

# The Sabotaging Piano: key-to-pitch remapping as a source of new techniques in music improvisation

Teodoro Dannemann  
Centre for Digital Music  
Queen Mary University of  
London  
t.dannemann@qmul.ac.uk

Nick Bryan-Kinns  
Centre for Digital Music  
Queen Mary University of  
London  
n.bryan-kinns@qmul.ac.uk

## ABSTRACT

In this paper we present the Sabotaging Piano, a prepared electronic piano that alters key-to-pitch correspondence by reassigning adjacent pitches (i.e. one semi-tone higher or lower) to each key. Performers can control how many keys to remap through an expression pedal. If the pedal is not pressed the Sabotaging Piano works as a normal piano. When fully pressed, each key is remapped one semi-tone up or down with equal probability. Each new performance (i.e. when the piano is turned on) triggers a new and unknown remapping pattern, but the specific pattern remains fixed throughout the whole performance. This aims to provide a balance of uncertain but still explorable and learnable behaviour.

We invited three professional piano improvisers to rehearse with our piano in order to prepare a final improvisation concert. Through analysis of rehearsals' reports and the MIDI data collected in the final concert, here we show that the three pianists not only developed different techniques with the Sabotaging Piano, but they also leveraged the particularities of it to use them as creative resources.

## Author Keywords

music instruments interaction, sabotaging, music improvisation

## CCS Concepts

•Applied computing → Performing arts; •Human-centered computing → Empirical studies in HCI;

## 1. INTRODUCTION

Within NIME contexts, losing or sharing control with the instrument is a well established practice - to the point that Morreale et al [11] identify the *redistribution of agencies* as a foundational feature of NIME performers' identity.

However, we note that shared agency can emerge mainly in two ways. A first path is when control is not an intended goal since the inception of the instrument. This is precisely

the case for several NIME examples (e.g. [9, 3, 16]), where performers "can develop advanced performance skills with the instrument, but not in the virtuoso sense of highly specified and predictable control" [11].

A second path is when the performer develops a high level of control through exhaustive practice, and then they intentionally give away some control as a way of unlearn rehearsed patterns [6]. We relate this path to well-established music improvisation practices like jazz (especially free jazz) and free improvisation, where highly virtuoso performers emphasise the breaking of usual patterns and the use of mistakes as a source of creativity [14, 10, 13, 5] - as the old jazz adage says, "it is not a mistake if you play it twice" [1]. De Souza [6] documents several cases of what he defines as "voluntary self-sabotage", where virtuoso performers retune, redesign or intervene their instruments in order to unlearn them and therefore explore new creative possibilities.

Despite being a praised strategy within these virtuoso circles, we do not find further references on how these new techniques appear and what is the general adoption process when musicians are faced to sabotaging factors. The related literature revolves either around pedagogic techniques for beginner improvisers [8, 4] or around anecdotal - and sometimes legendary - stories about masters of jazz and improvisation [1, 7, 2].

In order to explore this adoption process we present the Sabotaging Piano, an electronic (MIDI) prepared piano that remaps keys into unexpected pitches. Through an expression pedal performers decide the amount of keys to be remapped, thus allowing them to continuously move from a non-modified piano (pedal not pressed), to a fully remapped one. We asked three professional pianists to rehearse with the piano and prepare an improvisation concert with it. We asked them to document their rehearsal process to shed light into their adoption process and the techniques they might develop for this particular instrument. We present the preliminary results of the improvisation concert where we recorded MIDI data of both the pedal and keys pressing in order to contrast with the rehearsals reports.

## 2. THE SABOTAGING PIANO

In this section we detail the mechanism of the Sabotaging Piano.

