Relationen-Algebra und Persistenz – Teil II

Implementierungskonzepte für und Anforderungen an Tupelstromoperatoren in SECONDO

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Inhalt

Grundlegende Datentypen

Tuple

```
            Name: tuple
       Signature: (IDENT x DATA)+ -> TUPLE
Example Type List: (tuple((Name string)(BevT int)))
        List Rep: (<attr1> ... <attrn>)
    Example List: ("Dortmund" 601)
```

Relation

```
            Name: rel
       Signature: TUPLE -> REL
Example Type List: (rel(tuple((Name string)(BevT int))))
        List Rep: (<tuple>*) where
                  <tuple> is (<attr1> ... <attrn>)
    Example List: (("Dortmund" 601)("Hagen" 187))
```

Grundlegende Operationen

```
     Name: feed
Signature: (rel t) -> (stream t)
   Syntax: _ feed
  Meaning: Produces a stream from a relation by
           scanning the relation tuple by tuple.
  Example: query Orte feed count
```

```
     Name: consume
Signature: (stream t) -> (rel t)
   Syntax: _ consume
  Meaning: Collects objects from a stream.
  Example: query Orte feed consume count
```

Grundlegende Operationen

```
     Name: filter
Signature: ((stream t) (map t bool)) -> (stream t)
   Syntax: _ filter [ fun ]
  Meaning: Only tuples fulfilling a certain condition
           are passed on to the output stream.
  Example: query Orte feed filter [.BevT > 500] count
```

```
     Name: attr
Signature: ((tuple ((x1 t1) ... (xn tn))) xi)  -> ti)
   Syntax: attr ( _ , _ )
  Meaning: Returns the value of an attribute at a given position.
  Example: query Orte feed filter
           [fun(t:STREAMELEM) attr(t, BevT) > 500] count
```

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Type Mapping für den Operator `filter`

Anfrage

```
query Orte feed filter [.BevT > 500] consume
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Eingabetyp

```
(stream (tuple ((Kennzeichen string) (Ort string)
                (Vorwahl string) (BevT int))))

  (map (tuple ((Kennzeichen string) (Ort string)
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Ergebnistyp

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Ergebnistyp

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(stream (tuple ((Kennzeichen string) (Ort string)
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Inhalt

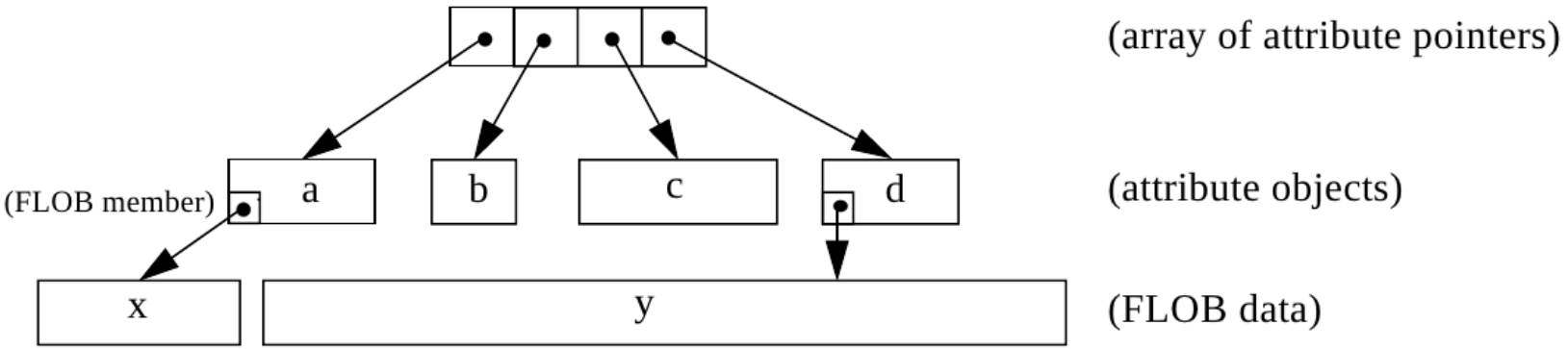
Motivation

- wichtige Operationen auf Tupeln:

`feed`	neue Tupel werden erzeugt
`filter`	Tupel werden unverändert weitergereicht (Selektion)
`consume`	Tupel werden verbraucht / gelöscht
`project`	Tupel werden „verändert“

Interne Darstellung

- Array von Zeigern auf Attributdatentyp-Objekte



Funktionen

Konstruktoren

```
TupleType(const ListExpr typeInfo)

Tuple(TupleType* tupleType)
Tuple(const ListExpr typeInfo)
```

Funktionen

Konstruktoren

```
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Tuple(TupleType* tupleType)
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```

Zugriff auf Attribute

```
Attribute* GetAttribute(int index)
void PutAttribute(int index, Attribute* attr)
void CopyAttribute(int sourceIndex, Tuple* source, int destIndex)
int GetNoAttributes()
```

Beispiel

Konstruktion eines Tupels

```
ListExpr tupleTypeList = nl->TwoElemList(
  nl->SymbolAtom(Tuple::BasicType()),
  nl->TwoElemList(
        nl->TwoElemList(nl->SymbolAtom("Ort"),
                        nl->SymbolAtom(CcString::BasicType())),
        nl->TwoElemList(nl->SymbolAtom("BevT"),
                        nl->SymbolAtom(CcInt::BasicType()))));
SecondoCatalog* sc = SecondoSystem::GetCatalog();
ListExpr numTupleTypeList = sc->NumericType(tupleTypeList);
TupleType *tupleType = new TupleType(numTupleTypeList);
Tuple *tuple = new Tuple(tupleType);
```

Beispiel

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ListExpr numTupleTypeList = sc->NumericType(tupleTypeList);
TupleType *tupleType = new TupleType(numTupleTypeList);
Tuple *tuple = new Tuple(tupleType);
```

Festlegung von Attributnamen und -typen

Beispiel

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SecondoCatalog* sc = SecondoSystem::GetCatalog();
ListExpr numTupleTypeList = sc->NumericType(tupleTypeList);
TupleType *tupleType = new TupleType(numTupleTypeList);
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```

Umwandlung in numerische Tupeltypliste

Beispiel

Konstruktion eines Tupels

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Erzeugung eines neuen Tupeltyps

Beispiel

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        nl->TwoElemList(nl->SymbolAtom("BevT"),
                        nl->SymbolAtom(CcInt::BasicType()))));
SecondoCatalog* sc = SecondoSystem::GetCatalog();
ListExpr numTupleTypeList = sc->NumericType(tupleTypeList);
TupleType *tupleType = new TupleType(numTupleTypeList);
Tuple *tuple = new Tuple(tupleType);
```

Erzeugung eines neuen (leeren) Tupels

Beispiel

Operator `project`

```
     Name: project
Signature: ((stream (tuple ((a1 T1) ... (an Tn)))) (ai1 ... aik))
           -> (stream (tuple ((ai1 Ti1) ... (aik Tik))))
   Syntax: _ project [ list ]
  Meaning: Produces a projection tuple for
           each tuple of its input stream.
  Example: query Orte feed project[Ort, BevT] count
```

Beispiel

Value Mapping des Operators `project`

```
int Project(Word* args, Word& result, int message,
            Word& local, Supplier s) {
  switch (message) {
    case OPEN: {
      ListExpr resultType = GetTupleResultType(s);
      TupleType *tupleType = new TupleType(
                             nl->Second(resultType));
      local.addr = tupleType;
      qp->Open(args[0].addr);
      return 0;
    }
      [...]
  }
}
```

Beispiel

Value Mapping des Operators `project`

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int Project(Word* args, Word& result, int message,
            Word& local, Supplier s) {
  switch (message) {
    case OPEN: {
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      TupleType *tupleType = new TupleType(
                             nl->Second(resultType));
      local.addr = tupleType;
      qp->Open(args[0].addr);
      return 0;
    }
      [...]
  }
}
```

aus Operatorknoten `s`: Liste der Form

```
(stream ((3 0) ((Ort (1 3)) (BevT (1 0)))))
```

