```
from __future__ import division
from searcher import *
from models import *
import sys, sk
from decimal import *
import numpy as np
from anzeigen import *
from time import gmtime, strftime
import sys, random, math, datetime, time,re
sys.dont_write_bytecode = True
rdivDemo=sk.rdivDemo

def what2say(k,modelName):
  hi, lo, kooling, indepSize, thresh, iterations = k.eigenschaften()
  if modelName.__doc__=="Simulated Annealing":
    return {'Max: ': hi, 'Min: ': lo, 'Cooling Factor: ':kooling,
            'Iterations: ': iterations}
  elif modelName.__doc__=="Max Walk-SAT":
    return {'Max: ': hi, 'Min: ': lo, 'Retries: ': 100,
            'Iterations: ': 100}
  elif modelName.__doc__='Genetic Algorithm':
    return {'Max: ': hi, 'Min: ': lo, 'Population: ': 50,
            'Generations: ': 400, 'crossover: ': 0.6}
  elif modelName.__doc__='Differential Evolution':
    return {'Max: ': hi, 'Min: ': lo, 'Iterations: ': 100,
            'NP: ':100, 'f: ':0.75, 'cf: ':0.3}



for x in [Viennet3]:
#==============================================================================
# for x in [Schaffer, Kursawe,
#           Fonseca, ZDT1, ZDT3, Viennet3]:
#==============================================================================
  early=True
  E=[]
  for i in xrange(50): sys.stdout.write('_')
  print '\n'
  print 'Model: ', x.__name__
  for i in xrange(50): sys.stdout.write('-')
  print '\n'
  print strftime("%a, %d %b %Y %H:%M:%S ", gmtime()), 'GMT', '\n'

  for y in [diffEvolve, GA, SimulatedAnnealer, MaxWalkSat]:
    eb=30*[0]
    print 'Searcher: ', y.__doc__
    k=x()
    reps=30
    dspl=anzeigen();
    hi, lo, kooling, indepSize, thresh, iterations = k.eigenschaften()
    print 'Settings:'
    toprint=what2say(k,y);
    for k in toprint:
      print k, toprint[k]
    #if early: print 'Early Termination!'  , '\n'
    for r in xrange(reps):
      a=y(x,disp=False,early=early)
      eb[r] =  a.runSearcher()
    eb.insert(0,y.__doc__)
    E.append(eb)
    #print dspl.xtile(eb[1:])
    """for r in xrange(reps):
   print dspl.xtile(eb[r:r+50], lo=lo, hi=hi)"""
    print 'Energy: ', "{:.3E}".format(Decimal(str(np.sum(eb[1:])/reps))), '\n'

  def _rDiv():
    rdivDemo(E)
  _rDiv()

  #

  sys.stdout.write('\n')
```

```
# -*- coding: utf-8 -*-
"""
Created on Mon Sep 15 03:04:43 2014

@author: rkrsn
"""
from __future__ import division
import sys
import math, random, numpy as np, scipy as sp
from math import ceil
sys.dont_write_bytecode = False
from models import *
from anzeigen import *
from dynamikliste import *
# from sk import Num
import analyzer
import types

# Define some aliases.
rand = random.uniform
randi = random.randint
exp = math.exp

class SimulatedAnnealer(object):
  "Simulated Annealing"
  def __init__(self, modelName, disp=False, early=False):
    self.modelName = modelName
    self.disp = disp
    self.early = early
  def runSearcher(self):
    modelbasics = modelBasics(self.modelName);
    modelFunction = self.modelName()
    anz = anzeigen();
    hi, lo, kooling, indepSize, thresh, iterations = \
     modelFunction.eigenschaften()
    emax, emin = modelbasics.baselining(self.modelName)
    sb = s = [randi(lo, hi) for z in xrange(indepSize)];
    eb = e = modelbasics.energy(s, emax, emin)
    enRec = dynamikliste()  # Creates a growing list.
    enRec[0] = 0;
    # Since iterations start from 1, lets initialize enRec[0] to 0
    analyser = analyzer.analyser()
    epochs = 5 if self.early else iterations;
    k = 1;
    while epochs ∧ k < iterations:
      sn = modelbasics.neighbour(s, hi, lo)
      en = modelbasics.energy(sn, emax, emin)
      t = k / iterations
      if en < eb:
        eb, sb, enRec[k] = en, sn, en;
        if self.disp:
          modelbasics.say('!')

