

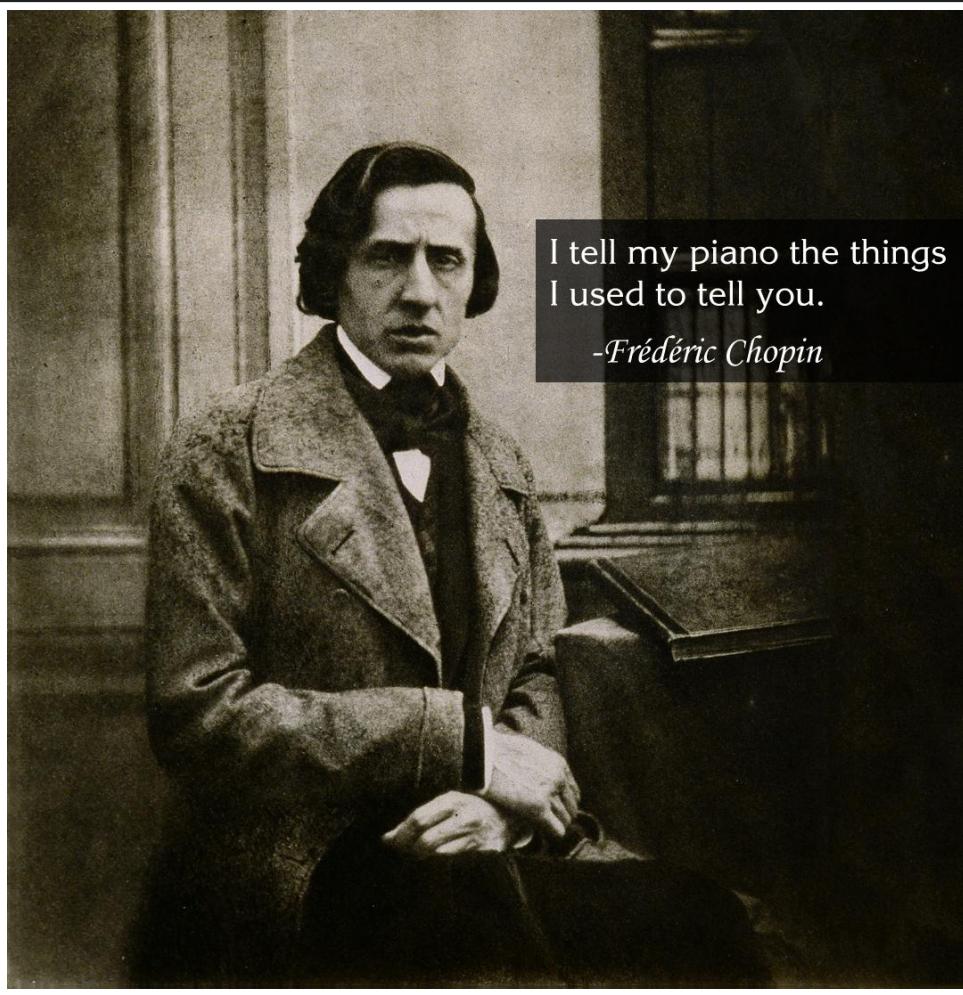
 MUSIC IS A LANGUAGE 

# TALK



# HEAR

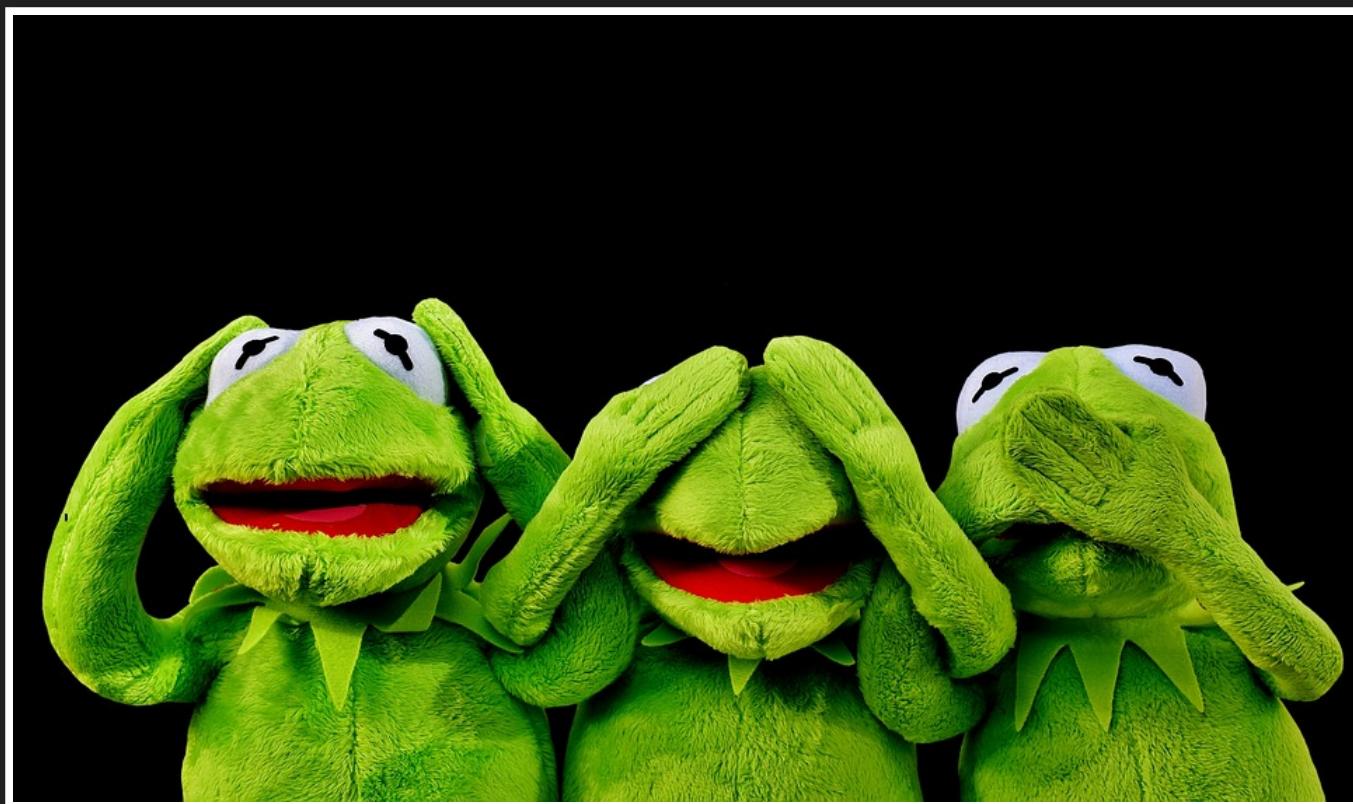




I tell my piano the things  
I used to tell you.

