Compiles Final Paper

today

Parsing

For our compiler, we decided not to use ANTLR or any other parser generator. Instead, we wrote our own tokenizer and parser.

Static Semantics:

Type Checking

Return path checking

Intermediate Representation

Our compiler stores the IR as a list of functions. Each function then stores a list of all the registers, instructions, and basic blocks. Each basic block stores and ordered list of references to instructions. Each instruction stores references to the registers it uses as well as the register it writes to and any other instruction specific data.

The IR is used as a control flow graph as well through the references which the basic blocks hold. This is esspecialy usefull for

Optimizations:

For our compiler, we implemented the following optimizations: ### Sparse Conditional Constant Propagation First, we implemented SCCP which propogates constant values. If while propogating a constant value, a conditional branch is reached, and the condition is known, we only continue propogating down that branch. Once we are finished any unreachable basic blocks are removed, and references to things in the blocks like phi nodes are replaced with the constant value.

Comparison Propagation

On top of SCCP, we implemented comparison propagation. This is an extention of SCCP that evalueates comparisons and removes redundant ones. For example, if we check that a value is less than some number and then check again if it is biger than some larger number, we can remove the child comparison as it is impossible to be true. We also can create constants from direct comparisons. For example, if we compare a value to 0, we can do constant propogation on the value in the branch where it is the case where the value is 0.

Dead Code Elimination

Finaly, we implemented mark and sweep dead code elimination. This was fairly straightforward to implement. For each function in the IR, we first marked all the side effects like calls as well as the return value. Then we marked everything that the marked values relied on. Finally we removed anything not marked.

Empty Block Removal

Somewhat related to dead code elimination, we also implemented empty block removal which removes any basic blocks with only a single jump instruction.

“‘{python} import altair as alt import pandas as pd import json import os

Create a simple dataframe from test.csv

data = json.load(open(“times.json”)) dfs = {} for key in data.keys(): dfs[key] = pd.DataFrame(data[key]) lineCountData = json.load(open(“instrCounts.json”)) istrCountDfs = {} for key in lineCountData.keys(): istrCountDfs[key] = pd.DataFrame(lineCountData[key])

````
```{python}
def plot(df_name):
   df = dfs[df_name]
   df_melted = df.melt(var_name="Compilation Type", value_name="Time (s)")
   chart = alt.Chart(df_melted).mark_boxplot(extent="min-max").encode(
      alt.X('Time (s):Q', title='Time (s)', scale=alt.Scale(nice = True, zero=False)),
      alt.Y('Compilation Type:O', title='Compilation Type'),
      alt.Color('Compilation Type:O', title=None, legend=None,  # Disable the legend
         scale=alt.Scale(scheme='category10'))
   ).properties(
      width=600,  # Adjust the width
      height=200  # Adjust the height
      )

   summary_stats = df_melted.groupby('Compilation Type')['Time (s)'].agg(['mean', 'std', 'co
   summary_stats.columns = ['Compilation Type', 'Average Time (s)', 'Standard Deviation (s)'

   table = alt.Chart(summary_stats).transform_fold(
       fold=['Average Time (s)', 'Standard Deviation (s)', 'Number of Runs'],
       as_=['Statistic', 'Value']
````
````

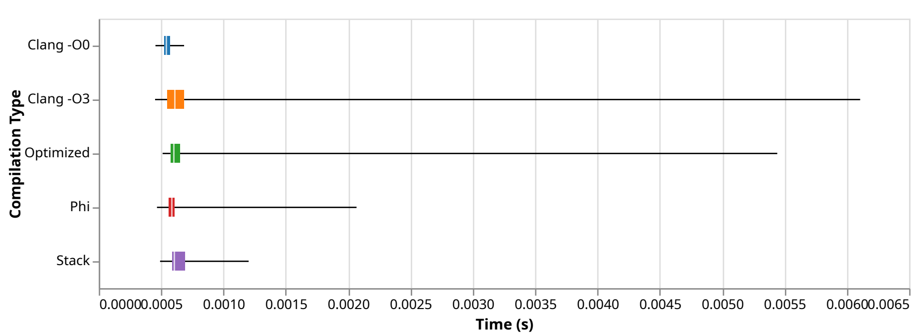
```
).mark_text().encode(
    alt.Y('Compilation Type:O', title='Compilation Type'),
    alt.X('Statistic:N', title='Statistic'),
    alt.Text('Value:Q', format=".4e"),
    alt.Color('Statistic:N', legend=None)  # Use color for text differentiation
).properties(
    width=600,  # Match the width of the chart
    height=100  # Adjust the height of the table
)

instrDf = istrCountDfs[df_name].melt(var_name="Compilation Type", value_name="Instructio

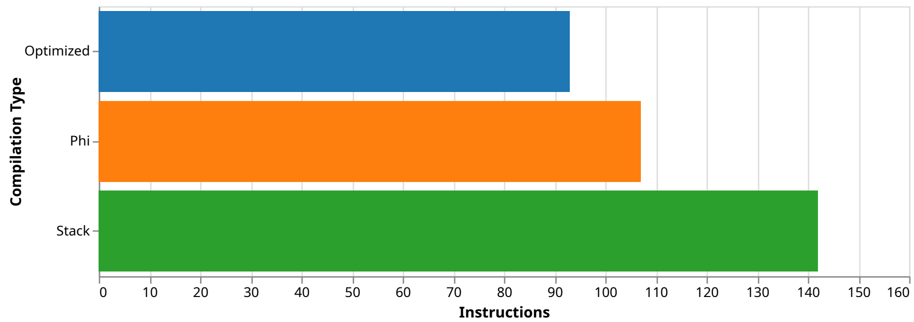
istrCountPlot = alt.Chart(instrDf).mark_bar().encode(
   alt.X('Instructions:Q', title='Instructions', scale=alt.Scale(nice = True, zero=False)
   alt.Y('Compilation Type:O', title='Compilation Type'),
   alt.Color('Compilation Type:O', title=None, legend=None,  # Disable the legend
      scale=alt.Scale(scheme='category10'))
).properties(
   width=600,  # Adjust the width
   height=200  # Adjust the height
   )

combined = alt.vconcat(
     chart,
     table,
     istrCountPlot
).resolve_scale(
        color='independent'
        )
return combined
```

