

Using Extrema_ExtAlgo_Tree in ShapeHealing

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Problem statement

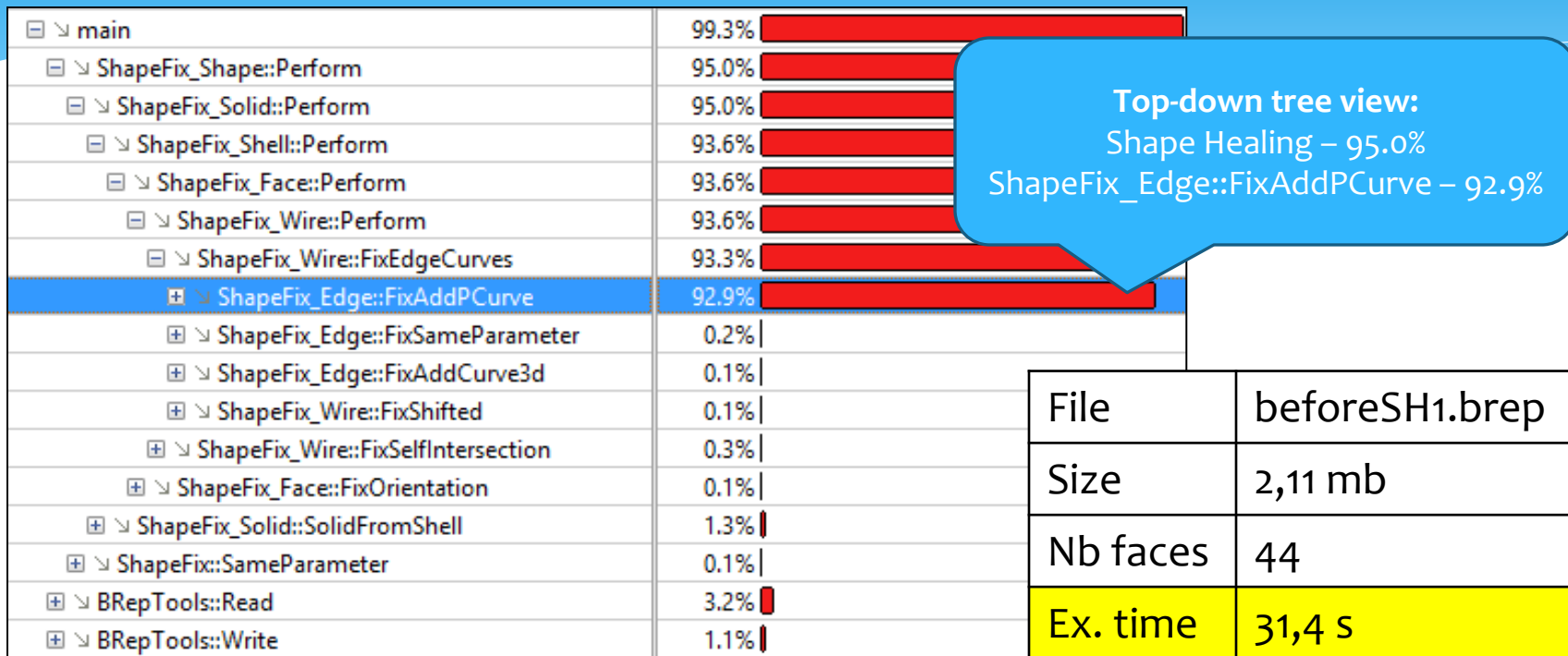
- * Some incoming shapes have edges without pcurve and shape-healing process on this shape may takes significant time, although the shape contains <50 faces.