      if en < e:
        s, e, enRec[k] = sn, en, en;
        if self.disp:
          modelbasics.say('+')

      if modelbasics.do_a_randJump(en, e, t, kooling):
        # The cooling factor needs to be really low for some reason!!
        s, e, enRec[k] = sn, en, en;
        if self.disp:
          modelbasics.say('?')
      else:
        enRec[k] = en
      if self.disp:
        modelbasics.say('.')
      if k % 50 ≡ 0 ∧ k > 50:
        # print enRec[:-10]
        proceed = analyser.isItGettinBetter(enRec[k - 100:])
        if proceed:
          epochs += 1;
        else:
```



```
          epochs -= 1;
        # print enRec[k-40:] #
      k = k + 1
      if k % 40 ≡ 0:
        if self.disp:
          modelbasics.say('\n')  # sa.say(format(sb,'0.2f'))

    if self.disp:
      modelbasics.say('\n'),
  # Print Energy and best value.
    for i in xrange(k):
      if self.disp:
        if i % 50 ≡ 0:
          print anz.xtile(enRec[i - 50:])
    if self.disp:
      modelbasics.say('\n')
    return eb

class MaxWalkSat(object):
  "Max Walk-SAT"
  def __init__(self, modelName, disp=False, early=True, maxTries=100,
               maxChanges=100):
    self.modelName = modelName
    self.disp = disp
    self.maxTries = maxTries
    self.maxChanges = maxChanges
  def runSearcher(self):
    modelbasics = modelBasics(self.modelName);
    modelFunction = self.modelName()
    hi, lo, kooling, indepSize, thresh, iterations = \
    modelFunction.eigenschaften()
    emax, emin = modelbasics.baselining(self.modelName)
    for i in xrange(self.maxTries):
        # Lets create a random assignment, I'll use list comprehesions here.
        x = xn = xb = [rand(lo, hi) for z in xrange(indepSize)]
        # Create a threshold for energy,
        # let's say thresh=0.1% of emax (which is 1) for starters
        for j in xrange(self.maxChanges):
            # Let's check if energy has gone below the threshold.
            # If so, look no further.
            if modelbasics.energy(xn, emax, emin) < thresh:
                xb=xn
            else:
              # Choose a random part of solution x
                randIndx = randi(0, indepSize - 1)
                if rand(0, 1) > 1 / (indepSize + 1):  # Probablity p=0.33
                    y = xn[randIndx]
                    xn[randIndx] = modelbasics.simpleneighbour(y, hi, lo)
                    # print 'Random change on', randIndx
                else:
                    # xTmp is a temporary variable
                    xBest = emax;
                    # Step from xmin to xmax, take 10 steps
                    Step = np.linspace(lo, hi, 10)
                    for i in xrange(np.size(Step)):
                        xNew = xn; xNew[randIndx] = Step[i];
                        if modelbasics.energy(xNew, emax, emin) < xBest:
                            xBest = modelbasics.energy(xNew, emax, emin)
                            xn = xNew

            if modelbasics.energy(xn, emax, emin) < modelbasics.energy(xb,
                                                                       emax,
                                                                       emin):
              xb = xn
              print modelbasics.energy(xn, emax, emin)
    return modelbasics.energy(xb, emax, emin)

class GA(object):
  "Genetic Algorithm"
  def __init__(self, modelName, disp=False, early=True, popcap=50,
               generations=400, crossover=0.6):
    self.modelName = modelName
    self.disp = disp
```

```
        self.popcap = popcap
        self.generations = generations
        self.crossover= crossover
    def runSearcher(self):
      modelbasics = modelBasics(self.modelName);
      modelFunction = self.modelName()