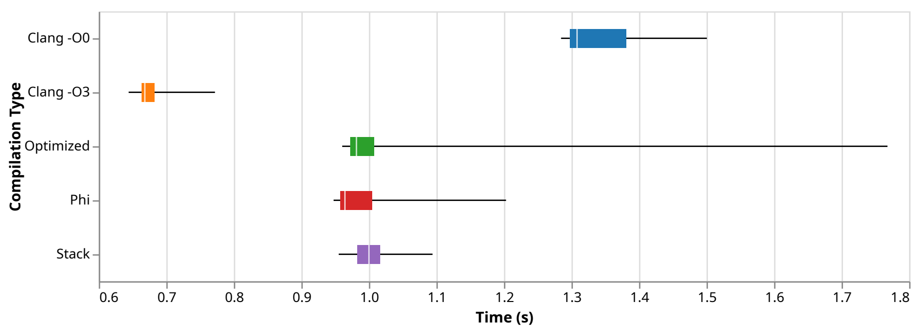
BenchMarkishTopics



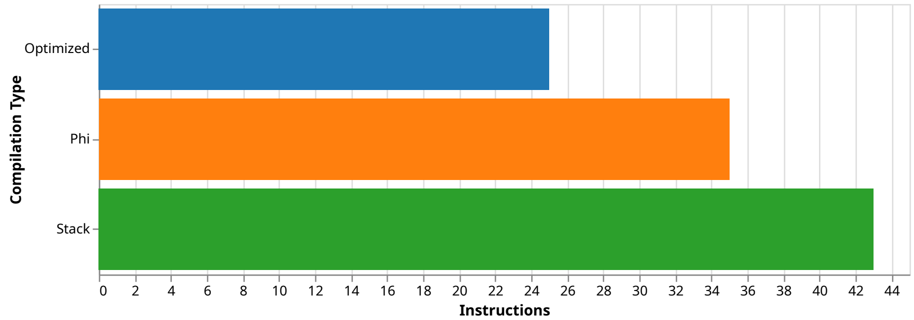
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.000548957	4.20744e-05	100
1	Clang -O3	0.000875332	0.000904613	100
2	Optimized	0.000765208	0.000645905	100
3	Phi	0.000602088	0.000154801	100
4	Stack	0.000656832	0.000130187	100



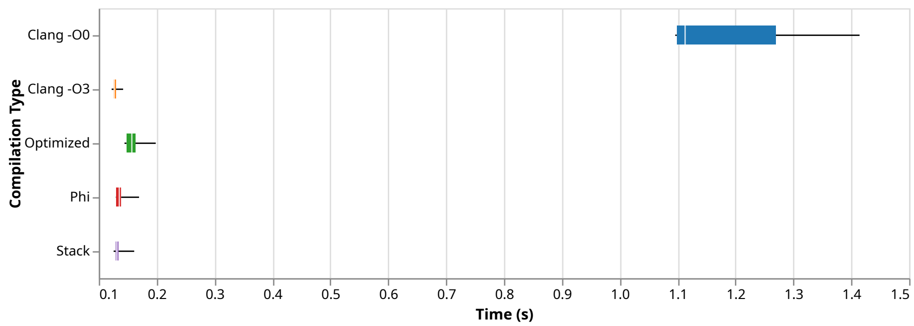
Fibonacci



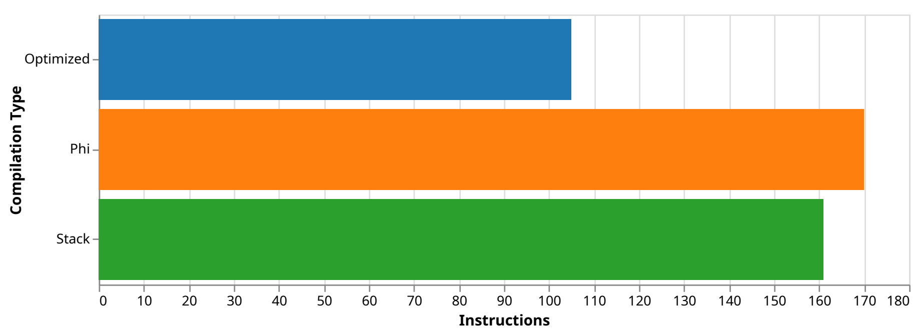
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	1.34265	0.06914	10
1	Clang -O3	0.686857	0.0448232	10
2	Optimized	1.1175	0.294606	10
3	Phi	0.999313	0.0796519	10
4	Stack	1.00541	0.0412773	10



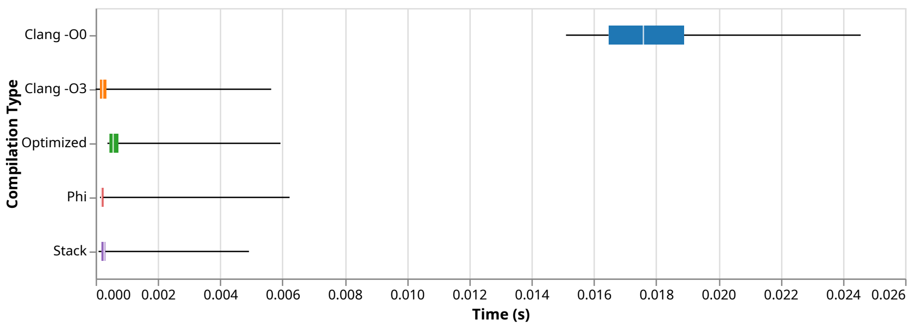
GeneralFunctAndOptimize



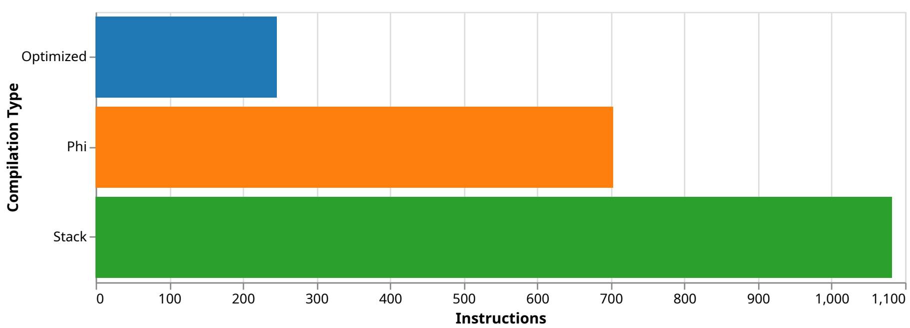
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	1.1972	0.131997	10
1	Clang -O3	0.128315	0.00548708	10
2	Optimized	0.160155	0.0166928	10
3	Phi	0.138412	0.0121598	10
4	Stack	0.13372	0.0100984	10