Beispiel

Value Mapping des Operators `project`

```
int Project(Word* args, Word& result, int message,
            Word& local, Supplier s) {
  switch (message) {
    case OPEN: {
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      TupleType *tupleType = new TupleType(
                             nl->Second(resultType));
      local.addr = tupleType;
      qp->Open(args[0].addr);
      return 0;
    }
      [...]
  }
}
```

aus Attributliste `nl->Second(resultType)`: Objekt vom Typ `TupleType`

Beispiel

Value Mapping des Operators `project`

```
case REQUEST: {
    [...]
  TupleType *tupleType = (TupleType*)local.addr;
  Tuple *tuple = new Tuple(tupleType);
  int noAttrs = ((CcInt*)args[2].addr)->GetIntval();
  for (int i = 0; i < noAttrs; i++) {
      [...]
    index = ((CcInt*)elem2.addr)->GetIntval();
    tuple->CopyAttribute(index - 1, (Tuple*)elem1.addr, i);
  }
  ((Tuple*)elem1.addr)->DeleteIfAllowed();
    [...]
}
```

Beispiel

Value Mapping des Operators `project`

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case REQUEST: {
    [...]
  TupleType *tupleType = (TupleType*)local.addr;
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      [...]
    index = ((CcInt*)elem2.addr)->GetIntval();
    tuple->CopyAttribute(index - 1, (Tuple*)elem1.addr, i);
  }
  ((Tuple*)elem1.addr)->DeleteIfAllowed();
    [...]
}
```

kopiert das (`index-1`)-te Attribut des Originaltupels an Position `i` des neuen Tupels `tuple`

Beispiel

Value Mapping des Operators `project`

```
case REQUEST: {
    [...]
  TupleType *tupleType = (TupleType*)local.addr;
  Tuple *tuple = new Tuple(tupleType);
  int noAttrs = ((CcInt*)args[2].addr)->GetIntval();
  for (int i = 0; i < noAttrs; i++) {
      [...]
    index = ((CcInt*)elem2.addr)->GetIntval();
    tuple->CopyAttribute(index - 1, (Tuple*)elem1.addr, i);
  }
  ((Tuple*)elem1.addr)->DeleteIfAllowed();
    [...]
}
```

löscht das `Tuple`-Objekt inklusive aller Attribute (unter Beachtung ggf. noch vorhandener Referenzen)

Beispiel

Value Mapping des Operators `project`

```
case CLOSE: {
  qp->Close(args[0].addr);
  if (local.addr) {
    ((TupleType*)local.addr)->DeleteIfAllowed();
    local.setAddr(0);
  }
  return 0;
}
```

Beispiel

Value Mapping des Operators `project`

```
case CLOSE: {
  qp->Close(args[0].addr);
  if (local.addr) {
    ((TupleType*)local.addr)->DeleteIfAllowed();
    local.setAddr(0);
  }
  return 0;
}
```

löscht das `TupleType`-Objekt (unter Beachtung ggf. noch vorhandener Referenzen)

Referenzzähler

- Ziel: Vermeidung von teuren Kopien, Speicherfehlern, Speicherlöchern
- Attributdatentypen
  - `Clone`: Tiefenkopie mit Referenz
  - `Copy`: weitere Referenz
  - `DeleteIfAllowed`: eine Referenz weniger, ggf. Löschung des Attributobjekts
- Tupel / Tupeltyp
  - `Clone`: Tiefenkopie mit Referenz
  - `IncReference`: Zählerinkrementierung um 1
  - `DeleteIfAllowed` Zählerdekrementierung um 1, ggf. Löschung des Tupels

Inhalt

Motivation

- Gewünscht: Weitergabe (interner) Argumente an Value Mappings zwecks
  - Übergabe von Attribut-Indizes
  - Verwendung von Default-Parametern

Lösung: APPEND

- Schlüsselwort `APPEND` im Type Mapping
- Rückgabe von

  `(APPEND <beliebigeListe> <Ergebnistypliste>)`

  statt wie bisher `<ErgebnistypListe>`

genaue Syntax

