor ∗ tensor )
```

Adds Tensor to table

Parameters

tensor	Tensor, that will be added

3.4.2.2 deleteFromMem()

```
virtual void athena::backend::AbstractMemoryManager::deleteFromMem (
            vm_word address )  [pure virtual]
```

Mark corresponding memory chunk as free

Parameters

address	Virtual address

Implemented in athena::backend::generic::GenericMemoryManager.

3.4.2.3 getPhysicalAddress()

```
virtual void* athena::backend::AbstractMemoryManager::getPhysicalAddress (
            vm_word virtualAddress )  [pure virtual]
```

Convert virtual address to physical one

Parameters

virtualAddress	Virtual address, unsigned long from 0 to 2^64-1

Returns

Pointer to physical memory

Implemented in athena::backend::generic::GenericMemoryManager.

3.4.2.4 load()

```
virtual void athena::backend::AbstractMemoryManager::load (
            vm_word address,
            unsigned long length )  [pure virtual]
```

Move data to the fastest memory type available (e.g. from hard drive to RAM) and lock it (prevent from being offloaded)

Parameters

address	Virtual address
length	Size of Tensor in bytes

Implemented in athena::backend::generic::GenericMemoryManager.

3.4.2.5 resetTable()

```
void athena::backend::AbstractMemoryManager::resetTable ( )
```

Clears table of Tensors

3.4.2.6 unlock()

```
virtual void athena::backend::AbstractMemoryManager::unlock (
             vm_word address )  [pure virtual]
```

Lets data be offloaded to a slower memory type (e.g. from RAM to HDD)

Parameters

address	Virtual address

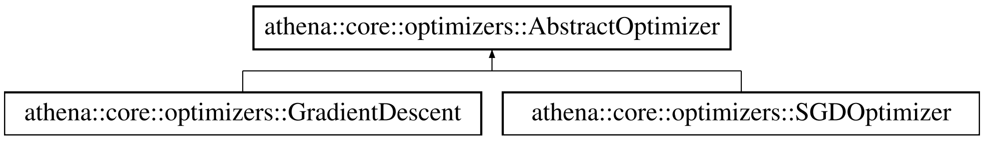
Implemented in athena::backend::generic::GenericMemoryManager.

The documentation for this class was generated from the following files:

- backend/AbstractMemoryManager.h
- backend/AbstractMemoryManager.cpp

3.5 athena::core::optimizers::AbstractOptimizer Class Reference

Inheritance diagram for athena::core::optimizers::AbstractOptimizer:


athena::core::optimizers::AbstractOptimizer
athena::core::optimizers::GradientDescent
athena::core::optimizers::SGDOptimizer

Public Member Functions

- **AbstractOptimizer** (athena::core::loss::AbstractLossFunction ∗loss)
- void **init** (Session ∗session)
- virtual void **prepare** ()=0
- virtual void **minimize** ()=0

Protected Attributes

- std::vector< InputNode ∗> **headNodes**
- std::vector< vm_word > **bytecode**
- unsigned long **lastResultCell**
- Session ∗ **session**
- athena::core::loss::AbstractLossFunction ∗ **loss**

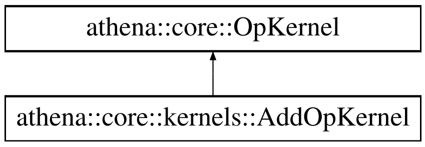
The documentation for this class was generated from the following files:

- core/optimizers/AbstractOptimizer.h
- core/optimizers/AbstractOptimizer.cpp

3.6 athena::core::kernels::AddOpKernel Class Reference

```
#include <AddOpKernel.h>
```

Inheritance diagram for athena::core::kernels::AddOpKernel:



Public Member Functions

- int getOperandsCount () override
- athena::core::TensorShape & getOutputShape (std::vector< athena::core::TensorShape > &shapes) override
- athena::core::TensorShape & getDerivativeShape (int d, std::vector< athena::core::TensorShape > &shapes) override
- std::vector< vm_word > **getOpBytecode** (std::vector< vm_word > args, vm_word resultCell) override
- std::vector< vm_word > getDerivativeBytecode (int d, std::vector< vm_word > args, vm_word resultCell) override

Additional Inherited Members

3.6.1 Detailed Description

Performs sum of 2 given Tensors

3.6.2 Member Function Documentation

3.6.2.1 getDerivativeBytecode()

```
std::vector< unsigned long > athena::core::kernels::AddOpKernel::getDerivativeBytecode (
            int d,
            std::vector< vm_word > args,
            vm_word resultCell ) [override], [virtual]
```

Generates bytecode to calculate partial derivative

Parameters

d	Number of variable with respect to which derivative is calculated
args	Function arguments
resultCell	Number of memory cell where results are saved

Returns

Implements athena::core::OpKernel.

3.6.2.2 getDerivativeShape()

```
athena::core::TensorShape & athena::core::kernels::AddOpKernel::getDerivativeShape (
            int d,
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

3.6.2.3 getOperandsCount()

```
int athena::core::kernels::AddOpKernel::getOperandsCount ( )  [override], [virtual]
```

There can be unary, binary and other operations

Returns

Number of operands accepted

Implements athena::core::OpKernel.