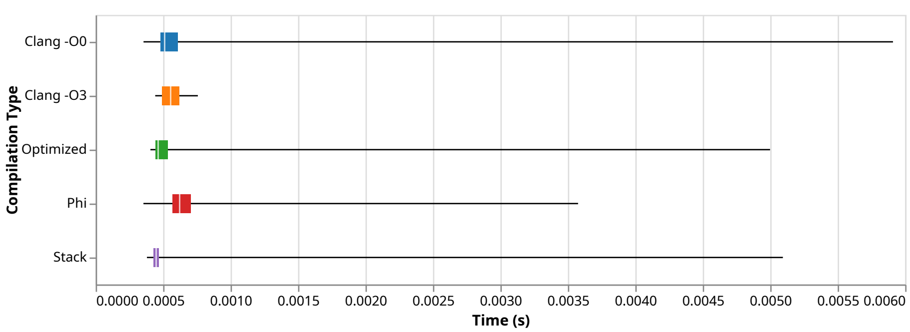
OptimizationBenchmark



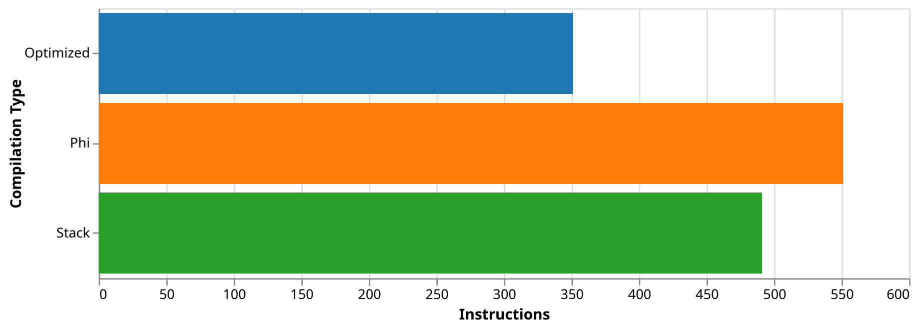
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.0180274	0.00196866	100
1	Clang -O3	0.000387386	0.000790512	100
2	Optimized	0.000707812	0.000695657	100
3	Phi	0.000664428	0.00130693	100
4	Stack	0.000310872	0.0004841	100



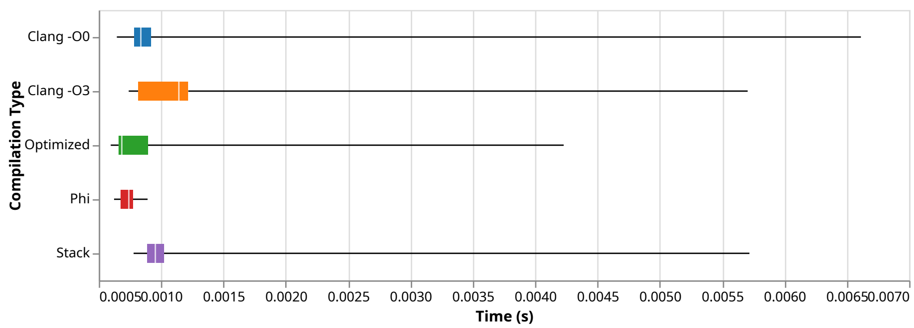
TicTac



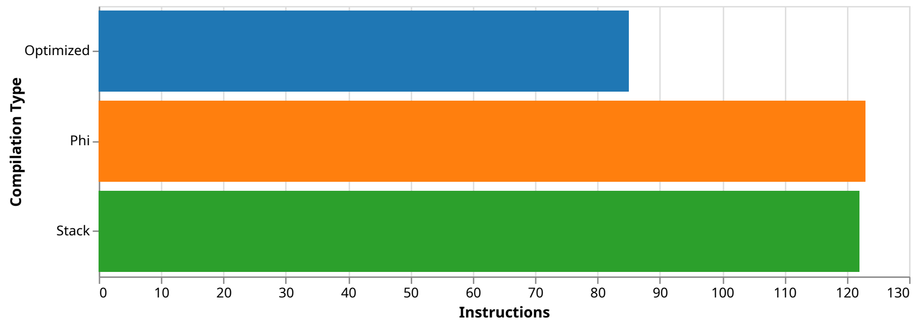
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.000679915	0.000679702	100
1	Clang -O3	0.000568203	8.50207e-05	100
2	Optimized	0.000553835	0.000502394	100
3	Phi	0.00077026	0.000537269	100
4	Stack	0.000506808	0.000473132	100



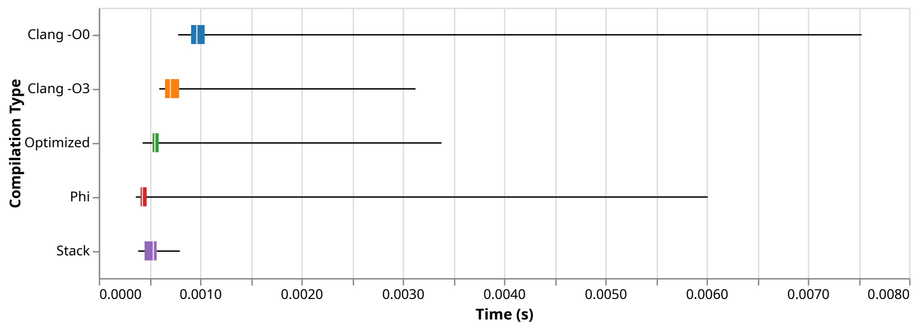
array_sort



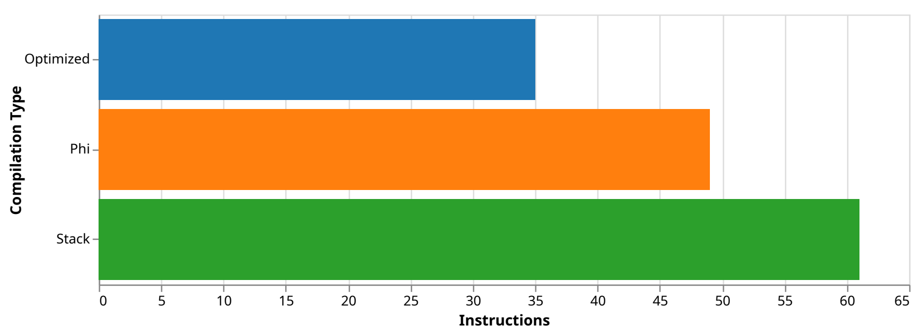
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.00102434	0.000777098	100
1	Clang -O3	0.00155305	0.00124491	100
2	Optimized	0.000830775	0.000435514	100
3	Phi	0.000728558	6.07833e-05	100
4	Stack	0.00108512	0.000680252	100



array_sum



	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.00108382	0.000731937	100
1	Clang -O3	0.000811957	0.000413607	100
2	Optimized	0.000627221	0.000388521	100
3	Phi	0.000600105	0.000721709	100
4	Stack	0.000529111	8.06176e-05	100