Reproducer

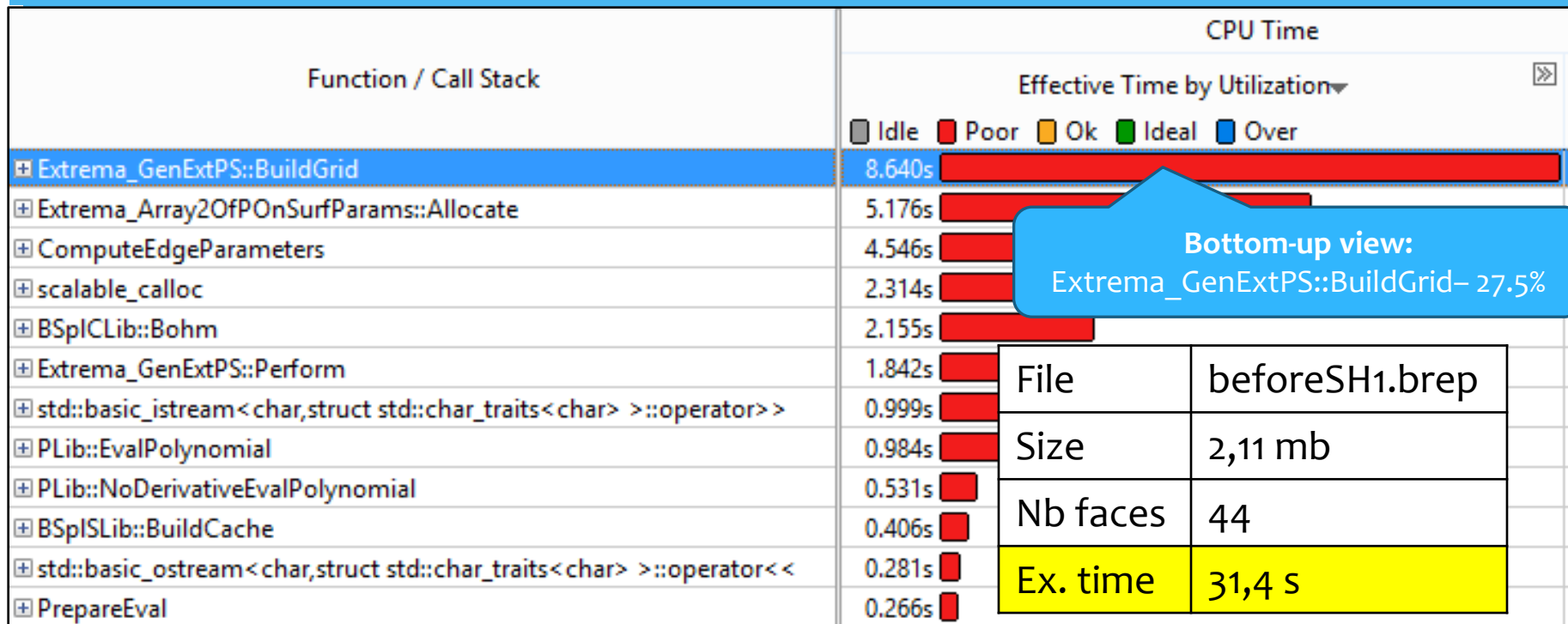
```
int main (int argc, char *argv[])
{
    const char* aSource = argv[1]; const char* aDest = argv[2];
    TopoDS_Shape aShape;
    if (!BRepTools::Read (aShape, aSource, BRep_Builder())) {
        cerr << "Failed to read the file " << aSource << endl;
        return 1;
    }

    auto aStartTime = high_resolution_clock::now();
    Handle(ShapeFix_Shape) sfs = new ShapeFix_Shape;
    sfs->Init (aShape);
    sfs->Perform();
    auto anEndTime = high_resolution_clock::now();
    cout << "Complete!" << endl;
    BRepTools::Write (aShape, aDest);
    cout << "Elapsed time: " << duration<double, std::milli> (anEndTime-aStartTime).count() << endl;
    return 0;
}
```