3.6.2.4 getOutputShape()

```
athena::core::TensorShape & athena::core::kernels::AddOpKernel::getOutputShape (
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

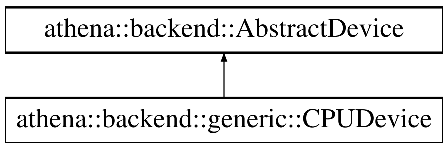
The documentation for this class was generated from the following files:

- core/kernels/AddOpKernel.h
- core/kernels/AddOpKernel.cpp

3.7 athena::backend::generic::CPUDevice Class Reference

```
#include <CPUDevice.h>
```

Inheritance diagram for athena::backend::generic::CPUDevice:


athena::backend::AbstractDevice
athena::backend::generic::CPUDevice

Public Member Functions

- AbstractMemoryManager ∗ **getMemoryManager** () override

Additional Inherited Members

3.7.1 Detailed Description

This class represents a CPU It encapsulates Memory Manager

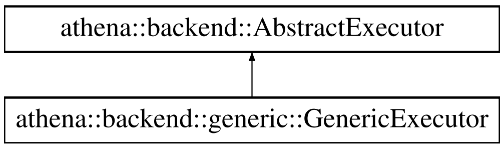
The documentation for this class was generated from the following files:

- backend/generic/CPUDevice.h
- backend/generic/CPUDevice.cpp

3.8 athena::backend::generic::GenericExecutor Class Reference

`#include <GenericExecutor.h>`

Inheritance diagram for athena::backend::generic::GenericExecutor:


athena::backend::AbstractExecutor
athena::backend::generic::GenericExecutor

Public Member Functions

- **GenericExecutor** (CPUDevice ∗cpuDevice)
- void execute () override
- AbstractMemoryManager ∗ getMemoryManager () override

Additional Inherited Members

3.8.1 Detailed Description

GenericExecutor is the state of the art implementation of AbstractExecutor. While we try to make it work fast, the main goal of this implementation is to be mathematically correct and provide an example for more specific implementation.

GenericExecutor executes `bytecode` with standard CPU device. The actual implementations of bytecode commands use BLAS to speed up calculations. There are several accelerators available:

- `Apple Accelerate Framework`
- `OpenBLAS`
- `BLIS`

You can configure them during compile time. Other accelerators may be added later.

3.8.2 Member Function Documentation

3.8.2.1 execute()

```
void athena::backend::generic::GenericExecutor::execute ( )  [override], [virtual]
```

Executes current bytecode. After execution threads state must be reset. However, memory state (Memory manager and its data) must persist.

Implements athena::backend::AbstractExecutor.

3.8.2.2 getMemoryManager()

```
athena::backend::AbstractMemoryManager * athena::backend::generic::GenericExecutor::getMemory↩
Manager ( )  [override], [virtual]
```

Returns

Memory Manager for current device

Implements athena::backend::AbstractExecutor.

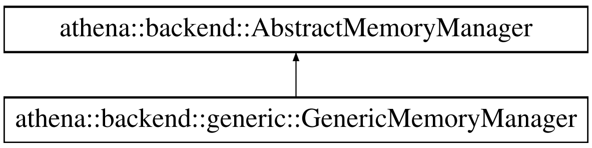
The documentation for this class was generated from the following files:

- backend/generic/GenericExecutor.h
- backend/generic/GenericExecutor.cpp

3.9 athena::backend::generic::GenericMemoryManager Class Reference

```
#include <GenericMemoryManager.h>
```

Inheritance diagram for athena::backend::generic::GenericMemoryManager:


athena::backend::AbstractMemoryManager
athena::backend::generic::GenericMemoryManager

Public Member Functions

- void init ()
- void deinit ()
- void ∗ getPhysicalAddress (vm_word virtualAddress) override
- void load (vm_word address, unsigned long length) override
- void unlock (vm_word address) override
- void deleteFromMem (vm_word address) override
- void **setMemSize** (size_t memSize)
- void **load** (athena::core::Tensor ∗tensor)
- void **load** (vm_word address)
- virtual void load (vm_word address, unsigned long length)=0

Protected Member Functions

- void processQueue (int laneId)

Protected Attributes

- std::list< SwapRecord ∗> **swapRecords**
- MemoryChunk ∗ **memoryChunksHead**
- void ∗ **memory**
- std::mutex **memoryChunksLock**
- std::vector< std::thread > **memLanes**
- size_t **allocatedMemory**
- std::queue< QueueItem ∗> **loadQueue**
- std::vector< bool > **laneFinished**

3.9.1 Detailed Description

This class implements AbstractMemoryManager interface for GenericExecutor. It pre-allocates RAM and uses persistent memory for swap. There are couple memory lanes - threads, that manage RAM. They monitor load←Queue for new queries and move data from hard drive to RAM if needed.

3.9.2 Member Function Documentation

3.9.2.1 deinit()