*-Frédéric Chopin*

# SEE



# COMMUNICATION



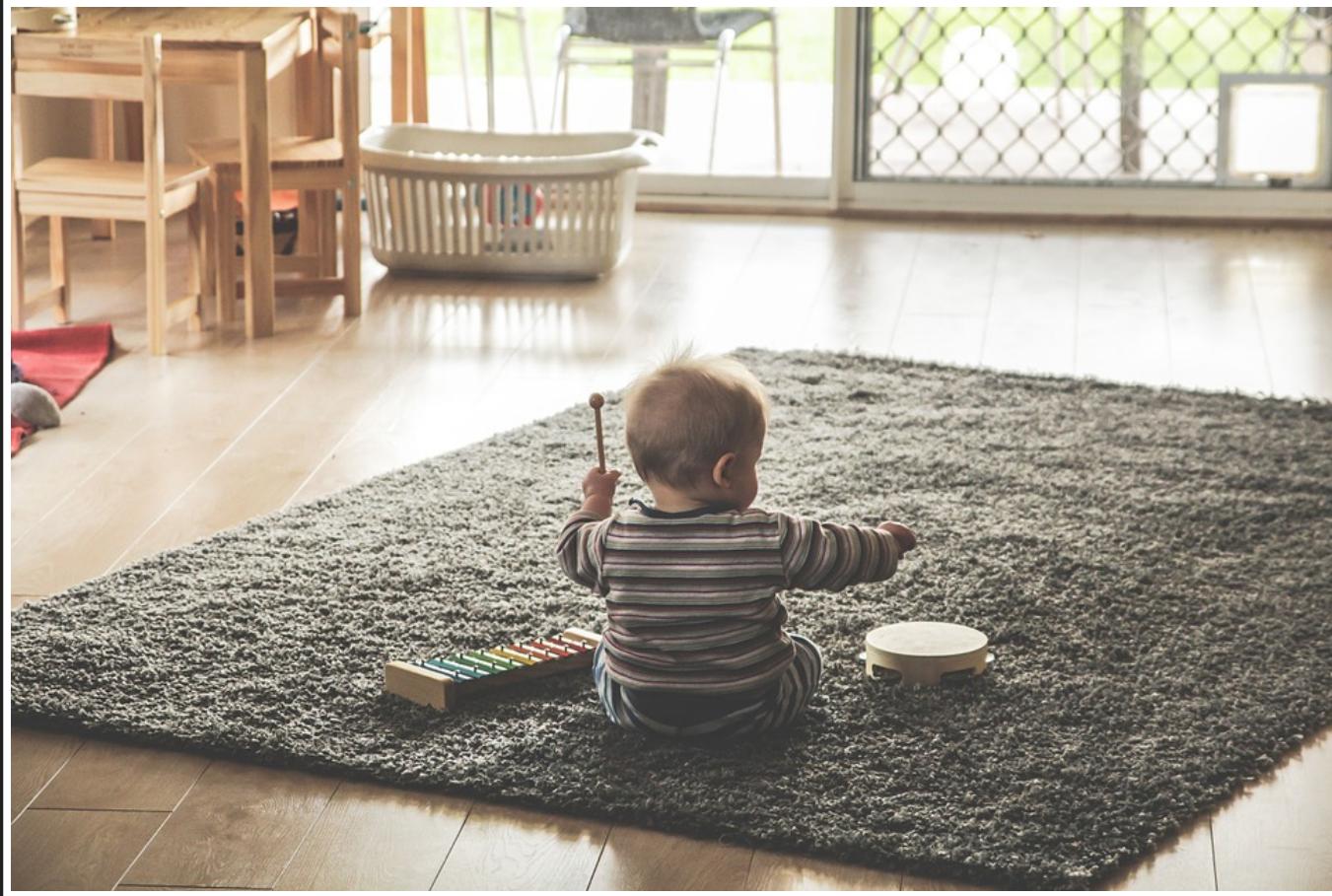
# EMOTIONS



# IT'S NOT ALWAYS SOFT!



# SOFT BUT ...



# FEEL THE ANGER...



♪ STILL A LANGUAGE ♪

# ALPHABET



# NOTES



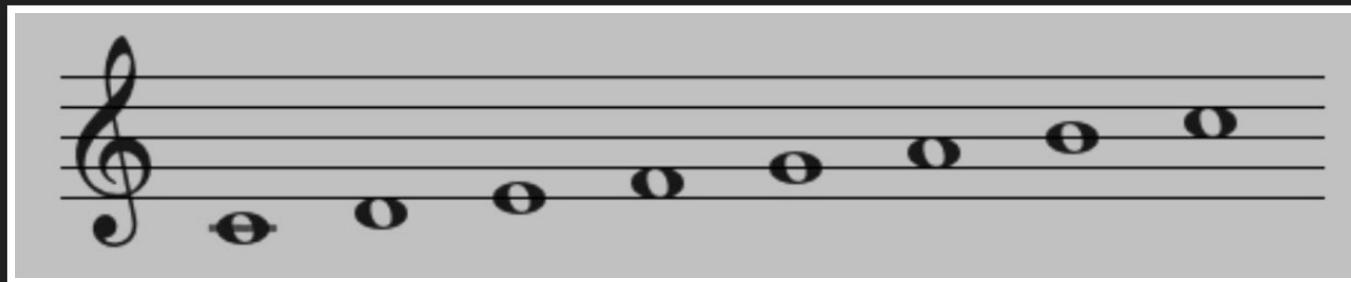
# DO RE MI FA SOL LA SI



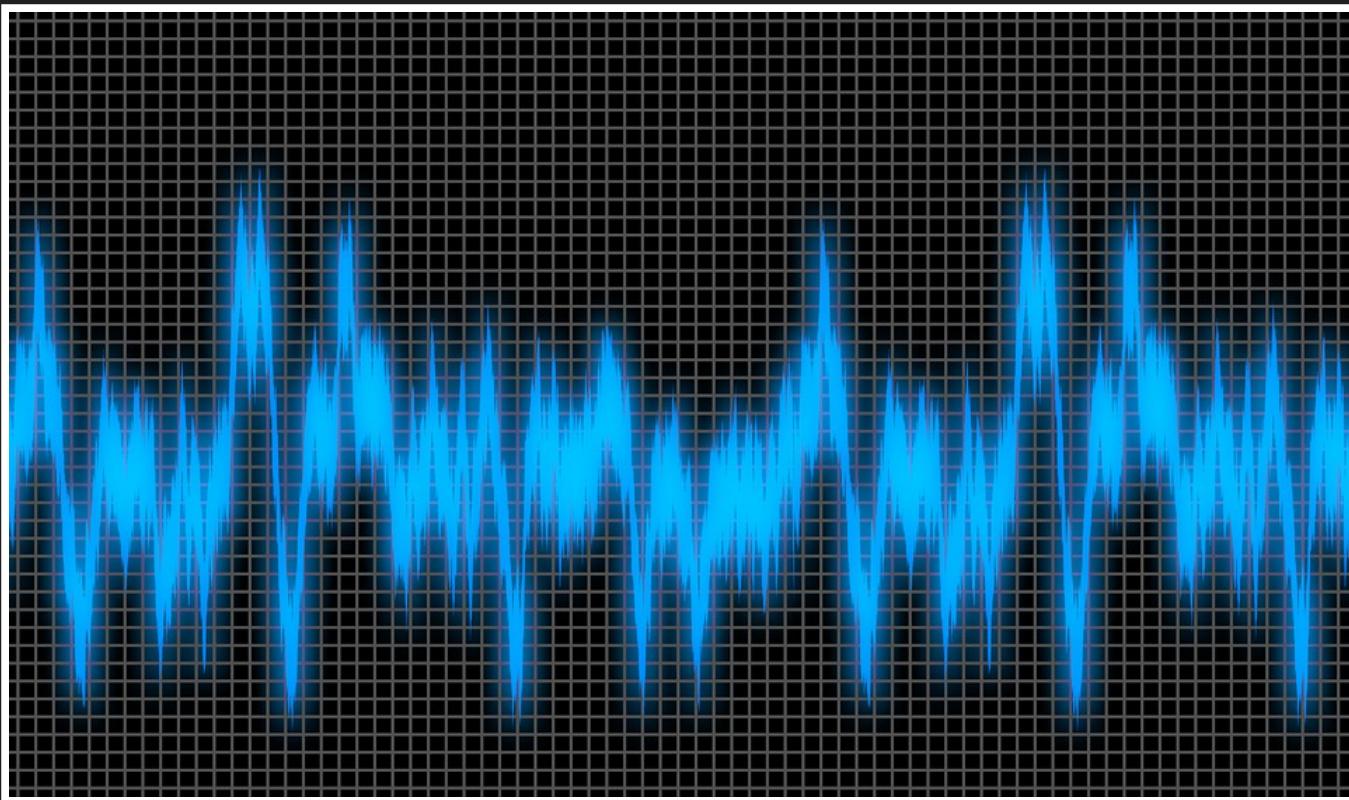
Do	Ré	Mi	Fa	Sol	La	Si
C	D	E	F	G	A	B
C	D	E	F	G	A	H

Miled As (Ravexina) - Harmony Search

# SCALE



# PITCH





# HARMONY SEARCH ALGORITHM



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# SAME OLD USUAL THINGS



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Near optimom solution

Reasonable time

Reasonable memory usage

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Near optimom solution

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Rules, Randomness

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SA, GA, Tabu

