CalPhy

Spring 2015 with A. Aho
Programming Languages & Translators

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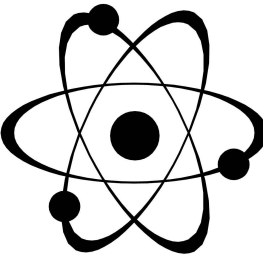
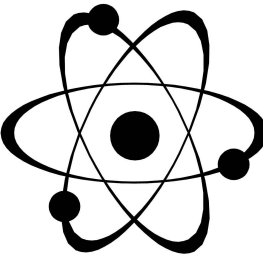
(Team 20)



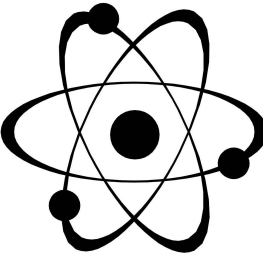
Why CalPhy?

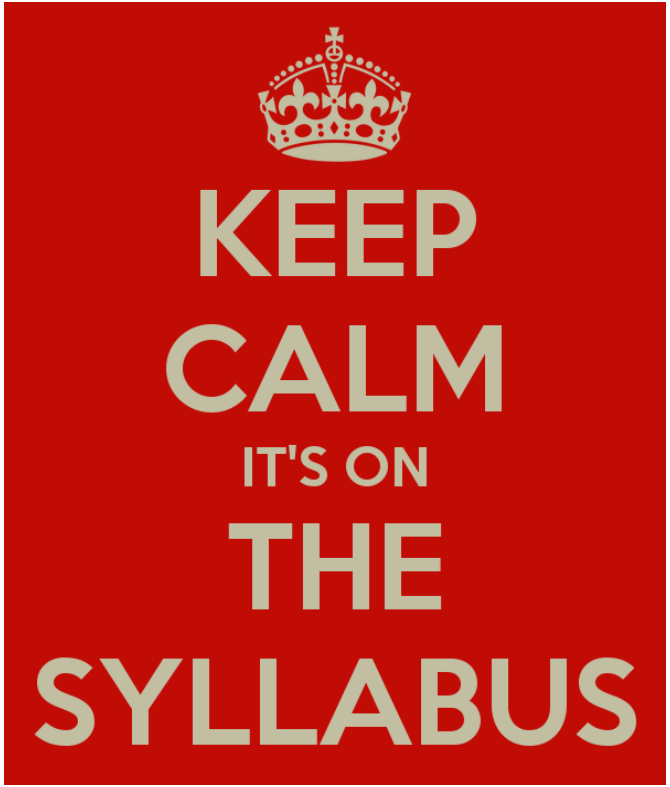
- Write problem information in CalPhy code.
- Use built-in Physics functions to solve problems.
- Convert Physics problems to code!
- Unit conservation is very important to us.



What problems can I solve?

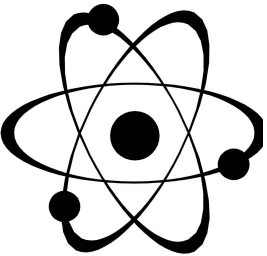
- Motion along a straight line.
- Vectors
- Motion in two dimensions.
- Force and Motion
- Kinetic Energy and Work
- Potential Energy
- Conservation of Energy
- and more...