```
void athena::backend::generic::GenericMemoryManager::deinit ( )
```

Free RAM and stop all threads-memory lanes

3.9.2.2 deleteFromMem()

```
void athena::backend::generic::GenericMemoryManager::deleteFromMem (
             vm_word address )  [override], [virtual]
```

Mark corresponding memory chunk as free

Parameters

address	Virtual address

Implements athena::backend::AbstractMemoryManager.

3.9.2.3 getPhysicalAddress()

```
void * athena::backend::generic::GenericMemoryManager::getPhysicalAddress (
             vm_word virtualAddress )  [override], [virtual]
```

Convert virtual address to physical one

Parameters

virtualAddress	Virtual address, unsigned long from 0 to 2^64-1

Returns

Pointer to physical memory

Implements athena::backend::AbstractMemoryManager.

3.9.2.4 init()

```
void athena::backend::generic::GenericMemoryManager::init ( )
```

Initialize memory manager. That's where actual memory allocation happens. All configurations should be done before this method is called.

3.9.2.5 load() [1/2]

```
void athena::backend::generic::GenericMemoryManager::load (
            vm_word address,
            unsigned long length )  [override], [virtual]
```

Move data to the fastest memory type available (e.g. from hard drive to RAM) and lock it (prevent from being offloaded)

Parameters

address	Virtual address
length	Size of Tensor in bytes

Implements athena::backend::AbstractMemoryManager.

3.9.2.6 load() [2/2]

```
virtual void athena::backend::AbstractMemoryManager::load
```

Move data to the fastest memory type available (e.g. from hard drive to RAM) and lock it (prevent from being offloaded)

Parameters

address	Virtual address
length	Size of Tensor in bytes

3.9.2.7 processQueue()

```
void athena::backend::generic::GenericMemoryManager::processQueue (
             int laneId )  [protected]
```

This is a thread function for memory lane-threads. It loads data to RAM and notifies corresponding threads

Parameters

lane←↩ Id	

3.9.2.8 unlock()

```
void athena::backend::generic::GenericMemoryManager::unlock (
             vm_word address )  [override], [virtual]
```

Lets data be offloaded to a slower memory type (e.g. from RAM to HDD)

Parameters

address	Virtual address

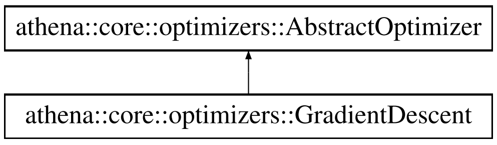
Implements athena::backend::AbstractMemoryManager.

The documentation for this class was generated from the following files:

- backend/generic/GenericMemoryManager.h
- backend/generic/GenericMemoryManager.cpp

3.10 athena::core::optimizers::GradientDescent Class Reference

Inheritance diagram for athena::core::optimizers::GradientDescent:


athena::core::optimizers::AbstractOptimizer
athena::core::optimizers::GradientDescent

Public Member Functions

- **GradientDescent** (athena::core::loss::AbstractLossFunction ∗loss, float learningRate)
- void **prepare** () override
- void **minimize** () override

Protected Member Functions

- std::tuple< std::vector< unsigned long >, unsigned long > **getByteCode** (athena::core::loss::AbstractLossFunction ∗node)

Protected Attributes

- float **learningRate**

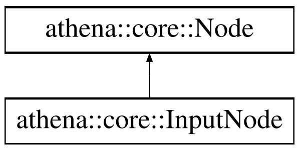
The documentation for this class was generated from the following files:

- core/optimizers/GradientDescent.h
- core/optimizers/GradientDescent.cpp

3.11 athena::core::InputNode Class Reference

`#include <InputNode.h>`

Inheritance diagram for athena::core::InputNode:



Public Member Functions

- **InputNode** (Tensor ∗input, bool isFrozen=true)
- bool isInputNode () override
- void setMappedMemCell (unsigned long cell)
- unsigned long getMappedMemCell ()
- void after (Node ∗) override
- Tensor ∗ getData ()
- bool isFrozen ()
- void setFrozen (bool frozen)

Additional Inherited Members

3.11.1 Detailed Description

Subclass of athena::core::Node Represents a node that has no predecessors

3.11.2 Member Function Documentation

3.11.2.1 after()

```
void athena::core::InputNode::after (
            Node *  )  [inline], [override], [virtual]
```

InputNodes can't be placed after other nodes in Athena's execution graph. This method does nothing

Reimplemented from athena::core::Node.

3.11.2.2 getData()

```
athena::core::Tensor * athena::core::InputNode::getData ( )
```

Get data associated with this InputNode

Returns

Pointer to Tensor

3.11.2.3 getMappedMemCell()

```
unsigned long athena::core::InputNode::getMappedMemCell ( )
```

Get the number of memory cell that is used to store tensor for this node

Returns

Memory cell number

3.11.2.4 isFrozen()