      hi, lo, kooling, indepSize, thresh, iterations = \
      modelFunction.eigenschaften()
      emax, emin = modelbasics.baselining(self.modelName)
      #-------------------------------------------------------------------------
      def init_pop(indepSize, lo, hi, N=self.popcap):
        return [[rand(lo,hi) for _ in xrange(indepSize)] for _ in xrange(N)]

      #-------------------------------------------------------------------------
      def evalPop(Pop, emax, emin):
        score=[];
        for individual in Pop:
          score.append(modelbasics.energy(individual,emax,emin))
        indices=[i[0] for i in sorted(enumerate(score), key=lambda x:x[1],
                                      reverse=False)]
        scores=[i[1] for i in sorted(enumerate(score), key=lambda x:x[1],
                                     reverse=False)]
        return [Pop[z] for z in indices], scores

      #-------------------------------------------------------------------------
      def evolve(Pop, emax, emin, hi, lo, indepSize, retain=0.2, randSelect=0.05,
                 crossover=self.crossover, mutate=1/(indepSize*(hi-lo))):
        parents, score=evalPop(Pop, emax, emin)
        parents=parents[:int(len(score)*retain)]
        # Increase diversity by selecting bad parents
        for indv in parents[int(len(score)*retain):]:
          if rand(0,1)<randSelect:
            parents.append(indv)

        # Crossover parents to create children
        childern=[]
        numChildren=len(Pop)-len(parents)

        while len(childern)<numChildren:
          he=randi(0,len(parents)-1);
          she=randi(0,len(parents)-1);
          #print parents
          if he≠she:
            he=parents[he]; she=parents[she]
            if indepSize≡1:
              flatten = lambda x: x if ¬ isinstance(x, list) else x[0]
              #print he, she
              child=0.5*(flatten(he)+flatten(she)) \
              if mutate<rand(0,1) else rand(lo,hi)
            else:
              #print he, she
              child=he[:int(0.5*indepSize)]+she[int(0.5*indepSize):]
              if mutate>rand(0,1): child[randi(0,indepSize-1)]=rand(lo,hi)
            childern.append(child)

        parents.extend(childern)

        return parents

      #-------------------------------------------------------------------------
      Pop=init_pop(indepSize, lo, hi, self.popcap)
      pn, en= evalPop(Pop, emax, emin)
      eb=en[0]
      pBest=pn[0]
      for i in xrange(self.generations):
        Pop=evolve(Pop, emax, emin, hi, lo, indepSize)
        # Spit out the magic variables please
        pn, en= evalPop(Pop, emax, emin)
        if en[0]<eb:
          eb=en[0]; pBest=pn[0]
      #print pBest
      return eb
```



```
class diffEvolve(object):
  "Differential Evolution"
  def __init__(self, modelName, disp=False, early=False,
               maxIter=100, NP=100, f=0.75, cf=0.3):
    self.modelName = modelName
    self.disp=disp
    self.early=early
    self.maxIter=maxIter
    self.NP,self.f,self.cf=NP,f,cf
  def runSearcher(self):
    modelbasics = modelBasics(self.modelName);
    modelFunction = self.modelName()
    hi, lo, __, indepSize, thresh, __ = modelFunction.eigenschaften()
    emax, emin = modelbasics.baselining(self.modelName)
    #-------------------------------------------------------------------------
    def inititalPopultaion(indepSize, lo, hi, N=self.NP):
      return [[lo+(hi-lo)*rand(0,1) for _ in xrange(indepSize)]
              for _ in xrange(N)]

    #-------------------------------------------------------------------------
    def evalFront(Pop, emax, emin):
      score=[];
      for individual in Pop:
        score.append(modelbasics.energy(individual,emax,emin))
      indices=[i[0] for i in sorted(enumerate(score), key=lambda x:x[1],
                                    reverse=False)]
      scores=[i[1] for i in sorted(enumerate(score), key=lambda x:x[1],
                                   reverse=False)]
      return Pop[indices[0]], scores[0]

    #-------------------------------------------------------------------------
    def spawn(P0, Frontier, hi, lo, NP=self.NP, cf=self.cf, f=self.f):
      """
      Create a new member for the frontier using some new values and by
      extrapolating P0 (the old value)
      """
      first = P0
      second, third, fourth = first, first, first

      while second≡first:
        second=Frontier[randi(0,len(Frontier)-1)]
      while third≡second ∨ third≡first:
        third=Frontier[randi(0,len(Frontier)-1)]
      while fourth≡second ∨ fourth≡first ∨ fourth≡third:
        fourth=Frontier[randi(0,len(Frontier)-1)]
      trim = lambda x: max(lo, min(x, hi))
      return [first[z] if cf<rand(0,1) else trim(second[z]+f*(third[z]-fourth[z]
))
              for z in xrange(len(first))]

    Frontier=inititalPopultaion(indepSize, lo, hi)
    gBest, eBest = evalFront(Frontier, emax, emin)
    maxIter=self.maxIter
    while maxIter ∧ (eBest>thresh):
      newFrontier=[]
      for F_i in Frontier:
        newSamp=spawn(F_i, Frontier, hi, lo)
        if modelbasics.energy(newSamp,emax,emin) < modelbasics.energy(newSamp,
                                                                      emax,emin)
:
          newFrontier.append(newSamp)
        else:
          newFrontier.append(F_i)
      Frontier=newFrontier
      gBest, eBest = evalFront(Frontier, emax, emin)
      maxIter-=1
    return eBest
    #-------------------------------------------------------------------------


if __name__ ≡ 'main':
  SimulatedAnnealer(Schaffer)
```

```
"""
A models file that can be imported to run optimizers
"""
from __future__ import division
import sys, types
import math, random, numpy as np, scipy as sp
sys.dont_write_bytecode = False
# Define some aliases.
rand=random.uniform
randi=random.randint
exp=math.e
sin=math.sin
sqrt=math.sqrt
pi=math.pi

class modelBasics(object):
  def __init__(i,model):
    i.model=model()
    i.name=model.__name__
  def do_a_randJump(i, e, en, t, k):
    p=exp**(-(e-en)/(t**k))<rand(0,1)
    return p
  def simpleneighbour(self,x,xmax,xmin):
      return xmin+(xmax-xmin)*rand(0,1)
  def neighbour(i,x,xmax,xmin):
    def __new(x,z):
        return xmin+(xmax-xmin)*rand(0,1) if rand(0,1)<1/(i.model.indepSize) \
          else x[z]
    x_new=[__new(x,z) for z in xrange(i.model.indepSize)]
    return x_new
  def energy(i,x,emax,emin):
    ener=i.model.score(x);
    e_norm= abs((ener-emin)/(emax-emin))
    return e_norm
  def baselining(i,model):
    emax=0;emin=0;
    indepSize=i.model.indepSize;
    for _ in xrange(int(1e3)):
      x_tmp=[rand(i.model.baselo,i.model.basehi) for _ in xrange(indepSize)]
      ener=i.model.score(x_tmp);
      if ener>emax:
        emax=ener
      elif ener<emin:
        emin=ener
    return emax,emin
  f=open('log_sa_schaffer.txt','w')
  def say(i,x):
    sys.stdout.write(str(x));
    sys.stdout.flush()

class Schaffer(object):

  def __init__(i,hi=100,lo=-100, basehi=1000, baselo=-1000, kooling=0.7,
               indepSize=1, thresh=1e-2, iterations=2000):
    i.hi, i.lo, i.basehi, i.baselo=  hi, lo, basehi, baselo
    i.thresh=thresh
    i.kooling, i.indepSize, i.iterations= kooling, indepSize, iterations
    random.seed()
  def f1(i,x):
    return x*x
  def f2(i,x):
    return (x-2)**2
  def score(i,x):
    from compiler.ast import flatten