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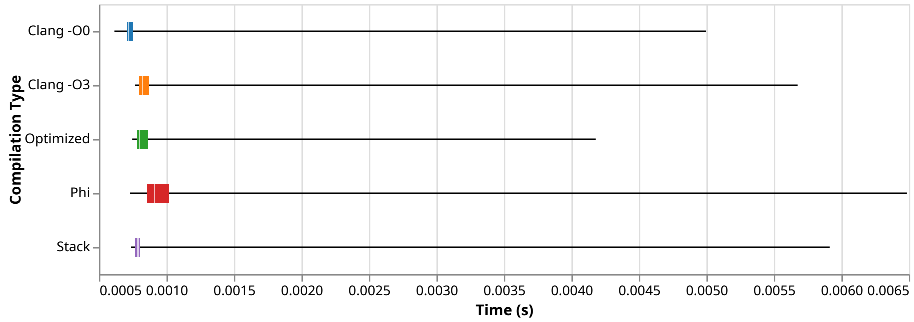
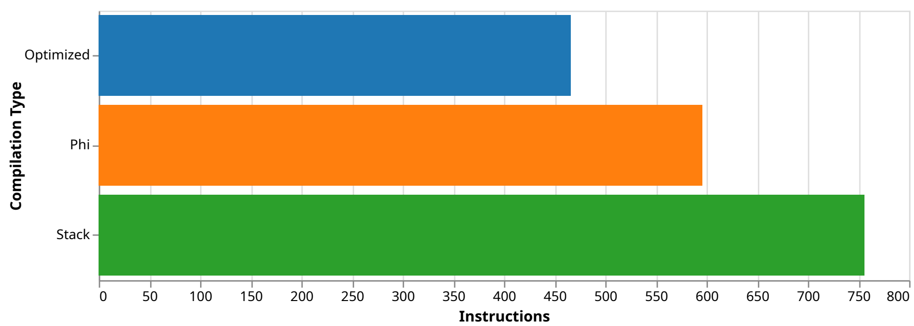
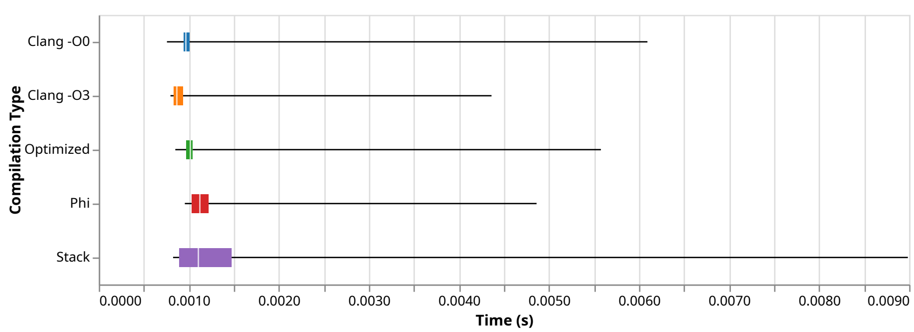


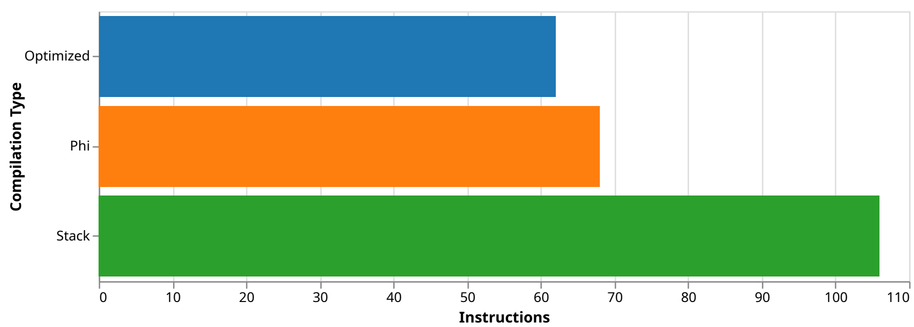
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.000842613	0.000569818	100
1	Clang -O3	0.000937838	0.000563945	100
2	Optimized	0.000871462	0.000390434	100
3	Phi	0.001087	0.000820705	100
4	Stack	0.000848477	0.000515771	100



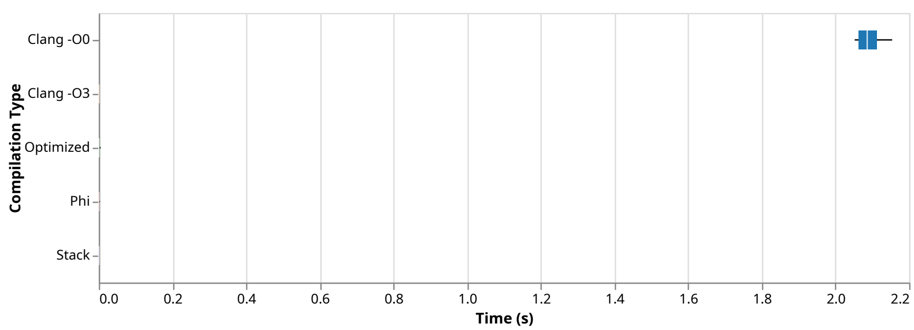
biggest



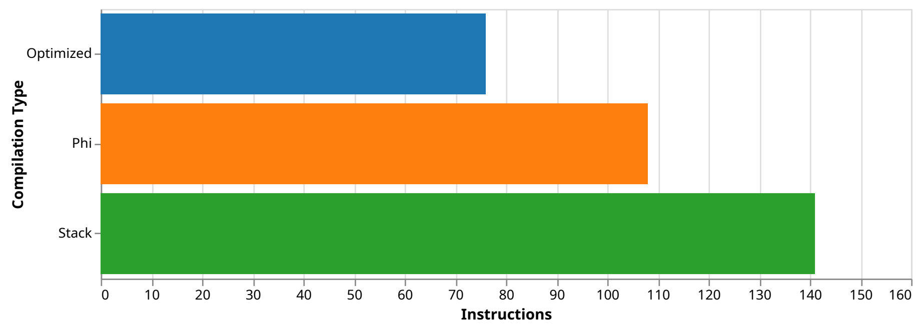
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.00113256	0.000766537	100
1	Clang -O3	0.000949541	0.000442268	100
2	Optimized	0.00113283	0.00059959	100
3	Phi	0.00116739	0.000387661	100
4	Stack	0.00147517	0.00126153	100