**IS IT POSSIBLE TO DEVELOP A NEW HEURISTIC ALGORITHM WITH BETTER PERFORMANCE**

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Fewer iterations!

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Better solutions!

Fewer iterations!

Than existing heuristic algorithms?

MUSIC IS ONE OF THE MOST SATISFYING PROCESSES  
GENERATED BY HUMAN ENDEAVORS

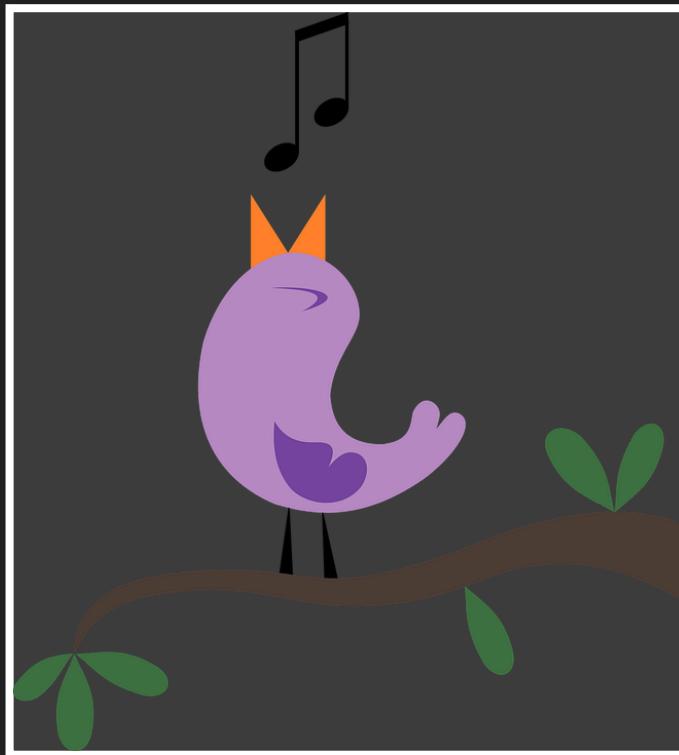
# MUSIC IS ONE OF THE MOST SATISFYING PROCESSES GENERATED BY HUMAN ENDEAVORS

A new heuristic algorithm derived from an artificial phenomenon found in musical performance namely the process of "searching for better harmony", can be introduced.

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# MELODY



A sequence of single notes that is musically satisfying.

# HARMONY



When 2 or more notes play together at the same time  
in “harmony” with each other.