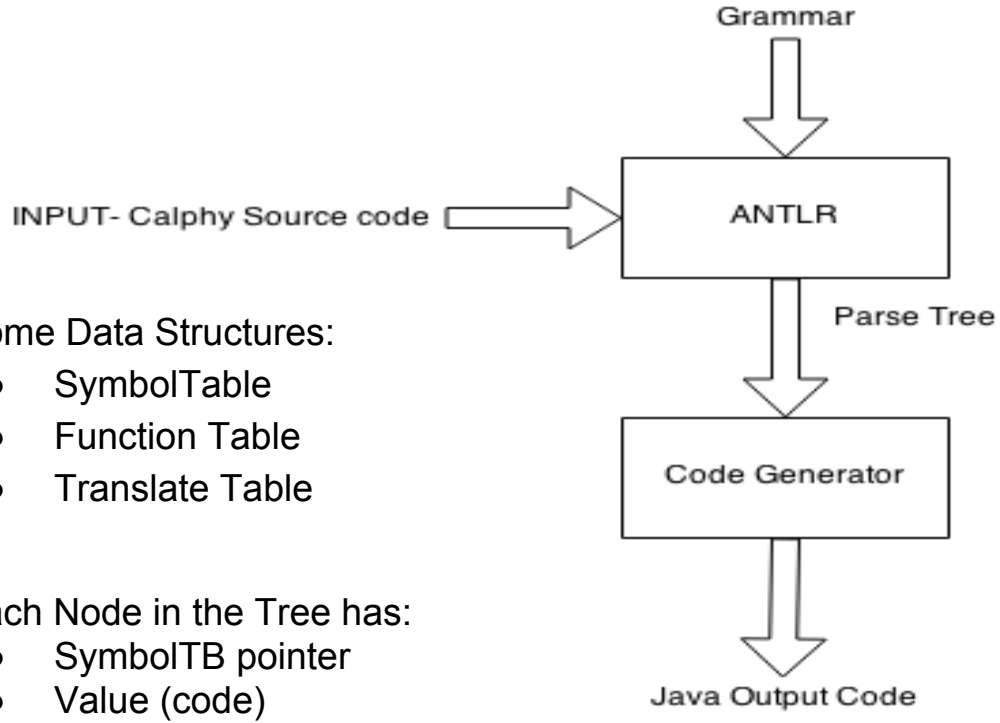


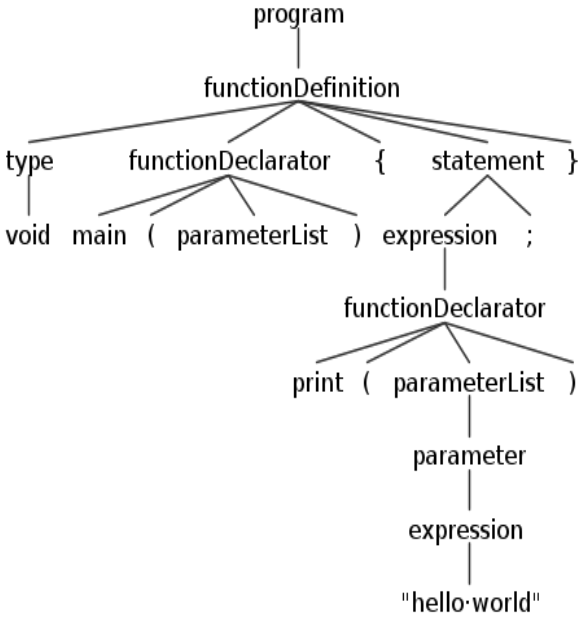
CalPhy Feature Set

- Physics data types
- Physics units
- Implicit unit conversion + type checking
- Built-in library with many helper functions



CalPhy Architecture





Some Data Structures:

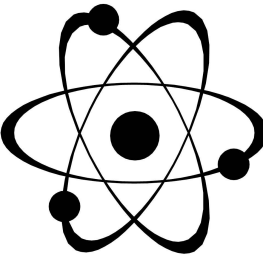
- SymbolTable
- Function Table
- Translate Table

Each Node in the Tree has:

- SymbolTB pointer
- Value (code)
- Type

“Hello World!”

```
void main() {
    print (“Hello World!”);
}
```



Physics Data Types + Units

Currently supported Physics Types:

Scalar : Time, Mass, Power, Energy

Vector : Velocity, Force, Acceleration, Displacement

Lots of choice of units (Total 40 units) : nm, um, mm, m, km

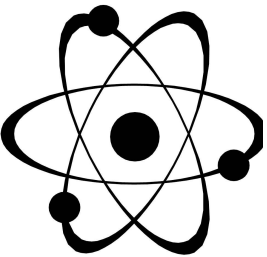
Q. A 1000 kg car is moving on a road with a speed of 60 m/s.