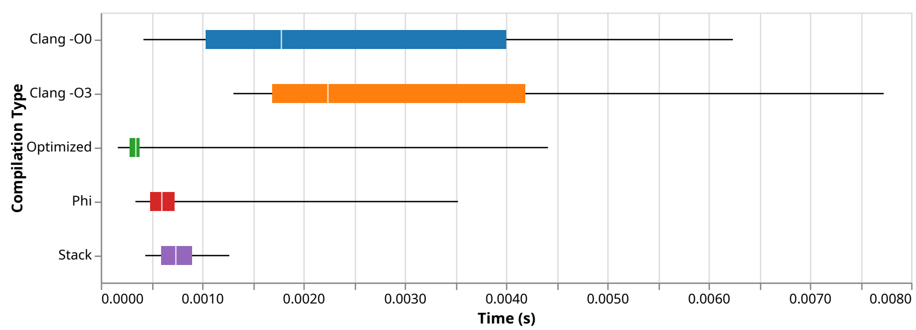
binaryConverter



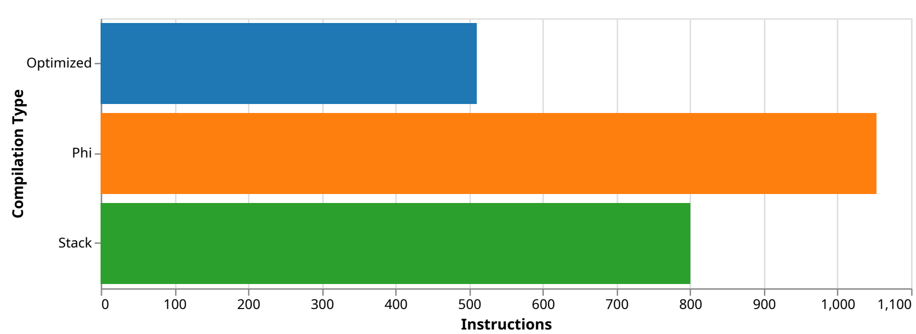
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	2.09172	0.0362483	10
1	Clang -O3	0.000170964	1.44655e-05	10
2	Optimized	0.00119744	0.00149786	10
3	Phi	0.000996188	0.00119554	10
4	Stack	0.000306354	4.05001e-05	10



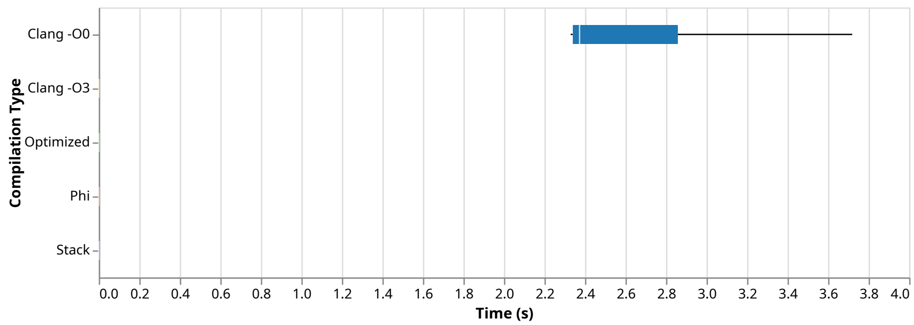
brett



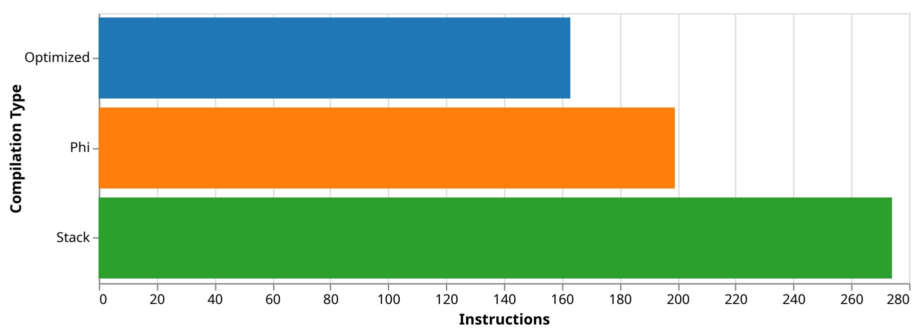
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.00256278	0.0018535	100
1	Clang -O3	0.00311457	0.00203451	100
2	Optimized	0.000392386	0.000441803	100
3	Phi	0.000662178	0.000405433	100
4	Stack	0.000771347	0.000215964	100



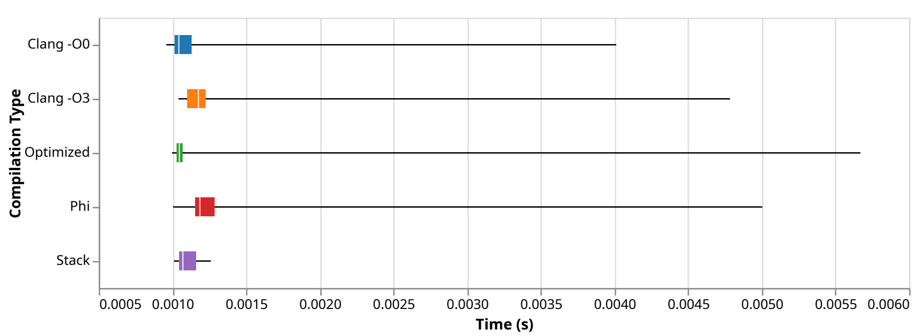
creativeBenchMarkName



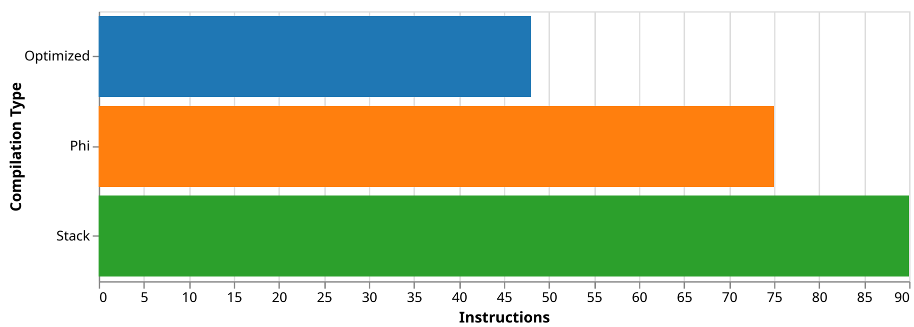
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	2.67323	0.53446	10
1	Clang -O3	0.000504582	1.66441e-05	10
2	Optimized	0.000570717	3.12939e-05	10
3	Phi	0.000562817	3.55185e-05	10
4	Stack	0.000579521	3.73848e-05	10