```
return nl->ThreeElemList(
                    nl->SymbolAtom(Symbol::APPEND()),
                    <beliebigeListe>,
                    <ErgebnistypListe>);
```

Beispiel

Type Mapping des Operators attr

```
ListExpr AttrTypeMap(ListExpr args) {
  if (nl->ListLength(args) != 2) {
    return listutils::typeError("two arguments expected");
  }
  ListExpr first = nl->First(args);
  if (!Tuple::checkType(first)) {
    return listutils::typeError
           ("first argument must be tuple(...)");
  }
  ListExpr second = nl->Second(args);
  if (!listutils::isSymbol(second)) {
    return listutils::typeError
           ("second argument must be an attribute name");
  }
```

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  ListExpr second = nl->Second(args);
  if (!listutils::isSymbol(second)) {
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  }
```

übliche Prüfungen

Beispiel

Type Mapping des Operators attr

```
  string name = nl->SymbolValue(second);
  ListExpr attrtype;
  int j = listutils::findAttribute
                    (nl->Second(first), name, attrtype);
  if (j == 0) {
    return listutils::typeError
          ("Attr name " + name + " not found in attribute list");
  }
  return nl->ThreeElemList(nl->SymbolAtom(Symbol::APPEND()),
                           nl->OneElemList(nl->IntAtom(j)),
                           attrtype);
}
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                           attrtype);
}
```

gibt den Datentyp `attrtype` und den Index `j` zum Attributnamen `name` in der Attributliste `nl->Second(first)` zurück

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sendet Fehlerbericht, falls `name` nicht in der Attributliste vorkommt

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gibt die Datentypbeschreibung `attrtype` zurück; angehängt ist eine Liste mit dem Attributindex

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Beispiel

- Eingabe fürs Type Mapping:

```
((tuple ((Kennzeichen string) (Ort string) (Vorwahl string)
         (BevT int))) Vorwahl)
```

- Rückgabe des Type Mappings:

```
(APPEND (3) string)
```

Value Mapping für Operator `attr`

```
int Attr(Word* args, Word& result,
         int message, Word& local, Supplier s) {
  Tuple* tuple = (Tuple*)args[0].addr;
  int index = ((CcInt*)args[2].addr)->GetIntval();
  assert(1 <= index && index <= tuple->GetNoAttributes());
  result.setAddr(tuple->GetAttribute(index - 1));
  return 0;
}
```

Beispiel

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Beispiel

- `args[1]` (Attributname) wird nicht mehr benötigt
- Type Mapping: `args[1]` $\mapsto$ `args[2]` (Attributindex)

Value Mapping für Operator `attr`

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```

Inhalt

Hinweise zur Fehlerbehebung

- Anzeige der Hilfe (in der TTY-Konsole)
  `help`
- Anzeige von Speicherfehlern durch
  `SecondoTTYBDB --valgrind`
  und Speicherlöchern (ungenutzter und nicht wieder freigegebener Speicher) durch
  `SecondoTTYBDB --valgrindlc`
- Fehlerquelle: wiederholtes Löschen von Zeigern, der Speicher könnte bereits anderweitig belegt sein;
  Empfehlung: nicht verwendete Zeiger auf 0 setzen
  - unter Linux: Setzen der Umgebungsvariable
    `MALLOC_CHECK=2` $\Rightarrow$ sofortiger Programmabbruch

MARIO 576400 ×47 WORLD 8-4 TIME 244

THANK YOU MARIO!

YOUR QUEST IS OVER.

WE PRESENT YOU A NEW QUEST.

PUSH BUTTON B

TO SELECT A WORLD