CalPhy code to initialize Physics types:

```
mass car_m = 1000 [_kg];    // scalar
velocity car_v = <60,0> [_m/s];   // vector
```

Physics Variable Manipulation

- Operators
  - Arithmetic manipulation
    - mass m2 = m1 * 2;
    - velocity v1 = <2, 3> + v2;
    - v1 += <2,3>;
- Access values in x and y direction (for vectors), access units
  - Acceleration a; a.x = 5; print (a.x);
  - force f; f.x = (m.value) * (a.x);
  - print(f.unit);
- Using library functions
  - See example …



Built-in Physics functions

Q. An object of mass 300 kg is observed to accelerate at the rate of 4 m/s^2. Calculate the force required to produce this acceleration.

```
//Initialize Physics variables
mass m = 300;
acceleration a = <4,0> [_m/s^2];

//Call built-in Physics methods
force f = getForce(m,a);
print(f);
```

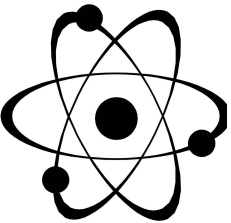
Output: <1200.0, 0.0> N

Example of library functions:

- velocity getVel(energy e, mass m)
- acceleration getAccel(force f, mass m)
- double sin(double degree)
- double arcsin(double value)
- And a lot more...

User Defined Methods

```
velocity doubleVel(velocity v) {
  return 2.0*v;
}
double doubleVel_x(velocity v) {
  return 2.0*v.x;
}
void main() {
  velocity v = <300,400> [_m/s];
  print("v in m/s : ");
  println(v);
  velocity v2 = doubleVel(v);
  println(v2);
  v2.x = doubleVel_x(v2);
  println(v2);
}
```



Some Rules:

- User defined functions need to have unique names.
- You need to define the function before using it.

Loops!

Q. A point moves in space at a speed of 10 m/s for 5 s, with an acceleration of 2 m/s^2. Calculate the distance travelled at each second.

```
int i;
time t = 5;
acceleration a = <2,0>;
velocity v = <10,0> [_m/s]
displacement d;
for (i = 0; i < t.value; i++) {
    d = getDisp(a, i, v);
    print(d);
}
```

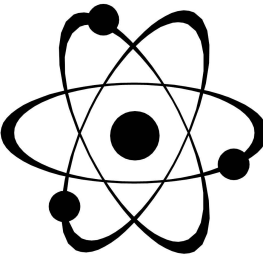
How do I run CalPhy code?

From the project root directory:

```
$ cd grammar
$ make all
$ cd ../testcode
$ ./sh calphyc.sh sourcecode.calphy output
$ ./sh calphy.sh output
```

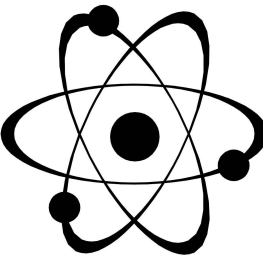
Project Management

Sample Physics Problems



Q1. If it takes 4J of work to stretch a Hooke's law spring 10 cm from its unstretched length, determine the extra work required to stretch it an additional 10 cm.

[*Diff. level = Easy*]

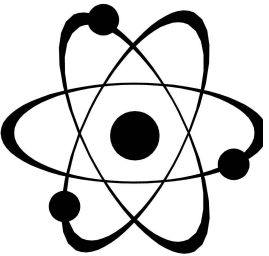


Q2. A stone is projected at a cliff of height h with an initial speed of 42.0 m/s directed at angle 60.0° above the horizontal. The stone strikes at 5.50 s after launching. Find:

(a) the height h of the cliff

(b) the speed of the stone just before impact at A.