# HARMONY

Music harmony is a combination of sounds considered pleasing from an aesthetic point of view.

# FANTASTIC HARMONY

Musical performances  
seek a best state determined by aesthetic estimation!

Optimization algorithms seek a best state.

# BEST STATE?

# BEST STATE?

Global optimum

# BEST STATE?

Global optimum

Minimum cost

# BEST STATE?

Global optimum

Minimum cost

Maximum benefit

# BEST STATE?

Global optimum

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Maximum benefit

Determined by objective function

SOUNDS CAN BE IMPROVED FOR BETTER  
AESTHETIC ESTIMATION

# SOUNDS CAN BE IMPROVED FOR BETTER AESTHETIC ESTIMATION

Through practice after practice

**VALUES FOR BETTER OBJECTIVE  
FUNCTION EVALUATION CAN BE  
IMPROVED**

# VALUES FOR BETTER OBJECTIVE FUNCTION EVALUATION CAN BE IMPROVED

Iteration by iteration

# COMPARISON BETWEEN OPTIMIZATION AND MUSICAL PERFORMANCE

COMPARISON FACTOR	OPTIMIZATION PROCESS	PERFORMANCE PROCESS
Best state	Global Optimum	Fantastic Harmony
Estimated by	Objective Function	Aesthetic Standard
Estimated with	Values of Variables	Pitches of Instruments
Process unit	Each Iteration	Each Practice

**STEPS IN THE PROCEDURE OF HS ARE AS  
FOLLOWS:**

# **STEP 1. INITIALIZE A HARMONY MEMORY (HM).**

## STEP 2. IMPROVISE A NEW HARMONY FROM HM.

**STEP 3. IF THE NEW HARMONY IS BETTER THAN  
MINIMUM HARMONY IN HM, INCLUDE THE NEW  
HARMONY IN HM, AND EXCLUDE THE MINIMUM  
HARMONY FROM HM.**

**STEP 4. IF STOPPING CRITERIA ARE NOT SATISFIED,  
GO TO STEP 2.**

	Fiddle	Saxophone	Keyboard	Evaluation
Rank 1	C	E	G	Excellent
Rank 2	C	F	A	Good
Rank 3	B	D	G	Fair
Harmony Memory				

## CONSIDER THIS SIMPLE EXAMPLE

$$\text{Min } f(\mathbf{x}) = (x_1 - 2)^2 + (x_2 - 3)^4 + (x_3 - 1)^2 + 3$$



	$X_1$	$X_2$	$X_3$	$F$
Rank 1	2	2	1	4
Rank 2	1	3	4	13
Rank 3	5	3	3	16

	$X_1$	$X_2$	$X_3$	$F$
Rank 1	2	2	1	4
Rank 2	1	3	4	13
Rank 3	5	3	3	16

	$X_1$	$X_2$	$X_3$	$F$
Rank 1	2	2	1	4
Rank 2	1	2	3	9
Rank 3	1	3	4	13

# PROBLEM!



# HMCR



# HMCR

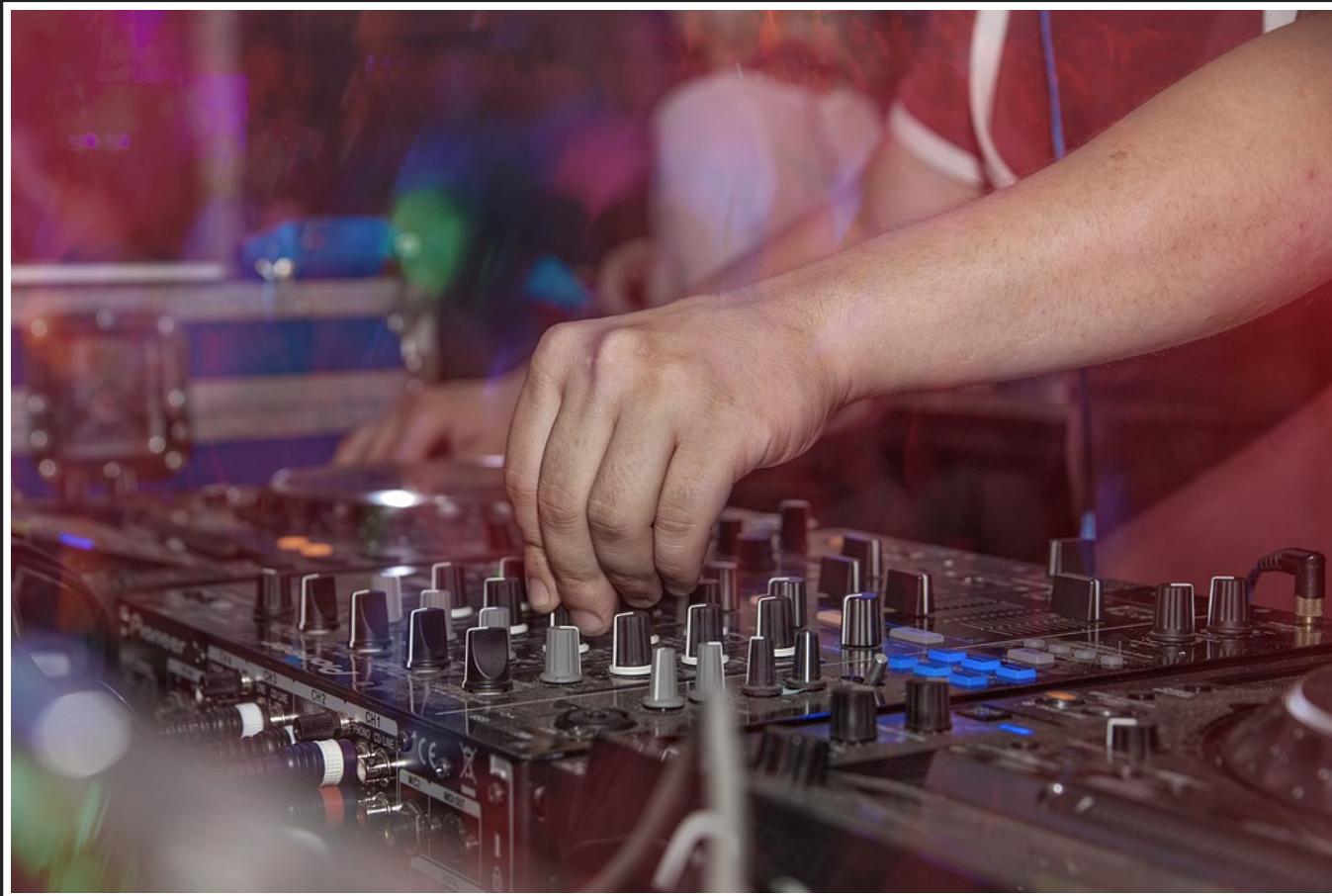


Harmony memory consideration rate

# PAR



# PAR



[1, 2, 4, {6}, 7, 9]