Bottleneck analysis



Bottleneck analysis



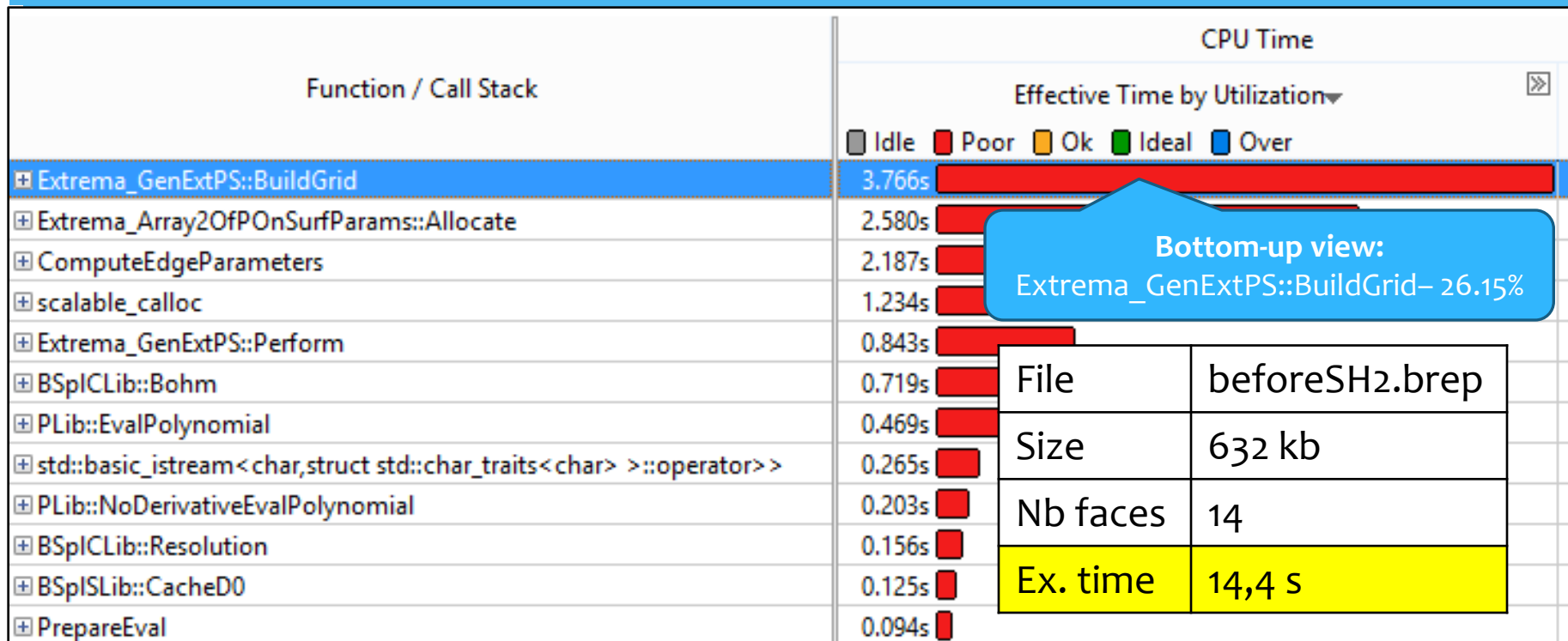
Bottleneck analysis

| | |
|------------------------------------|-------|
| main | 99.1% |
| ShapeFix_Shape::Perform | 96.5% |
| ShapeFix_Solid::Perform | 96.5% |
| ShapeFix_Shell::Perform | 95.7% |
| ShapeFix_Face::Perform | 95.7% |
| ShapeFix_Wire::Perform | 95.6% |
| ShapeFix_Wire::FixEdgeCurves | 95.5% |
| ShapeFix_Edge::FixAddPCurve | 95.3% |
| ShapeFix_Edge::FixSameParameter | 0.1% |
| ShapeFix_Edge::FixAddCurve3d | 0.1% |
| ShapeFix_Wire::FixSelfIntersection | 0.1% |
| ShapeFix_Face::FixOrientation | 0.1% |
| ShapeFix_Solid::SolidFromShell | 0.8% |
| BRepTools::Read | 1.9% |
| BRepTools::Write | 0.7% |

Top-down tree view:
Shape Healing – 96.5%
ShapeFix_Edge::FixAddPCurve – 95.3%

| | |
|----------|----------------|
| File | beforeSH2.brep |
| Size | 632 kb |
| Nb faces | 14 |
| Ex. time | 14,4 s |

Bottleneck analysis



Bottleneck analysis. Resume.

- * Essentially all the time was occupied by projecting point on surfaces (Extrema_ExtPS::Perform() takes all the time). By default, Extrema_ExtAlgo_Grad algorithm from Extrema_GenExtPS package is used, where method Extrema_GenExtPS::BuildGrid() takes significant time.
- * This projection is required by OCC – OCC requires that each edge has 3D curve and its Pcurve on a surface, whereas Parasolid/ACIS allows to have 3D only.