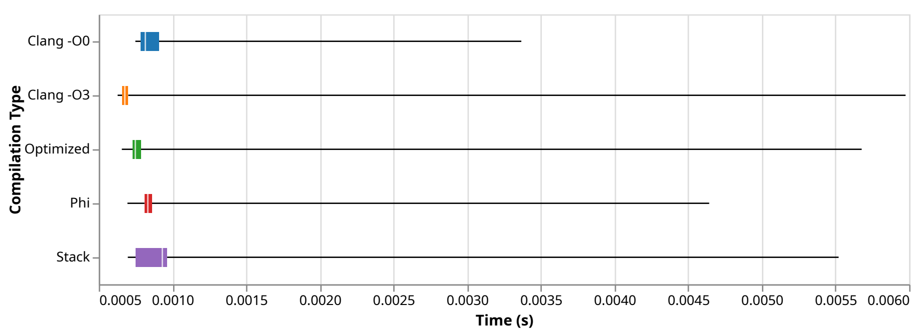
fact_sum



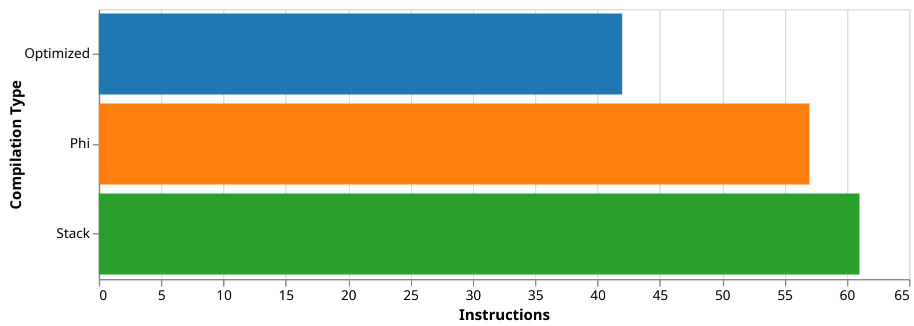
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.0012927	0.000623988	100
1	Clang -O3	0.00122239	0.000407783	100
2	Optimized	0.00110627	0.000471794	100
3	Phi	0.00137334	0.000660169	100
4	Stack	0.00109687	6.46681e-05	100



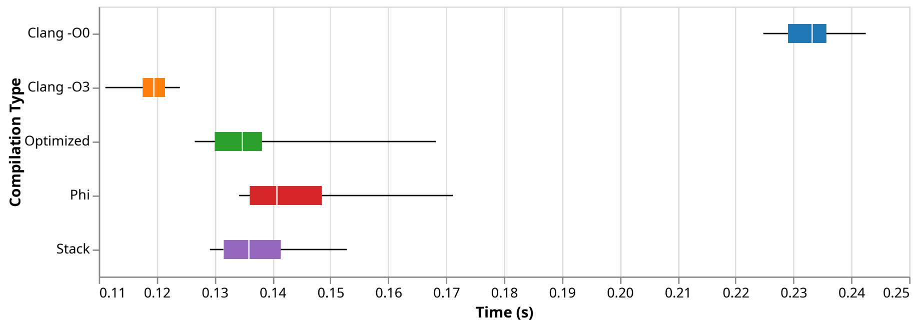
hailstone



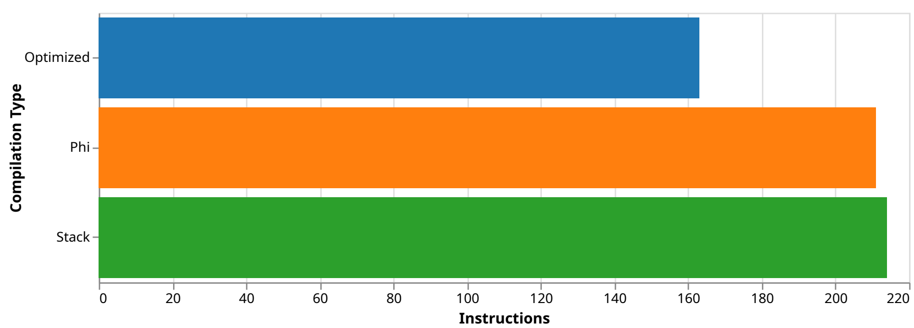
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.000902551	0.000359201	100
1	Clang -O3	0.000765127	0.000565975	100
2	Optimized	0.000907937	0.000724356	100
3	Phi	0.000879652	0.000405196	100
4	Stack	0.0010427	0.000755512	100



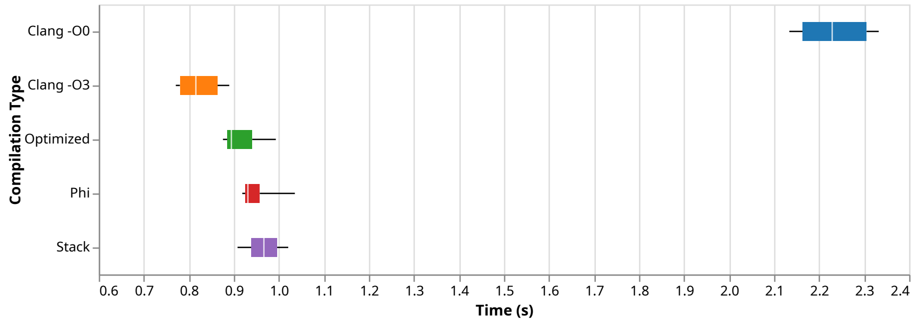
hanoi_benchmark



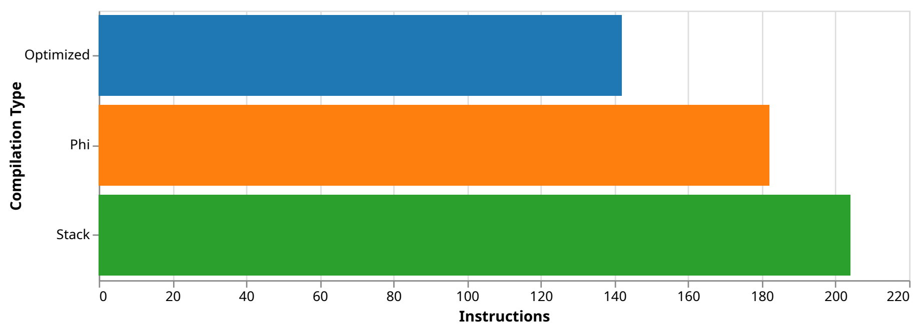
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.232941	0.00549127	10
1	Clang -O3	0.118951	0.00363262	10
2	Optimized	0.137448	0.0121549	10
3	Phi	0.144565	0.0118456	10
4	Stack	0.137341	0.00766898	10