## AN EXAMPLE

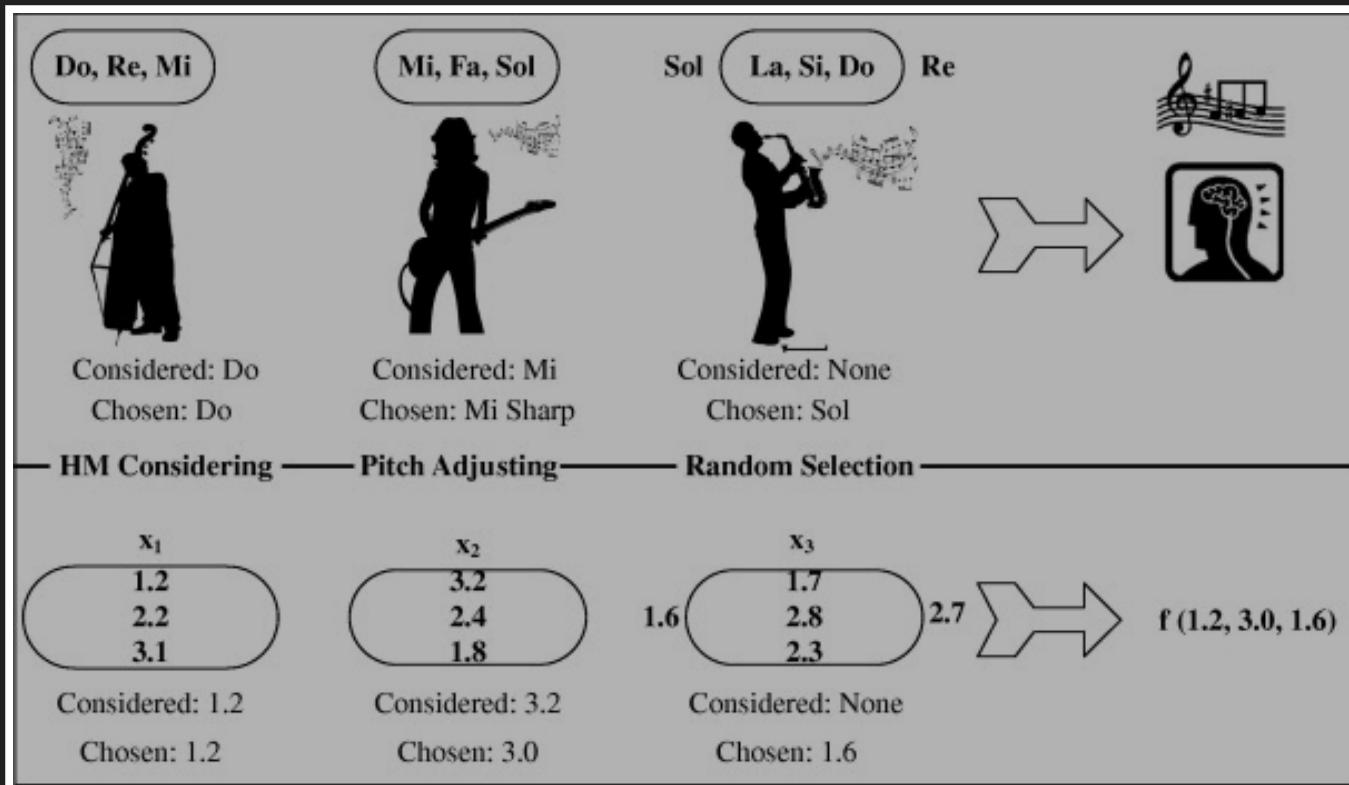
Possible values of an instrument (a variable) is:

{C, D, E, F, G}

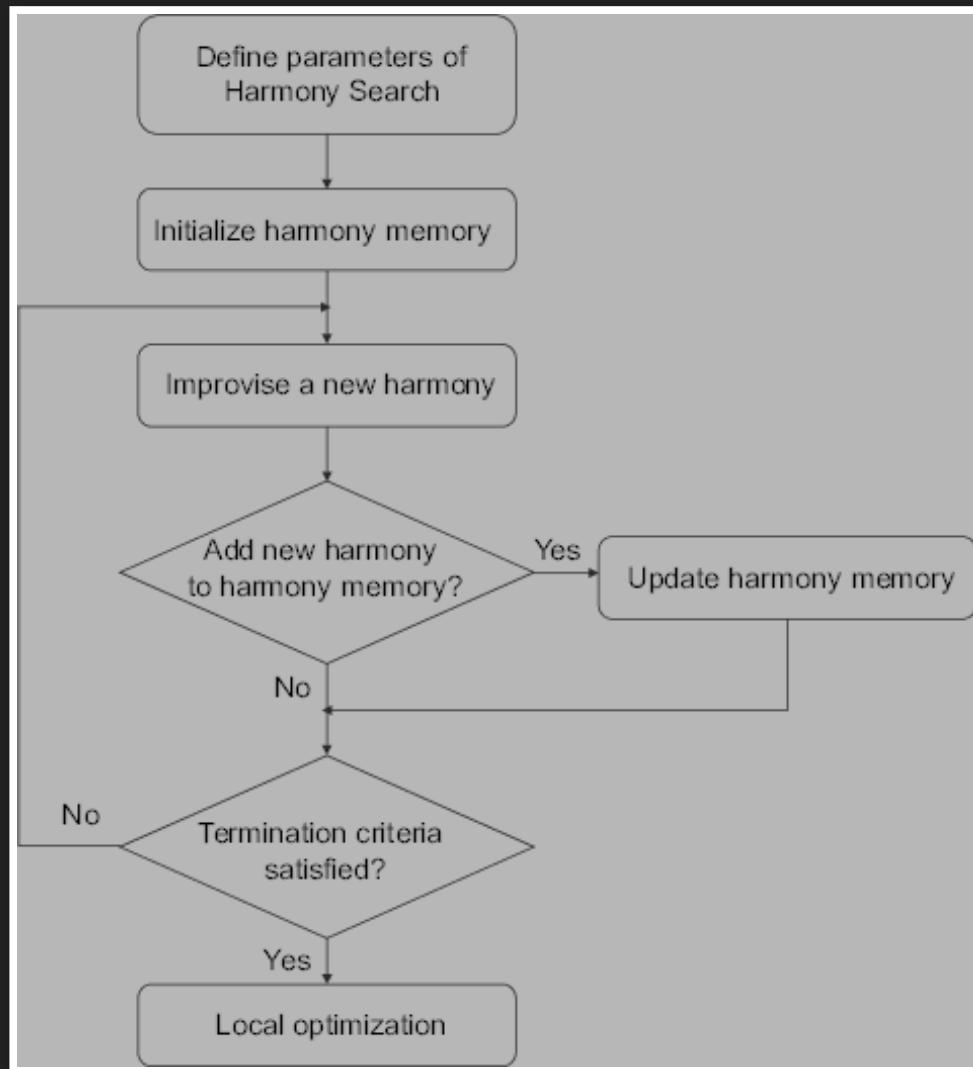
HMCR is 0.95, PAR is 0.10

The instrument now has: {C, E, G} in HM.

# ALL IN ONE



# BASIC FLOWCHART



**HS INCORPORATES THE STRUCTURE OF EXISTING  
HEURISTIC METHODS.**

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Preserve history of past vectors

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Vary HMCR

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Preserve history of past vectors

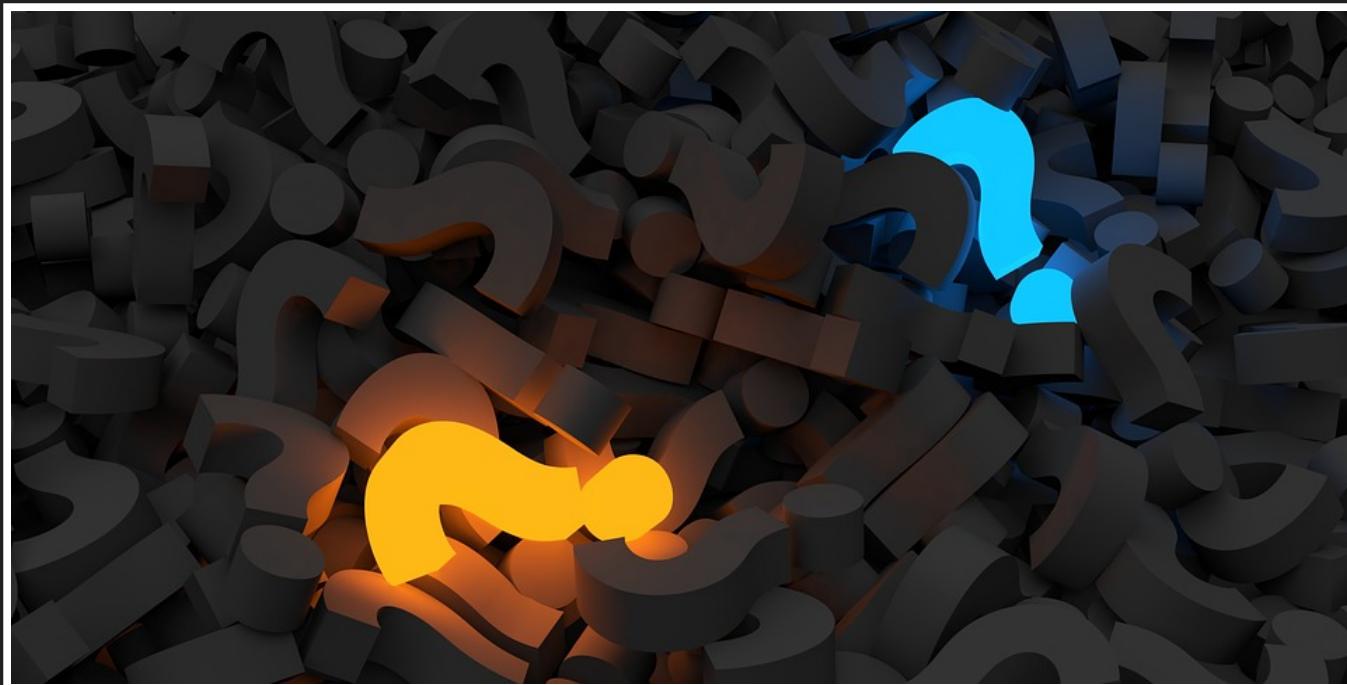
Vary HMCR

Manages several vectors simultaneously

# RESULTS OBTAINED FROM VARIOUS HS APPLICATIONS

EXAMPLE	VAR. #	COMBINATION #	MAX. ITER. #	MIN. SOLUTION	COMMENTS
Problem 1 (TSP)	20	$(20-1)!/2 =$ $6.08 \times 10^{16}$	5,000	117	Global Optimum
Problem 2 (Function)	2	$3000^2 =$ $9.0 \times 10^6$	40,000	1.3771	GA=1.4339 EP=1.3772
Problem 3 (Pipe Design)	34	$6^{34} =$ $2.87 \times 10^{26}$	200,000	\$6.056M	GA=\$6.073M NLPG=\$6.320M