Experiments

Source code:

src\Extrema\Extrema_GenExtPS.cxx

```
Extrema_GenExtPS::Extrema_GenExtPS()
{
    myDone = Standard_False;
    myInit = Standard_False;
    myFlag = Extrema_ExtFlag_MINMAX;
    //myAlgo =Extrema_ExtAlgo_Grad;
    myAlgo = Extrema_ExtAlgo_Tree;
}
```

- * Change the default projection algorithm from Extrema_ExtAlgo_Grad to Extrema_ExtAlgo_Tree

Results

| | | |
|------------------------------------|--------------|--|
| main | 97.5% | <div><div style="width: 97.5%;"></div></div> |
| ShapeFix_Shape::Perform | 73.5% | <div><div style="width: 73.5%;"></div></div> |
| ShapeFix_Solid::Perform | 73.2% | <div><div style="width: 73.2%;"></div></div> |
| ShapeFix_Shell::Perform | 65.5% | <div><div style="width: 65.5%;"></div></div> |
| ShapeFix_Face::Perform | 65.5% | <div><div style="width: 65.5%;"></div></div> |
| ShapeFix_Wire::Perform | 65.3% | <div><div style="width: 65.3%;"></div></div> |
| ShapeFix_Wire::FixEdgeCurves | 63.3% | <div><div style="width: 63.3%;"></div></div> |
| ShapeFix_Edge::FixAddPCurve | 61.3% | <div><div style="width: 61.3%;"></div></div> |
| ShapeFix_Edge::FixSameParameter | 1.1% | <div><div style="width: 1.1%;"></div></div> |
| ShapeFix_Edge::FixAddCurve3d | 0.8% | <div><div style="width: 0.8%;"></div></div> |
| ShapeFix_Wire::FixSelfIntersection | 2.0% | <div><div style="width: 2.0%;"></div></div> |
| ShapeFix_Wire::Load | 0.3% | <div><div style="width: 0.3%;"></div></div> |
| ShapeFix_Solid::SolidFromShell | 7.6% | <div><div style="width: 7.6%;"></div></div> |
| ShapeFix::SameParameter | 0.3% | <div><div style="width: 0.3%;"></div></div> |
| BRepTools::Read | 18.1% | <div><div style="width: 18.1%;"></div></div> |
| BRepTools::Write | 5.7% | <div><div style="width: 5.7%;"></div></div> |

Top-down tree view:
Shape Healing – 73.5%
ShapeFix_Edge::FixAddPCurve – 61.3%

| | |
|----------|----------------|
| File | beforeSH1.brep |
| Size | 2,11 mb |
| Nb faces | 44 |
| Ex. time | 5,9 s |

Results

| Function / Call Stack | CPU Time | |
|---|-------------------------------|--|
| | Effective Time by Utilization | |
| std::basic_istream<char,struct std::char_traits<char> >::operator> | 983.820ms | |
| BSplCLib::Bohm | 640.322ms | |
| PLib::EvalPolynomial | 624.941ms | |
| PLib::NoDerivativeEvalPolynomial | 328.376ms | |
| std::basic_ostream<char,struct std::char_traits<char> >::operator<< | 265.671ms | |
| sqrt | 250.116ms | |
| Bnd_Sphere::Distances | 187.338ms | |
| Bnd_Sphere::Distance | 171.984ms | |
| BSplCLib::Resolution | 171.980ms | |
| BSplCLib::CacheD1 | 125.020ms | |
| Bnd_Sphere::IsOut | 124.977ms | |

| | |
|----------|----------------|
| File | beforeSH1.brep |
| Size | 2,11 mb |
| Nb faces | 44 |
| Ex. time | 5,9 s |