```
bool athena::core::InputNode::isFrozen ( )
```

InputNodes can be frozen. This means their tensors won't be changed during back propagation process (e.g. InputNode contains your input data). By default new InputNodes are frozen.

Returns

Current freeze state

3.11.2.5 isInputNode()

```
bool athena::core::InputNode::isInputNode ( )  [override], [virtual]
```

Check if it is an input node

Returns

true

Reimplemented from athena::core::Node.

3.11.2.6 setFrozen()

```
void athena::core::InputNode::setFrozen (
            bool frozen )
```

InputNodes can be frozen. This means their tensors won't be changed during back propagation process (e.g. InputNode contains your input data). By default new InputNodes are frozen.

Parameters

frozen	True - freeze node, False - unfreeze node (make it variable)

3.11.2.7 setMappedMemCell()

```
void athena::core::InputNode::setMappedMemCell (
            unsigned long cell )
```

Specify which memory cell will be used to store tensor for this node

Parameters

cell	Memory cell number

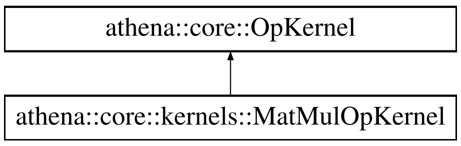
The documentation for this class was generated from the following files:

- core/InputNode.h
- core/InputNode.cpp

3.12 athena::core::kernels::MatMulOpKernel Class Reference

```
#include <MatMulOpKernel.h>
```

Inheritance diagram for athena::core::kernels::MatMulOpKernel:



Public Member Functions

- int getOperandsCount () override
- athena::core::TensorShape & getOutputShape (std::vector< athena::core::TensorShape > &shapes) override
- athena::core::TensorShape & getDerivativeShape (int d, std::vector< athena::core::TensorShape > &shapes) override
- std::vector< vm_word > **getOpBytecode** (std::vector< vm_word > args, vm_word resultCell) override
- std::vector< vm_word > getDerivativeBytecode (int d, std::vector< vm_word > args, vm_word resultCell) override

Additional Inherited Members

3.12.1 Detailed Description

Performs matrix multiplication of given Tensors. Matrix is a 2-D Tensor. The main restriction for this operation is that the number of columns for the first column must be equal to the number of rows for the second matrix. The reason to introduce this operation apart from Tensor product is that it is widely adopted by different acceleration mechanism (BLAS, cuBLAS, Accelerate Framework, etc)

3.12.2 Member Function Documentation

3.12.2.1 getDerivativeBytecode()

```
std::vector< vm_word > athena::core::kernels::MatMulOpKernel::getDerivativeBytecode (
            int d,
            std::vector< vm_word > args,
            vm_word resultCell )  [override], [virtual]
```

Generates bytecode to calculate partial derivative

Parameters

d	Number of variable with respect to which derivative is calculated
args	Function arguments
resultCell	Number of memory cell where results are saved

Returns

Implements athena::core::OpKernel.

3.12.2.2 getDerivativeShape()

```
athena::core::TensorShape & athena::core::kernels::MatMulOpKernel::getDerivativeShape (
            int d,
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

3.12.2.3 getOperandsCount()

```
int athena::core::kernels::MatMulOpKernel::getOperandsCount ( )  [override], [virtual]
```

There can be unary, binary and other operations

Returns

Number of operands accepted

Implements athena::core::OpKernel.

3.12.2.4 getOutputShape()

```
athena::core::TensorShape & athena::core::kernels::MatMulOpKernel::getOutputShape (
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

The documentation for this class was generated from the following files:

- core/kernels/MatMulOpKernel.h
- core/kernels/MatMulOpKernel.cpp

3.13 athena::backend::generic::MemoryChunk Struct Reference

```
#include <GenericMemoryManager.h>
```

Public Attributes

- vm_word **virtualAddress**
- void ∗ **begin**
- size_t **length**
- bool **isFree**
- bool **isLocked**
- MemoryChunk ∗ **next**
- MemoryChunk ∗ **prev**

3.13.1 Detailed Description

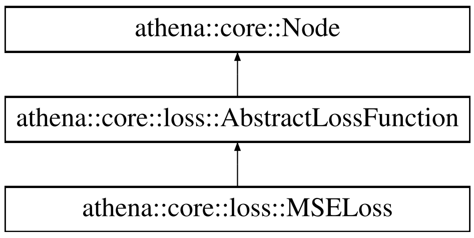
Describes single memory chunk that is allocated in RAM. Free status means there is no data in this chunk Locked status means this chunk is being used now and can't be unload to persistent memory.

The documentation for this struct was generated from the following file:

- backend/generic/GenericMemoryManager.h

3.14 athena::core::loss::MSELoss Class Reference

Inheritance diagram for athena::core::loss::MSELoss:


athena::core::Node
athena::core::loss::AbstractLossFunction
athena::core::loss::MSELoss

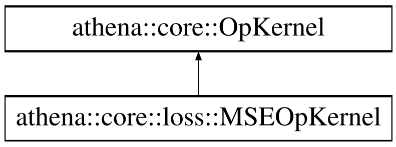
Additional Inherited Members

The documentation for this class was generated from the following files:

- core/loss/MSELoss.h
- core/loss/MSELoss.cpp

3.15 athena::core::loss::MSEOpKernel Class Reference

Inheritance diagram for athena::core::loss::MSEOpKernel:



Public Member Functions

- int getOperandsCount () override
- athena::core::TensorShape & getOutputShape (std::vector< athena::core::TensorShape > &shapes) override
- athena::core::TensorShape & getDerivativeShape (int, std::vector< athena::core::TensorShape > &shapes) override
- std::vector< unsigned long > **getOpBytecode** (std::vector< unsigned long > args, unsigned long resultCell) override
- std::vector< unsigned long > getDerivativeBytecode (int d, std::vector< unsigned long > args, unsigned long resultCell) override

Additional Inherited Members

3.15.1 Member Function Documentation

3.15.1.1 getDerivativeBytecode()