# ANY QUESTION?

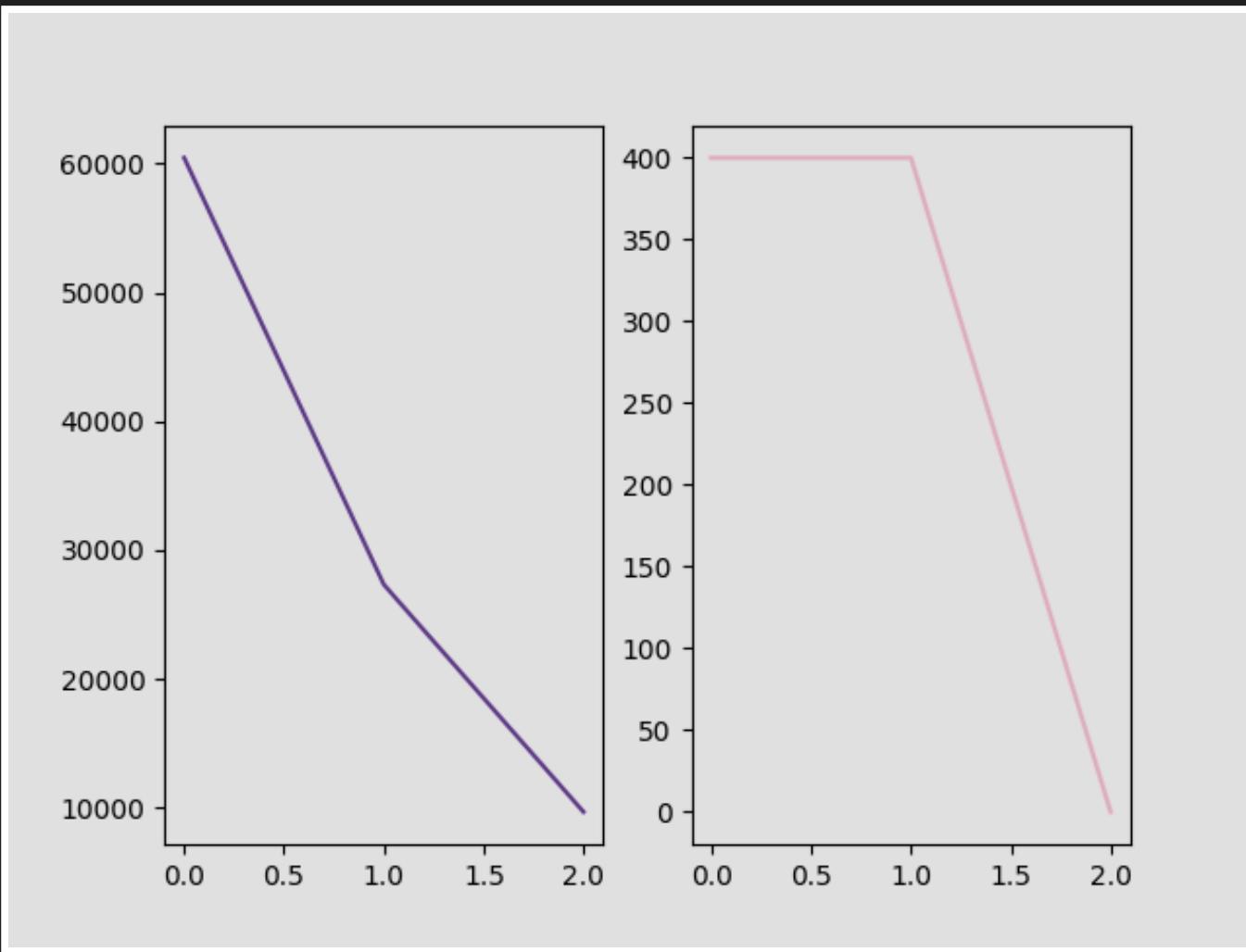


# CODE

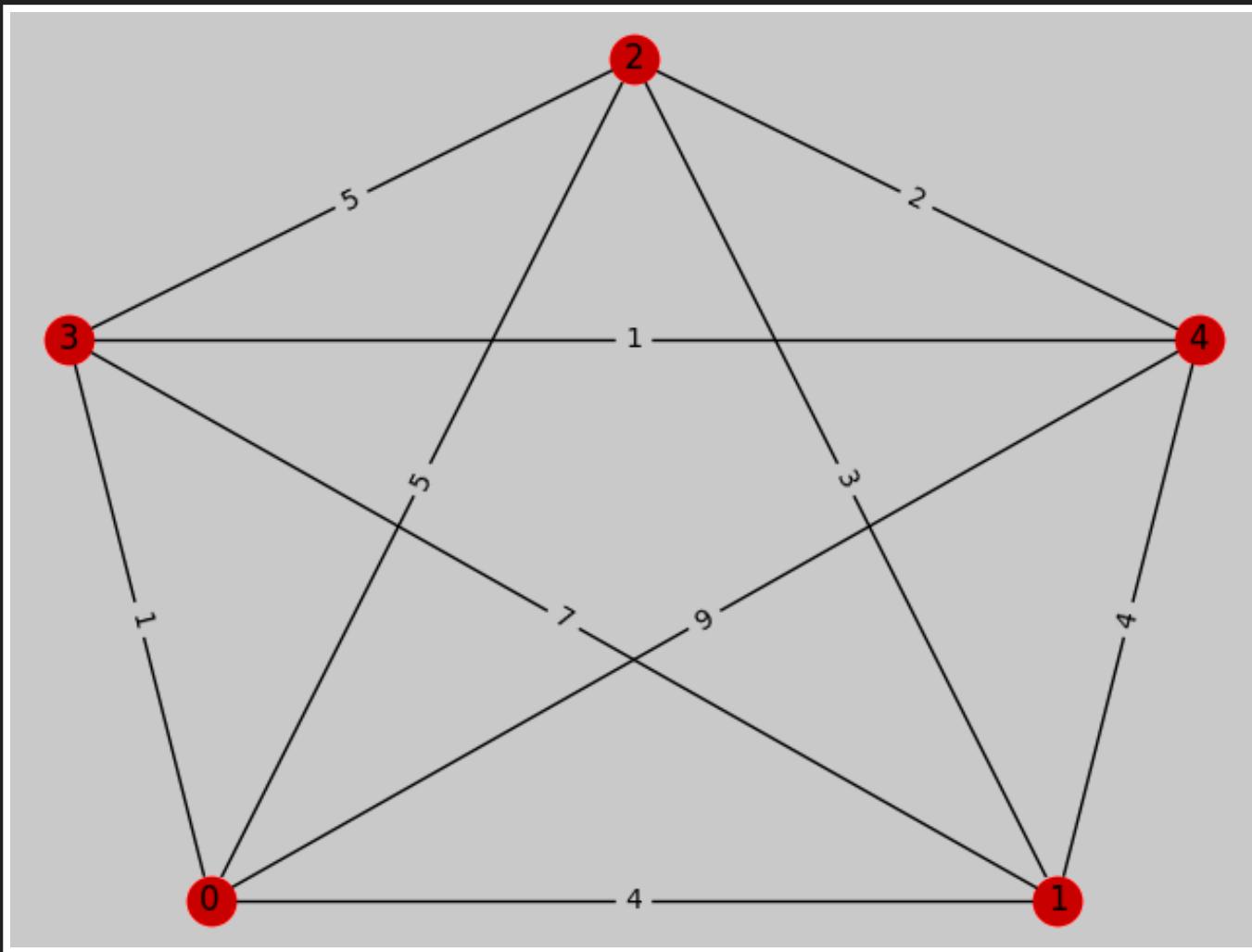
```
177         ),
178         default='Y',
179     )
180     global_scale_setting = FloatProperty(
181         name="Scale",
182         min=0.01, max=1000.0,
183         default=1.0,
184     )
185
186     def execute(self, context):
187
188         # get the folder
189         folder_path = (os.path.dirname(self.filepath))
190
191         # get objects selected in the viewport
192         viewport_selection = bpy.context.selected_objects
193
194         # get export objects
195         obj_export_list = viewport_selection
196         if self.use_selection_setting == False:
197             obj_export_list = [i for i in bpy.context.scene.objects]
198
199         # deselect all objects
200         bpy.ops.object.select_all(action='DESELECT')
201
202         for item in obj_export_list:
203             item.select = True
204             if item.type == 'MESH':
205                 file_path = os.path.join(folder_path, "{}.obj".format(item.name))
206                 bpy.ops.export_scene.obj(filepath=file_path, use_selection=True,
207                                         axis_forward=self.axis_forward_setting,
208                                         axis_up=self.axis_up_setting,
209                                         use_animation=self.use_animation_setting,
210                                         use_mesh_modifiers=self.use_mesh_modifiers_setting,
211                                         use_edges=self.use_edges_setting,
212                                         use_smooth_groups=self.use_smooth_groups_setting,
213                                         use_smooth_groups_bitflags=self.use_smooth_groups_bitflags_setting,
214                                         use_normals=self.use_normals_setting,
215                                         useUvs=self.useUvs_setting,
216                                         use_materials_setting,
```