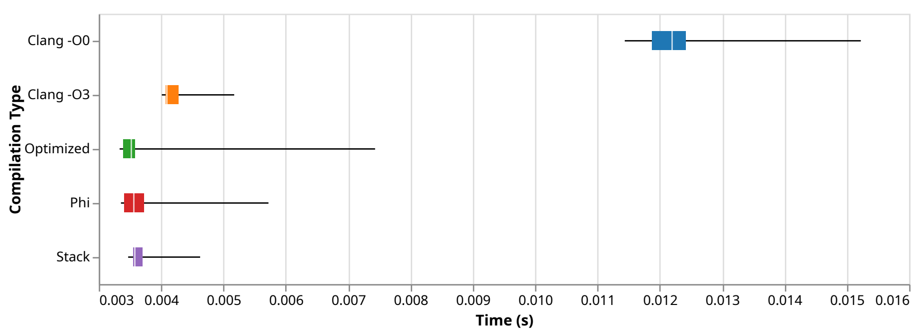
killerBubbles



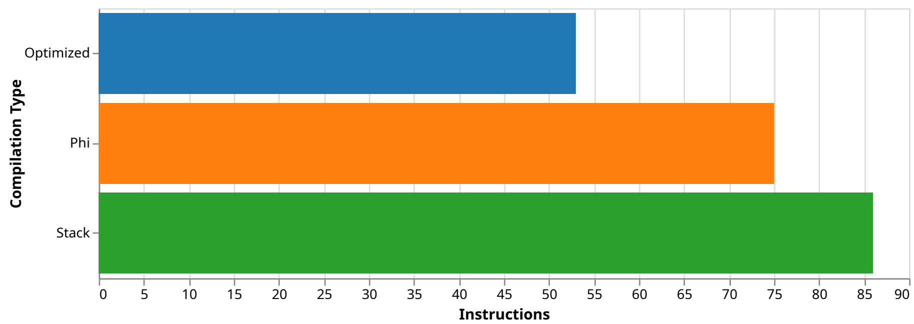
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	2.23463	0.0805044	10
1	Clang -O3	0.822052	0.0471532	10
2	Optimized	0.912434	0.0407113	10
3	Phi	0.947376	0.0360129	10
4	Stack	0.966933	0.0396408	10



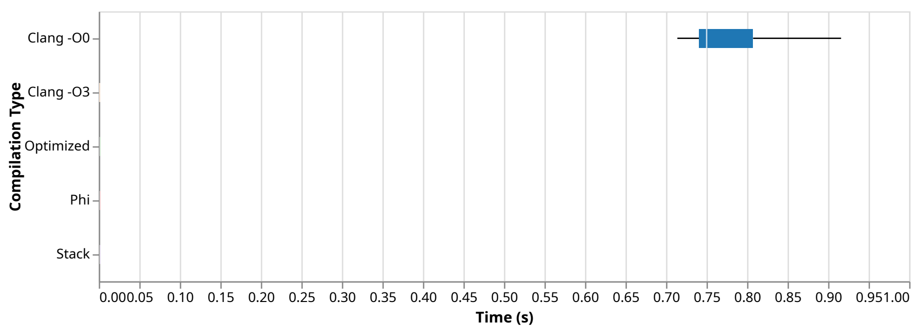
mile1



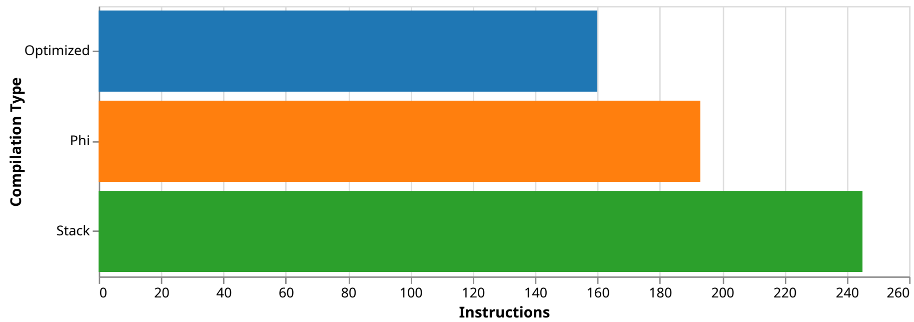
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.0122475	0.000701151	100
1	Clang -O3	0.00418146	0.000174946	100
2	Optimized	0.00359542	0.000495696	100
3	Phi	0.00359835	0.000275374	100
4	Stack	0.00363771	0.000162381	100



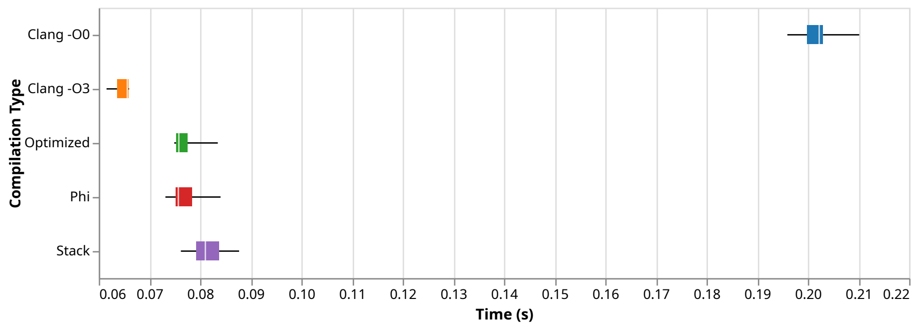
mixed



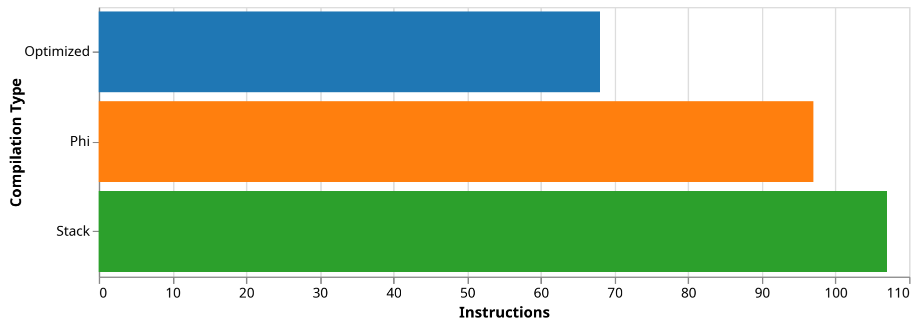
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.775253	0.0614453	10
1	Clang -O3	0.001174	1.88162e-05	10
2	Optimized	0.00163659	0.00016647	10
3	Phi	0.00172488	0.000210161	10
4	Stack	0.00156477	3.19865e-05	10