```
std::vector< unsigned long > athena::core::loss::MSEOpKernel::getDerivativeBytecode (
            int d,
            std::vector< unsigned long > args,
            unsigned long resultCell )  [override], [virtual]
```

Generates bytecode to calculate partial derivative

Parameters

d	Number of variable with respect to which derivative is calculated
args	Function arguments
resultCell	Number of memory cell where results are saved

Returns

Implements athena::core::OpKernel.

3.15.1.2 getDerivativeShape()

```
athena::core::TensorShape & athena::core::loss::MSEOpKernel::getDerivativeShape (
            int d,
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

3.15.1.3 getOperandsCount()

```
int athena::core::loss::MSEOpKernel::getOperandsCount ( )  [override], [virtual]
```

There can be unary, binary and other operations

Returns

Number of operands accepted

Implements athena::core::OpKernel.

3.15.1.4 getOutputShape()

```
athena::core::TensorShape & athena::core::loss::MSEOpKernel::getOutputShape (
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

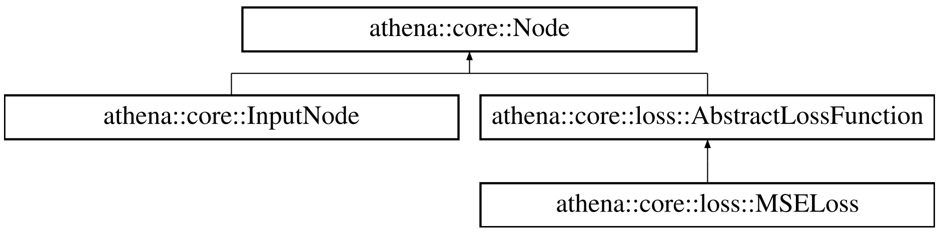
The documentation for this class was generated from the following files:

- core/loss/MSELoss.h
- core/loss/MSELoss.cpp

3.16 athena::core::Node Class Reference

```
#include <Node.h>
```

Inheritance diagram for athena::core::Node:


athena::core::Node
athena::core::InputNode
athena::core::loss::AbstractLossFunction
athena::core::loss::MSELoss

Public Member Functions

- **Node** (OpKernel ∗)
- virtual void after (Node ∗predecessor)
- virtual bool isInputNode ()
- OpKernel ∗ **getOp** ()
- std::vector< Node ∗> & **getIncomingNodes** ()
- std::string **getName** ()
- void **addDerivative** (unsigned long d)
- unsigned long **getDerivative** (int i)
- void **setCalculated** (unsigned long resCell)
- bool **isCalculated** ()
- unsigned long **getResult** ()
- void **updateUsageCount** ()
- bool **isGarbage** ()

Protected Member Functions

- std::string **getRandomNodeName** ()

Protected Attributes

- std::vector< Node *> **incomingNodes**
- std::vector< Node *> **outcomingNodes**
- OpKernel * **operation**
- std::string **name**
- bool **calculated**
- std::vector< vm_word > **derivatives**
- unsigned long **resultCell**
- unsigned long **usageCount**
- bool **derivativeMark**

3.16.1 Detailed Description

A basic element of execution graph Each node has pointers to its predecessors and successors. It encapsulates operation and data.

3.16.2 Member Function Documentation

3.16.2.1 after()

```
void athena::core::Node::after (
            Node * predecessor )  [virtual]
```

Makes a new oriented edge in execution graph from predecessor to this node

Parameters

predecessor	A predecessor node

Reimplemented in athena::core::InputNode.

3.16.2.2 isInputNode()

```
bool athena::core::Node::isInputNode ( )  [virtual]
```

Check if it is an input node

Returns

false

Reimplemented in athena::core::InputNode.

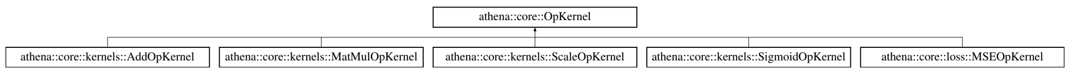
The documentation for this class was generated from the following files:

- core/Node.h
- core/Node.cpp

3.17 athena::core::OpKernel Class Reference