... Python

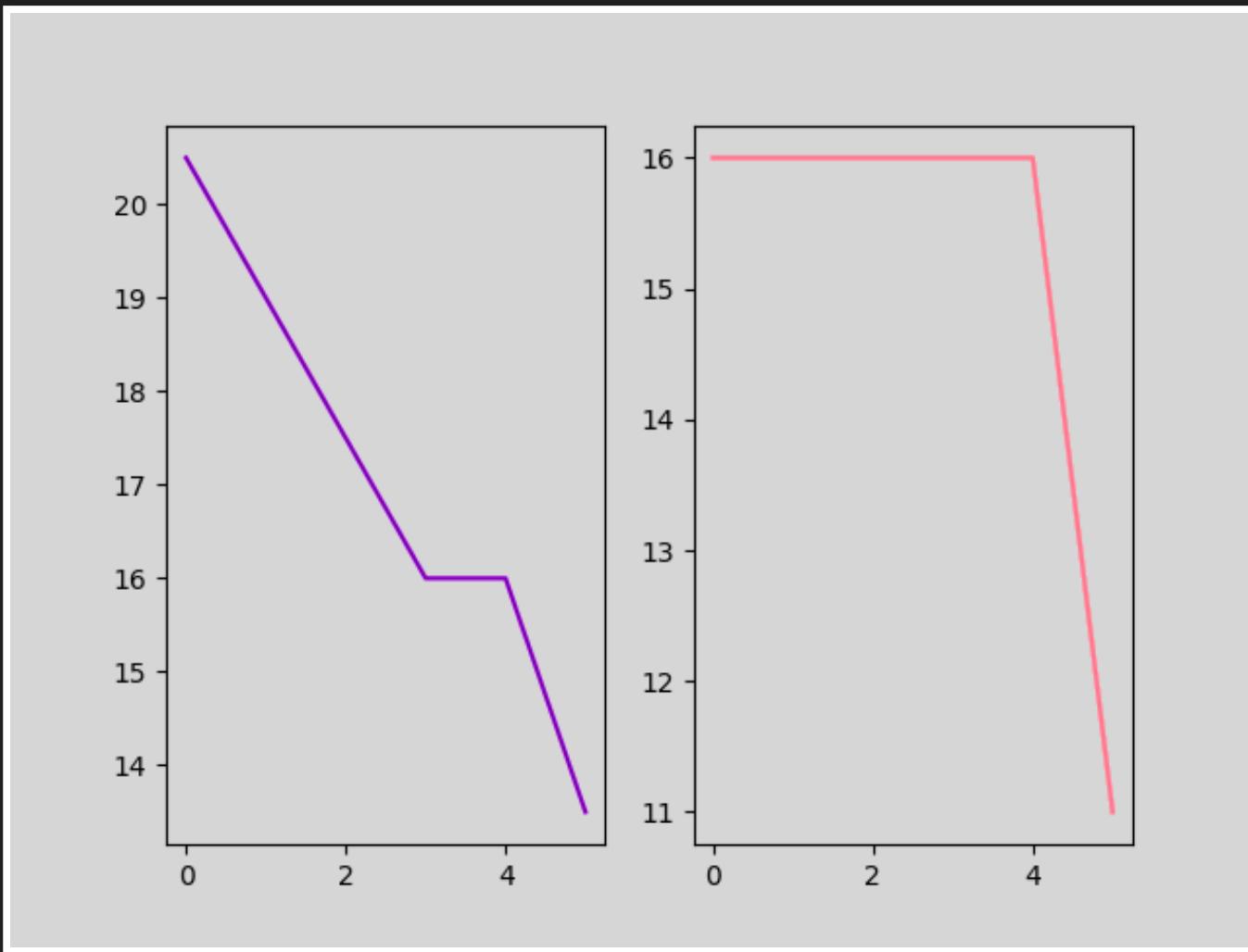
# MIN



# TSP



# TSP RESULTS



## REFERENCE:

Geem, Zong W. Kim, Joong H. Loganathan, G.V. "A New Heuristic Optimization Algorithm: Harmony Search." Simulation [USA] 2001. Print.

# THANK YOU FOR YOUR ATTENTION

