CSCI 334:
Principles of Programming Languages

Lecture 14: Project Ideas / Evaluation

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Williams

Announcements
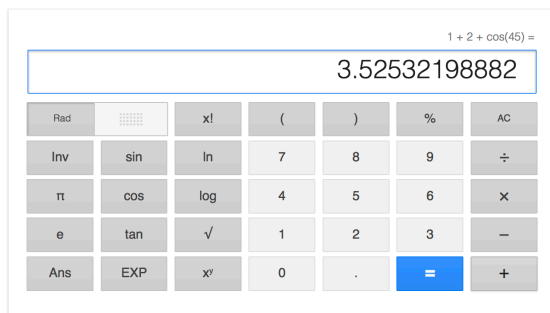
No class Thursday

Example: brace language

- An *expression* is a sequence of *terms*, consisting of *at least one term*.
- A *term* is either `'aaa'`, `'bbb'`, or a *brace expression*.
- A *brace expression* is `'{'`, followed by an *expression*, followed by `'}'`.
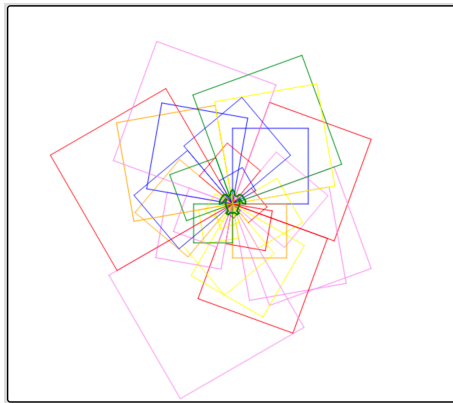

Lexical vs Dynamic Scope

Inspiration for Projects

Scientific Calculator

(using infix expressions)


```
                              1 + 2 + cos(45) =
                  3.52532198882

Rad    ▦     x!     (     )     %    AC
Inv   sin    ln     7     8     9     ÷
π     cos    log    4     5     6     ×
e     tan    √      1     2     3     −
Ans   EXP    xʸ     0     .     =     +
```

https://www.google.com/search?q=google+calculator

Logo Interpreter

```
TO square :length
  repeat 4 [ fd :length rt 90 ]
END
TO randomcolor
  setcolor pick [ red orange yellow green blue violet ]
END
clearscreen
repeat 36 [ randomcolor square random 200 rt 10 ]
```

Run
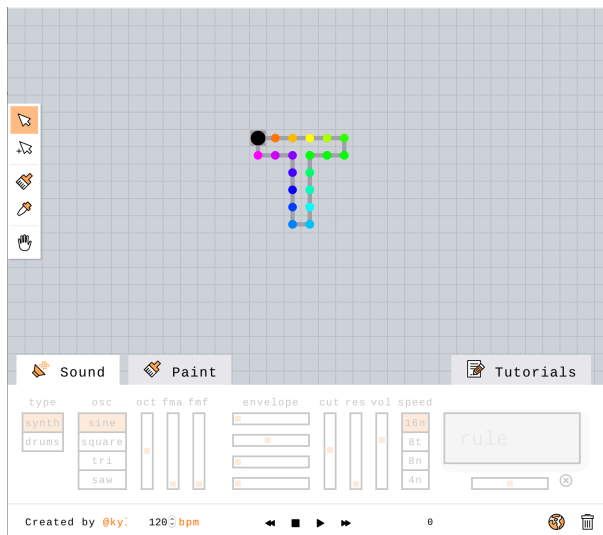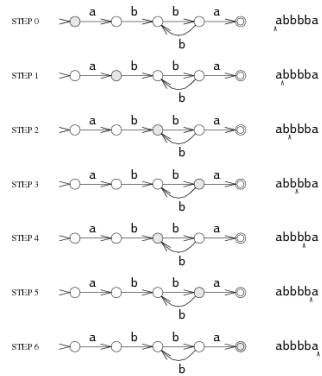
Clear

https://www.calormen.com/jslogo/

Turtle Audio

Sound   Paint   Tutorials

type osc oct fma fmf envelope cut res vol speed

synth sine   16n
drums square   8t
       tri   8n
       saw   4n

rule

Created by @ky: 120 bpm   0
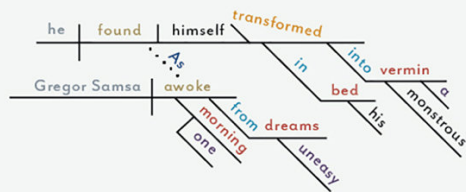
https://turtle.audio