[*Diff. level = Medium*]



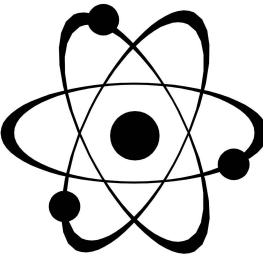
Q3. A block of mass m = 5.00 kg is pulled along a horizontal frictionless floor by a cord that exerts a force of magnitude F = 12.0 N at an angle u = 25.0°.

(a) What is the magnitude of the block's acceleration?

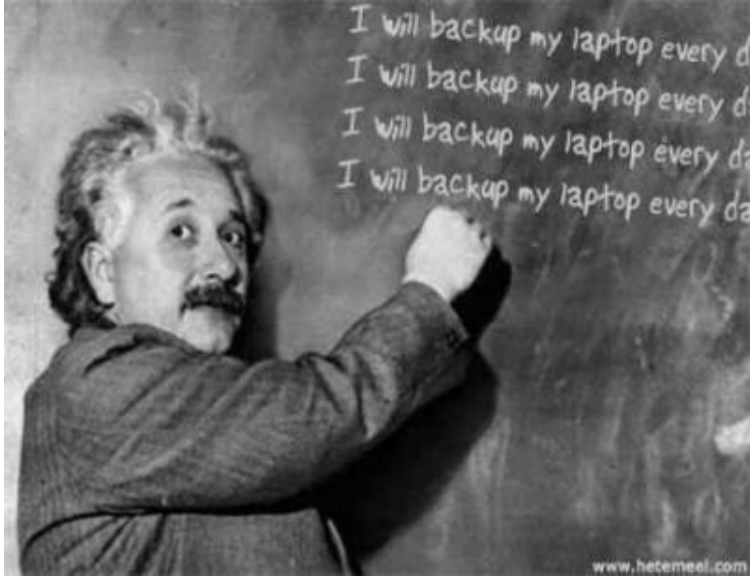
(b) The force magnitude F is slowly increased. What is its value just before the block is lifted (completely) off the floor?

(c) What is the magnitude of the block's acceleration just before it is lifted (completely) off the floor?

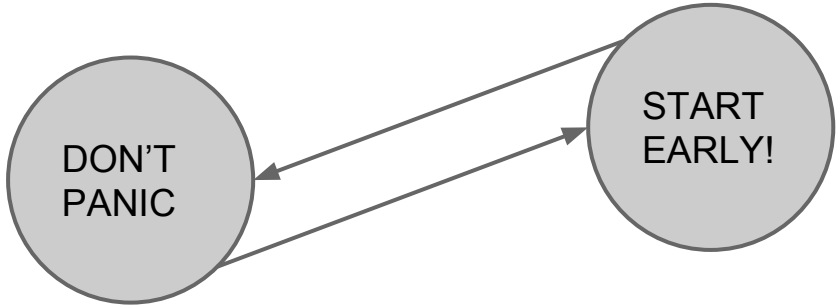
[*Diff. level = Hard*]



Some lessons learned...



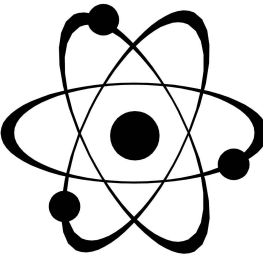
- Meet at least twice a week.
- Code some, test a lot.
- Use everyone's strengths.



Future Work- CalPhy v2.0

Added features:

- Graphical simulations for user to visualize motion
- Create graphs for a set of results.
- More CalPhy library methods- solve more Physics problems!
- Wider domain for Physics problem set- include Magnetism, Fluids, etc.
- Support for ArrayLists.
- Support for conversion to user defined unit.
- More acceptable units.



Acknowledgements

Thank you Prof. Aho, Daniel!

Github link:

`https://github.com/mrampton/calphy`

-CalPhy team