Results

| | | |
|------------------------------------|--------|-----------------------------------|
| main | 100.0% | <div style="width: 100%;"></div> |
| ShapeFix_Shape::Perform | 80.7% | <div style="width: 80.7%;"></div> |
| ShapeFix_Solid::Perform | 79.9% | <div style="width: 79.9%;"></div> |
| ShapeFix_Shell::Perform | 75.0% | <div style="width: 75.0%;"></div> |
| ShapeFix_Face::Perform | 75.0% | <div style="width: 75.0%;"></div> |
| ShapeFix_Wire::Perform | 74.2% | <div style="width: 74.2%;"></div> |
| ShapeFix_Wire::FixEdgeCurves | 73.4% | <div style="width: 73.4%;"></div> |
| ShapeFix_Edge::FixAddPCurve | 71.0% | <div style="width: 71.0%;"></div> |
| ShapeFix_Edge::FixSameParameter | 1.6% | <div style="width: 1.6%;"></div> |
| ShapeFix_Edge::FixAddCurve3d | 0.8% | <div style="width: 0.8%;"></div> |
| ShapeFix_Wire::FixSelfIntersection | 0.8% | <div style="width: 0.8%;"></div> |
| ShapeFix_Face::FixMissingSeam | 0.8% | <div style="width: 0.8%;"></div> |
| ShapeFix_Solid::SolidFromShell | 4.8% | <div style="width: 4.8%;"></div> |
| ShapeFix::SameParameter | 0.8% | <div style="width: 0.8%;"></div> |
| BRepTools::Read | 13.7% | <div style="width: 13.7%;"></div> |
| BRepTools::Write | 4.8% | <div style="width: 4.8%;"></div> |

Top-down tree view:
Shape Healing – 80.7%
ShapeFix_Edge::FixAddPCurve – 71.0%

| | |
|----------|----------------|
| File | beforeSH2.brep |
| Size | 632 kb |
| Nb faces | 14 |
| Ex. time | 2,4 s |

Results

| Function / Call Stack | CPU Time | |
|---|--|---|
| | Effective Time by Utilization | |
| | Idle Poor Ok Ideal Over | |
| PLib::EvalPolynomial | 375.176ms | <div style="width: 100%; height: 10px; background-color: red;"></div> |
| BSpICLib::Bohm | 281.134ms | <div style="width: 75%; height: 10px; background-color: red;"></div> |
| std::basic_istream<char,struct std::char_traits<char> >::operator> | 265.313ms | <div style="width: 70%; height: 10px; background-color: red;"></div> |
| sqrt | 125.051ms | <div style="width: 33%; height: 10px; background-color: red;"></div> |
| PLib::NoDerivativeEvalPolynomial | 78.127ms | <div style="width: 15%; height: 10px; background-color: red;"></div> |
| std::basic_ostream<char,struct std::char_traits<char> >::operator<< | 78.077ms | |
| NCollection_UBTree<int,class Bnd_Sphere>::Add | 78.034ms | |
| Bnd_Sphere::Distances | 62.618ms | |
| PLib::RationalDerivatives | 62.491ms | |
| BSpICLib::Resolution | 62.399ms | |
| BSpISLib::BuildCache | 46.853ms | |

| | |
|----------|----------------|
| File | beforeSH2.brep |
| Size | 632 kb |
| Nb faces | 14 |
| Ex. time | 2,4 s |

Results. Resume.

| | Execution Time, s (ExtAlgo_Grad) | Execution Time, s (ExtAlgo_Tree) | Increased performance, X |
|----------------|-------------------------------------|-------------------------------------|-----------------------------|
| beforeSH1.brep | 31,4 | 5,9 | 5,32 |
| beforeSH2.brep | 14,4 | 2,4 | 6 |

- * Changing the default projection algorithm resulted in an increased performance by more than 5 times

Summary

- * Projection of points on surface is a frequent case. Using another Extrema_ExtAlgo algorithm leads to more than 5X speed up on shapes, that contained edges without pcurves. This approach looks promising, but requires more information about its side-effects.
- * Next steps: run OCC test suite, get feedback from OCC-team

Backup

| | |
|-------------------------|--|
| Processor | Intel Core i5-4210M |
| RAM | 8 Gb |
| OS | Windows 8.1 (64 bit) |
| *.exe | Release with debug info (/O2 / Zi /DEBUG) |
| Open CASCADE Technology | 6.7.1 |
| MMGT_OPT | 2 |