```
#include <OpKernel.h>
```

Inheritance diagram for athena::core::OpKernel:


athena::core::OpKernel
athena::core::kernels::AddOpKernel
athena::core::kernels::MatMulOpKernel
athena::core::kernels::ScaleOpKernel
athena::core::kernels::SigmoidOpKernel
athena::core::loss::MSEOpKernel

Public Member Functions

- **OpKernel** (OpCode opCode, std::string name)
- virtual int getOperandsCount ()=0
- virtual athena::core::TensorShape & getOutputShape (std::vector< athena::core::TensorShape > &shapes)=0
- virtual athena::core::TensorShape & getDerivativeShape (int d, std::vector< athena::core::TensorShape > &shapes)=0
- virtual std::vector< vm_word > **getOpBytecode** (std::vector< vm_word > args, vm_word resultCell)=0
- virtual std::vector< vm_word > getDerivativeBytecode (int d, std::vector< vm_word > args, vm_word resultCell)=0

Protected Attributes

- OpCode **opCode**
- std::string **name**

3.17.1 Detailed Description

Operation skeleton Each operation has OpCode

3.17.2 Member Function Documentation

3.17.2.1 getDerivativeBytecode()

```
virtual std::vector< vm_word > athena::core::OpKernel::getDerivativeBytecode (
            int d,
            std::vector< vm_word > args,
            vm_word resultCell ) [pure virtual]
```

Generates bytecode to calculate partial derivative

Parameters

d	Number of variable with respect to which derivative is calculated
args	Function arguments
resultCell	Number of memory cell where results are saved

Returns

Implemented in athena::core::kernels::MatMulOpKernel, athena::core::kernels::SigmoidOpKernel, athena::core::loss::MSEOpKernel, athena::core::kernels::AddOpKernel, and athena::core::kernels::ScaleOpKernel.

3.17.2.2 getDerivativeShape()

```
virtual athena::core::TensorShape& athena::core::OpKernel::getDerivativeShape (
            int d,
            std::vector< athena::core::TensorShape > & shapes )  [pure virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implemented in athena::core::kernels::MatMulOpKernel, athena::core::kernels::SigmoidOpKernel, athena::core::loss::MSEOpKernel, athena::core::kernels::AddOpKernel, and athena::core::kernels::ScaleOpKernel.

3.17.2.3 getOperandsCount()

```
virtual int athena::core::OpKernel::getOperandsCount ( )  [pure virtual]
```

There can be unary, binary and other operations

Returns

Number of operands accepted

Implemented in athena::core::kernels::MatMulOpKernel, athena::core::kernels::SigmoidOpKernel, athena::core::loss::MSEOpKernel, athena::core::kernels::AddOpKernel, and athena::core::kernels::ScaleOpKernel.

3.17.2.4 getOutputShape()

```
virtual athena::core::TensorShape& athena::core::OpKernel::getOutputShape (
            std::vector< athena::core::TensorShape > & shapes )  [pure virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implemented in athena::core::kernels::MatMulOpKernel, athena::core::kernels::SigmoidOpKernel, athena::core::loss::MSEOpKernel, athena::core::kernels::AddOpKernel, and athena::core::kernels::ScaleOpKernel.

The documentation for this class was generated from the following file:

- core/OpKernel.h

3.18 athena::backend::generic::QueueItem Struct Reference

```
#include <GenericMemoryManager.h>
```

Public Attributes

- vm_word **address**
- size_t **length**
- bool **alloc** = false
- std::condition_variable **loadHandle**
- std::mutex **m**
- bool **notified** = false

3.18.1 Detailed Description

Describes which Tensors should be loaded to RAM Alloc flag means we should not search for data in Swap

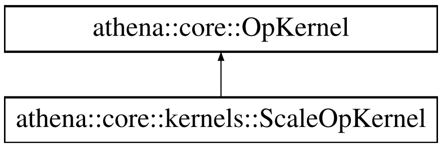
The documentation for this struct was generated from the following file:

- backend/generic/GenericMemoryManager.h

3.19 athena::core::kernels::ScaleOpKernel Class Reference

```
#include <ScaleOpKernel.h>
```

Inheritance diagram for athena::core::kernels::ScaleOpKernel:



Public Member Functions

- int getOperandsCount () override
- athena::core::TensorShape & getOutputShape (std::vector< athena::core::TensorShape > &shapes) override
- athena::core::TensorShape & getDerivativeShape (int d, std::vector< athena::core::TensorShape > &shapes) override
- std::vector< vm_word > **getOpBytecode** (std::vector< vm_word > args, vm_word resultCell) override
- std::vector< vm_word > getDerivativeBytecode (int d, std::vector< vm_word > args, vm_word resultCell) override

Additional Inherited Members

3.19.1 Detailed Description

Multiply Tensor by scalar

3.19.2 Member Function Documentation

3.19.2.1 getDerivativeBytecode()

```
std::vector< vm_word > athena::core::kernels::ScaleOpKernel::getDerivativeBytecode (
            int d,
            std::vector< vm_word > args,
            vm_word resultCell )  [override], [virtual]
```

Generates bytecode to calculate partial derivative

Parameters

d	Number of variable with respect to which derivative is calculated
args	Function arguments
resultCell	Number of memory cell where results are saved

Returns

Implements athena::core::OpKernel.

3.19.2.2 getDerivativeShape()

```
athena::core::TensorShape & athena::core::kernels::ScaleOpKernel::getDerivativeShape (
            int d,
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

3.19.2.3 getOperandsCount()

```
int athena::core::kernels::ScaleOpKernel::getOperandsCount ( )  [override], [virtual]
```

There can be unary, binary and other operations

Returns

Number of operands accepted

Implements athena::core::OpKernel.