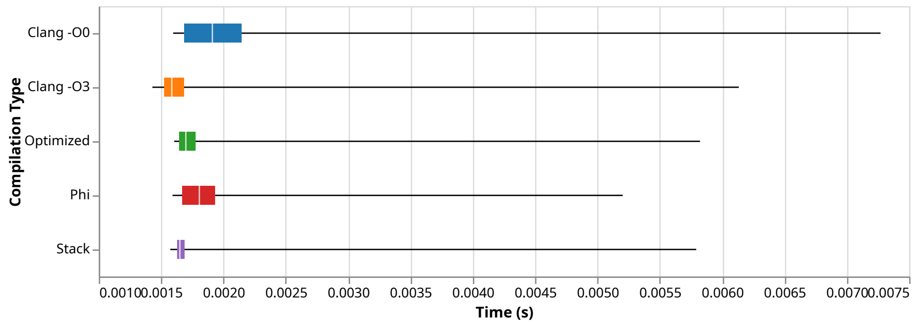
primes



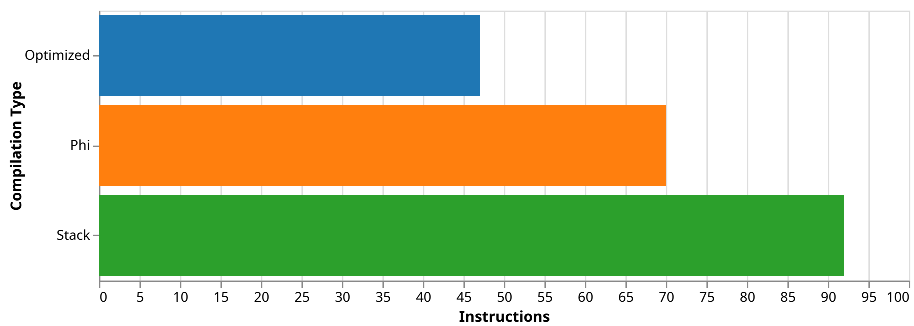
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.20195	0.00389725	10
1	Clang -O3	0.0646186	0.00162882	10
2	Optimized	0.0769258	0.00271621	10
3	Phi	0.0770291	0.00319007	10
4	Stack	0.0815229	0.00371512	10



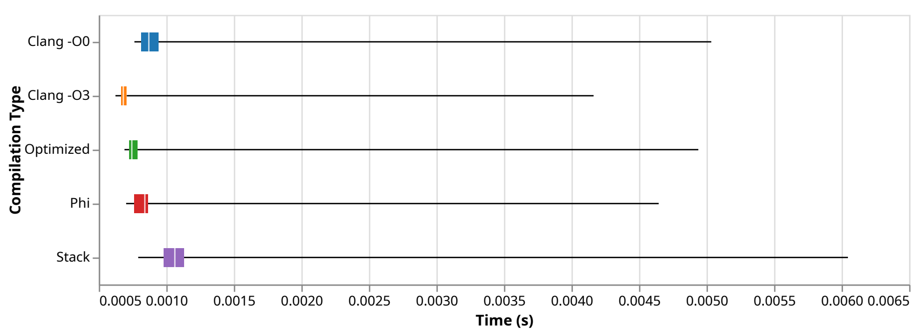
programBreaker



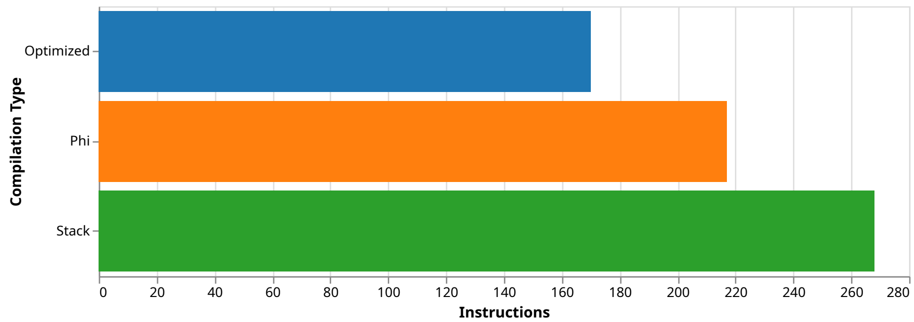
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.00212459	0.000868234	100
1	Clang -O3	0.00174558	0.000629745	100
2	Optimized	0.0017958	0.000510778	100
3	Phi	0.00196772	0.000658493	100
4	Stack	0.00172016	0.000426571	100



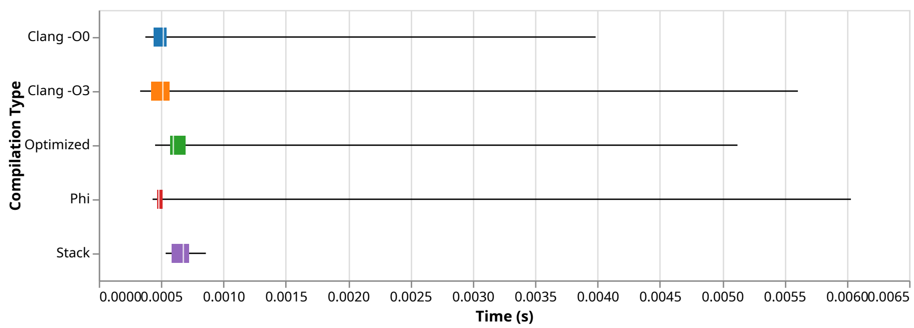
stats



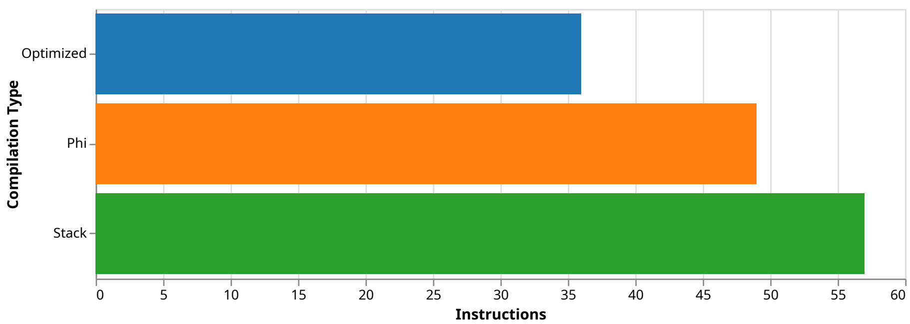
	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.00094608	0.000470526	100
1	Clang -O3	0.000767719	0.000460487	100
2	Optimized	0.000865027	0.000505186	100
3	Phi	0.000879366	0.00043165	100
4	Stack	0.00122152	0.000710277	100



wasteOfCycles



	Compilation Type	Average Time (s)	Standard Deviation (s)	Number of Runs
0	Clang -O0	0.000596629	0.000508627	100
1	Clang -O3	0.000691545	0.000717693	100
2	Optimized	0.00071117	0.000536161	100
3	Phi	0.000547953	0.000555762	100
4	Stack	0.000666436	9.17061e-05	100


Compilation Type
Optimized
Phi
Stack
0
5
10
15
20
25
30
35
40
45
50
55
60
Instructions