Regular Expressions

Auto Sentence Diagramming

As Gregor Samsa awoke one morning from uneasy dreams
he found himself transformed in his bed into a monstrous vermin.
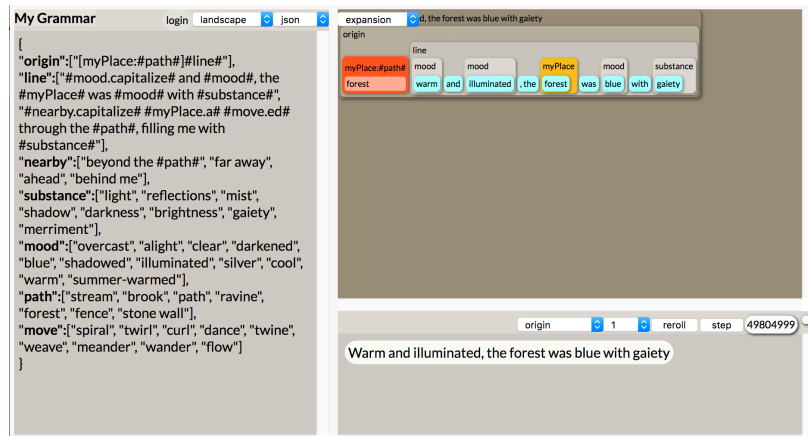
Kafka, Metamorphosis

BASIC

```
710 IF PR(IPS,3)=1 THEN PRINT "Your victim is badly wounded" :: RETURN
720 PRINT "You killed your victim"
730 PR(IPS,1)=0 :: IVW=8+IPS
740 VP(IVW)=IKM :: IPS=0
750 RETURN
760 PRINT "Possible commands:"
770 FOR I=1 TO 15
780 PRINT H$(I)
790 NEXT I
800 RETURN
810 IF IVW<>0 THEN 840
820 PRINT "There is nothing to take     here"
830 RETURN
840 IF BLL=0 AND IKM<25 THEN PRINT "You cannot take things that you do not see"
:: RETURN
850 PRINT "I take the ";V$(IVW);" for you"
860 B(IBMAX)=IVW
870 IBMAX=IBMAX+1
880 VP(IVW)=0
890 IVW=0
900 RETURN
910 INPUT "What would you like to drop? ":D$
920 LNG=LEN(D$)
930 IVWB=0
940 FOR I=1 TO 12
950 IF D$=SEG$(V$(I),1,LNG)THEN IVWB=I :: I=12
960 NEXT I
970 IF IVWB<>0 THEN 1000
980 PRINT "I do not understand you"
```

A BNF parser and generator

http://tracery.io/editor/

An algebra solver

ChucK

```
SinOsc ge => dac;

while( true )
{
  Math.random2f(30,1000) => ge.freq;
  .5::second => now;
}
```

Program Evaluation as Reduction

1 + 2 * 3 - 1

$(\lambda x.\lambda x.x)(\lambda x.y)$

$\Downarrow \alpha$

$(\lambda x.\lambda a.a)(\lambda b.y)$

Goal: alpha-normal form

1. No bound variable uses the same name as any free variable.
2. No bound variable uses the same name as any other bound variable.

In other words, all variable names are unique.

Parts

```
e: Expr            An expression
b: Set<char>       Variable bindings
r: Map<char,char>  Renamings
```

```
alphanorm(e: Expr)(b: Set<char>)(r: Map<char,char>)
              : Expr*Set<char>
```

What is passed in; returned

```
alphanorm(e: Expr)(b: Set<char>)(r: Map<char,char>)
                : Expr*Set<char>
```

Note that we want the set of bindings to persist,
therefore it is both *passed in* and *out*.

But the set of renamings is *scoped*: it is only passed in.

Algorithm

Var(v):
  if there is a renaming rule, rename and return
renamed Var;
  otherwise, return original Var

App(e1, e2):
  α-norm e1 & e2 and return App(e1, e2)

Abs(v,e):
  if v is already bound, add renaming rule, **α**-norm e,
then return Abs(v', e');
  otherwise, return **α**-norm e and return Abs(v, e')