Scalar Evolution in LLVM

1 Example

1.1 Source

```
void foo(float *a, uint64_t n, uint64_t k) {
        for (uint64_t i = 0; i < n; i++) {
                a[i] = i * k;
        }
}
```

1.2 LLVM IR

```
clang -Oz -S sourcefile.cpp -emit-llvm
```

```
; Function Attrs: minsize mustprogress nofree norecurse nosync nounwind optsize
uwtable writeonly
define dso_local void @_Z3fooPfmm(float* nocapture noundef writeonly %0, i64
noundef %1, i64 noundef %2) local_unnamed_addr #0 {
  br label %4


4:                                                ; preds = %8, %3
  %5 = phi i64 [ 0, %3 ], [ %12, %8 ]
  %6 = icmp eq i64 %5, %1
  br i1 %6, label %7, label %8


7:                                                ; preds = %4
  ret void


8:                                                ; preds = %4
  %9 = mul i64 %5, %2
  %10 = uitofp i64 %9 to float
  %11 = getelementptr inbounds float, float* %0, i64 %5
  store float %10, float* %11, align 4, !tbaa !5
  %12 = add i64 %5, 1
  br label %4, !llvm.loop !9
}
```

1.3 Scalar Evolution

```
opt --enable-new-pm=0 -analyze -scalar-evolution sourcefile.ll
```

```
Printing analysis 'Scalar Evolution Analysis' for function '_Z3fooPfmm':

Classifying expressions for: @_Z3fooPfmm

  %5 = phi i64 [ 0, %3 ], [ %12, %8 ]

  -->  {0,+,1}<%4> U: full-set S: full-set              Exits: %1
LoopDispositions: { %4: Computable }

  %9 = mul i64 %5, %2

  -->  {0,+,%2}<%4> U: full-set S: full-set              Exits: (%1 * %2)
       LoopDispositions: { %4: Computable }

  %11 = getelementptr inbounds float, float* %0, i64 %5

  -->  {%0,+,4}<%4> U: full-set S: full-set              Exits: ((4 * %1) + %0)
       LoopDispositions: { %4: Computable }

  %12 = add i64 %5, 1

  -->  {1,+,1}<nw><%4> U: full-set S: full-set          Exits: (1 + %1)
LoopDispositions: { %4: Computable }

Determining loop execution counts for: @_Z3fooPfmm

Loop %4: backedge-taken count is %1

Loop %4: max backedge-taken count is -1

Loop %4: Predicated backedge-taken count is %1

 Predicates:


Loop %4: Trip multiple is 1
```