3.19.2.4 getOutputShape()

```
athena::core::TensorShape & athena::core::kernels::ScaleOpKernel::getOutputShape (
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

The documentation for this class was generated from the following files:

- core/kernels/ScaleOpKernel.h
- core/kernels/ScaleOpKernel.cpp

3.20 athena::core::Session Class Reference

```
#include <Session.h>
```

Public Member Functions

- void prepare (Node ∗logits)
- Tensor ∗ run ()
- unsigned long **getResultCell** ()
- void **setExecutor** (athena::backend::AbstractExecutor ∗exec)

3.20.1 Detailed Description

The class encapsulates everything needed for a single training step

3.20.2 Member Function Documentation

3.20.2.1 prepare()

```
void athena::core::Session::prepare (
            Node ∗ logits )
```

Generates bytecode for the whole graph

Parameters

logits	

3.20.2.2 run()

```
athena::core::Tensor ∗ athena::core::Session::run ( )
```

does single training step

Returns

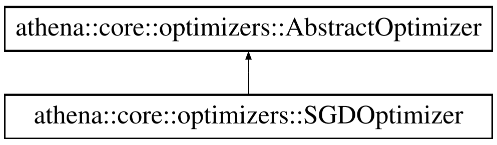
result tensor

The documentation for this class was generated from the following files:

- core/Session.h
- core/Session.cpp

3.21 athena::core::optimizers::SGDOptimizer Class Reference

Inheritance diagram for athena::core::optimizers::SGDOptimizer:


athena::core::optimizers::AbstractOptimizer
athena::core::optimizers::SGDOptimizer

Public Member Functions

- **SGDOptimizer** (athena::core::loss::AbstractLossFunction ∗logits)

Additional Inherited Members

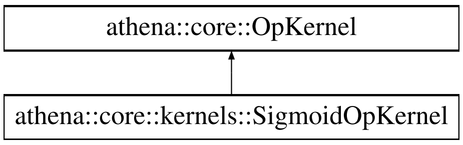
The documentation for this class was generated from the following file:

- core/optimizers/SGDOptimizer.h

3.22 athena::core::kernels::SigmoidOpKernel Class Reference

```
#include <SigmoidOpKernel.h>
```

Inheritance diagram for athena::core::kernels::SigmoidOpKernel:



Public Member Functions

- int getOperandsCount () override
- athena::core::TensorShape & getOutputShape (std::vector< athena::core::TensorShape > &shapes) override
- athena::core::TensorShape & getDerivativeShape (int d, std::vector< athena::core::TensorShape > &shapes) override
- std::vector< vm_word > **getOpBytecode** (std::vector< vm_word > args, vm_word resultCell) override
- std::vector< vm_word > getDerivativeBytecode (int d, std::vector< vm_word > args, vm_word resultCell) override

Additional Inherited Members

3.22.1 Detailed Description

Apply sigmoid function to every element of Tensor. See `https://en.wikipedia.org/wiki/Sigmoid_function` for more info

3.22.2 Member Function Documentation

3.22.2.1 getDerivativeBytecode()

```
std::vector< vm_word > athena::core::kernels::SigmoidOpKernel::getDerivativeBytecode (
            int d,
            std::vector< vm_word > args,
            vm_word resultCell )  [override], [virtual]
```

Generates bytecode to calculate partial derivative

Parameters

d	Number of variable with respect to which derivative is calculated
args	Function arguments
resultCell	Number of memory cell where results are saved

Returns

Implements athena::core::OpKernel.

3.22.2.2 getDerivativeShape()

```
athena::core::TensorShape & athena::core::kernels::SigmoidOpKernel::getDerivativeShape (
            int d,
            std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

3.22.2.3 getOperandsCount()

```
int athena::core::kernels::SigmoidOpKernel::getOperandsCount ( )  [override], [virtual]
```

There can be unary, binary and other operations

Returns

Number of operands accepted

Implements athena::core::OpKernel.

3.22.2.4 getOutputShape()

```
athena::core::TensorShape & athena::core::kernels::SigmoidOpKernel::getOutputShape (
             std::vector< athena::core::TensorShape > & shapes )  [override], [virtual]
```

It is important for some operations to have certain size of their operands

Parameters

shape	Original operand shape
dim	Dimensionality

Returns

New shape

Implements athena::core::OpKernel.