    flatten = lambda x: x if ¬ isinstance(x, list) else x[0]
    return i.f1(flatten(x))+i.f2(flatten(x))
  def eigenschaften(i):
    return i.hi, i.lo, i.kooling, i.indepSize, i.thresh, i.iterations

class Kursawe(object):
  def __init__(i,hi=5,lo=-5,kooling=0.6, a=0.8, b=3, indepSize=3, basehi=1000,
               baselo=-1000, thresh=1e-2, iterations=2000):
    i.hi, i.lo, i.basehi, i.baselo, i.kooling = hi, lo, basehi, baselo, kooling
```



```
    i.thresh=thresh
    i.a, i.b, i.indepSize, i.iterations= a, b, indepSize, iterations
    random.seed()
  def f1(i,x):
    return np.sum([-10*exp**(-0.2*sqrt(x[z]**2+x[z+1]**2)) \
                   for z in xrange(i.indepSize-1)])
  def f2(i,x):
    return np.sum([abs(x[z])**i.a+5*sin(x[z]**i.b) \
                   for z in xrange(i.indepSize)])
  def score(i,x):
    return i.f1(x)+i.f2(x)
  def eigenschaften(i):
    return i.hi, i.lo, i.kooling, i.indepSize, i.thresh, i.iterations

class Fonseca(object):
  def __init__(i,hi=4,lo=-4, basehi=5, baselo=-5, kooling=1.99, indepSize=3,
               thresh=1e-2, iterations=2000):
    i.hi, i.lo, i.basehi, i.baselo, i.kooling, i.indepSize, i.thresh, i.iteratio
ns= \
    hi, lo, basehi, baselo, kooling, indepSize, thresh, iterations
    random.seed()
  def f1(i,x):
    return (1-exp**np.sum([(x[z]-1/((i.indepSize)**0.5)) \
                           for z in xrange(i.indepSize)]))
  def f2(i,x):
    return (1-exp**np.sum([(x[z]+1/((i.indepSize)**0.5)) \
                           for z in xrange(i.indepSize)]))
  def score(i,x):
    return i.f1(x)-i.f2(x)
  def eigenschaften(i):
    return i.hi, i.lo, i.kooling, i.indepSize, i.thresh, i.iterations

class ZDT1(object):
  def __init__(i,hi=1,lo=0, basehi=1, baselo=0, kooling=7e-3, indepSize=30,
               thresh=1e-2, iterations=2000):
    i.hi, i.lo, i.basehi, i.baselo, i.thresh= hi, lo, basehi, baselo, thresh
    i.kooling, i.indepSize, i.iterations= kooling, indepSize, iterations
    random.seed()
  def f1(i,x):
    return x[0]
  def g(i,x):
    return (1+9*(np.sum(x[1:]))/(i.indepSize-1))
  def f2(i,x):
    return i.g(x)*(1-sqrt(x[0]/i.g(x)))
  def score(i,x):
    return (i.f1(x)-i.f2(x))
  def eigenschaften(i): # German for features
    return i.hi, i.lo, i.kooling, i.indepSize, i.thresh, i.iterations

class ZDT3(object):
  def __init__(i,hi=1,lo=0, basehi=1, baselo=0, kooling=7e-3, indepSize=30,
               thresh=1e-2, iterations=2000):
    i.hi, i.lo, i.basehi, i.baselo, i.thresh = hi, lo, basehi, baselo, thresh
    i.kooling, i.indepSize, i.iterations = kooling, indepSize, iterations
    random.seed()
  def f1(i,x):
    return x[0]
  def g(i,x):
    return (1+9*(np.sum(x[1:]))/(i.indepSize-1))
  def f2(i,x):
    return i.g(x)*(1-(x[0]/i.g(x))**0.5-(x[0]/i.g(x))*sin(10*math.pi*x[0]))
  def score(i,x):
    return (i.f1(x)-i.f2(x))
  def eigenschaften(i): # German for features
    return i.hi, i.lo, i.kooling, i.indepSize, i.thresh, i.iterations


class Viennet3(object):
  def __init__(i,hi=1,lo=0, basehi=1, baselo=0, kooling=7e-3, indepSize=2,
               thresh=1e-2, iterations=2000):
    i.hi, i.lo, i.basehi, i.baselo, i.thresh =  hi, lo, basehi, baselo, thresh
    i.kooling, i.indepSize, i.iterations= kooling, indepSize, iterations
    random.seed()
```

```
      def f1(i,x):
        return 0.5*x[0]**2+x[1]**2+sin(x[0]**2+x[1]**2)
      def f2(i,x):
        return (3*x[0]-2*x[1]+4)**2/8+(x[0]-x[1]+1)**2/27+15
150   def f3(i,x):
        return 1/(x[0]**2+x[1]**2+1)-1.1*exp**(-x[0]**2-x[1]**2)
      def score(i,x):
        return (i.f1(x)-i.f2(x)-i.f3(x))
      def eigenschaften(i): # German for features
155     return i.hi, i.lo, i.kooling, i.indepSize, i.thresh, i.iterations
```