The documentation for this class was generated from the following files:

- core/kernels/SigmoidOpKernel.h
- core/kernels/SigmoidOpKernel.cpp

3.23 athena::backend::generic::SwapRecord Struct Reference

```
#include <GenericMemoryManager.h>
```

Public Attributes

- vm_word **address**
- size_t **length**
- std::string **filename**

3.23.1 Detailed Description

Describes single swap record - a file, that stores Tensor data

The documentation for this struct was generated from the following file:

- backend/generic/GenericMemoryManager.h

3.24 athena::core::Tensor Class Reference

```
#include <Tensor.h>
```

Public Member Functions

- **Tensor** (const TensorShape &shape, DataType dataType)
- const TensorShape & **getShape** () const
- DataType **getType** () const
- vm_word **getStartAddress** ()
- void **setStartAddress** (vm_word address)
- Tensor & **operator[ ]** (unsigned int idx)

3.24.1 Detailed Description

In mathematics **tensor** is an abstract object, expressing some definite type of multi-linear concept. See `Wikipedia` for more info.

In Athena Tensor is an abstraction to represent data inside computational graph. A 1-dimensional Tensor is either scalar or vector. A 2-dimensional Tensor is a matrix.

The documentation for this class was generated from the following files:

- core/Tensor.h
- core/Tensor.cpp

3.25 athena::core::TensorShape Class Reference

```
#include <TensorShape.h>
```

Public Member Functions

- **TensorShape** (std::vector< size_t > shape)
- **TensorShape** (unsigned long ∗shape, unsigned long length)
- **TensorShape** (const TensorShape &)
- TensorShape & **operator=** (const TensorShape &)
- unsigned long dimensions () const
- unsigned long dim (unsigned long n) const
- unsigned long totalSize () const
- const std::vector< unsigned long > & **getShape** () const
- bool operator== (const TensorShape &) const
- bool operator!= (const TensorShape &rhs) const

3.25.1 Detailed Description

Class represents size parameters for Tensor

3.25.2 Member Function Documentation

3.25.2.1 dim()

```
unsigned long athena::core::TensorShape::dim (
            unsigned long n ) const
```

Gives size for certain dimension

Parameters

n	Dimension index (0 <= d < dimensions)

Returns

Size of dimension n

3.25.2.2 dimensions()

```
unsigned long athena::core::TensorShape::dimensions ( ) const
```

Returns

Number of dimensions in Tensor

3.25.2.3 operator"!=()

```
bool athena::core::TensorShape::operator!= (
            const TensorShape & rhs ) const
```

Parameters

rhs	TensorShape to be compared with

Returns

True if dimensions are different, else False

3.25.2.4 operator==()

```
bool athena::core::TensorShape::operator== (
            const TensorShape & rhs ) const
```

Returns

True if dimensions are equal, else False

3.25.2.5 totalSize()

```
unsigned long athena::core::TensorShape::totalSize ( ) const
```

Returns

Total number of elements in Tensor

The documentation for this class was generated from the following files:

- core/TensorShape.h
- core/TensorShape.cpp

3.26 athena::backend::VirtualMemory Class Reference

```
#include <VirtualMemory.h>
```

Public Member Functions

- vm_word allocate (athena::core::Tensor *tensor)
- void free (athena::core::Tensor *tensor)
- void free (vm_word virtualAddress)

3.26.1 Detailed Description

Virtual memory is an abstraction of storage resources that are actually available on a given machine. Each thread has its own address space. In Athena's VM address space is linear. This means that valid addresses are 0 to 2^64 - 1. Address 0 is reserved for NULL value. When Tensor is initialized, it is given with a continuous block of virtual addresses. When one actually needs to access Tensor's data, Memory Manager allocates physical memory and converts virtual addresses to physical ones. This helps Athena to run in low-memory conditions. This class is heavily used in Session class to generate bytecode.
To discover more about Virtual Memory see article on `Wikipedia`

3.26.2 Member Function Documentation

3.26.2.1 allocate()

```
vm_word athena::backend::VirtualMemory::allocate (
            athena::core::Tensor * tensor )
```

Allocates virtual memory for given Tensor

Parameters

tensor	Tensor object

Returns

Virtual Address of 0 element of Tensor

3.26.2.2 free() [1/2]

```
void athena::backend::VirtualMemory::free (
            athena::core::Tensor * tensor )
```

Marks memory as free

Parameters

tensor	Corresponding tensor

3.26.2.3 free() [2/2]

```
void athena::backend::VirtualMemory::free (
            vm_word virtualAddress )
```

Marks memory as free

Parameters

virtualAddress	

The documentation for this class was generated from the following files:

- backend/VirtualMemory.h
- backend/VirtualMemory.cpp

3.27 athena::backend::VMemoryBlock Struct Reference

Public Attributes

- bool **isUsed**
- vm_word **startAddress**
- vm_word **endAddress**
- VMemoryBlock ∗ **nextBlock**
- VMemoryBlock ∗ **prevBlock**

The documentation for this struct was generated from the following file:

- backend/VirtualMemory.h

Index