For easier explanation, we define  $F(i)$  as the mapping function that takes each key  $i$  ( $i = 0, \dots, 127$ ) from the piano and maps it to a corresponding pitch. In a common piano, pitches would match the keys, so we would have  $F(i) = i$  (this is simply to say that in a piano, if we press the key denoted as  $C4$ , we will then hear the note  $C4$ , or to put it in our terms,  $F(C4) = C4$ ). For our modified piano, we propose the following mapping function:



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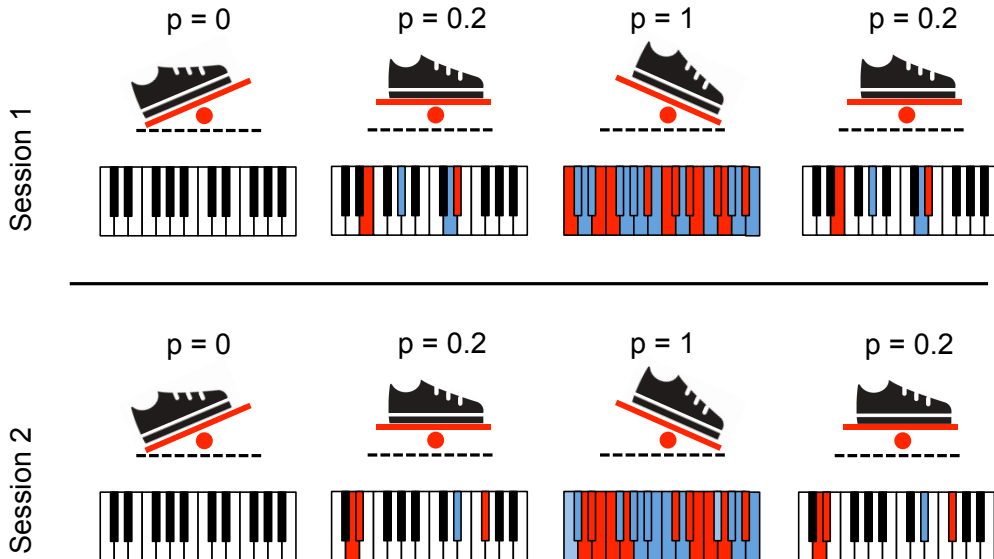


Figure 1: Example interaction with the Sabotaging Piano for two different sessions (performances). Each session is defined since the piano is turned on and until it is turned off, as this is when the remapping patterns change. Blue and red keys denote remapping of one semitone up or down, respectively. The remapping pattern is fixed for a whole session. However, the specific keys to be remapped are defined by the level of pressing of the pedal  $p$ .

$$F(i) = \begin{cases} i + 1 & \text{with probability } \frac{p}{2} \\ i - 1 & \text{with probability } \frac{p}{2} \\ i & \text{with probability } (1 - p) \end{cases} \quad (1)$$

where pianists can control the value of  $p$  (with  $0 \leq p \leq 1$ ) through an expression pedal. In this way, when the expression pedal is not pressed, then the Sabotaging Piano works as an usual piano ( $F(i) = i$ ), and when it is fully pressed, each key will deviate by one semitone, either up or down with the same probability. For intermediate values of  $p$ , a proportion  $p$  of keys will deviate by one semitone and the rest  $(1 - p)$  will work as usual. Although randomly generated, the remapping pattern stays fixed within a whole performance. This means that for a specific value of  $p$ , the same remapping pattern will be obtained, so performers can leave the pedal in a fixed position and explore the particular remapping that is given there. Each time the piano is reset, though, this remapping pattern will change - refer to Figure 1 for an illustrated explanatory example.

The idea of this mechanism is to follow Mudd’s idea of something that is at the same time unpredictable but learnable [12]. The resulting pitches are unexpected at first but remain fixed throughout the performance, so musicians are invited to explore the specific remapping and learn from it during their playing. Still, by changing the mapping for the next performance, we avoid performers completely assimilating the specific pattern, thus inviting them to explore and learn a new one. Then, performers can practice with the piano to have an idea of its working and to develop interaction strategies, but they will never know exactly what will they confront in the next performance.

### 3. METHODS

#### 3.1 Participants

We invited three professional piano improvisers to try out the Sabotaging Piano. We wanted to know how would they use - if used at all - the pedal in a real performance context

(including the rehearsal process) and what is the performers’ experience with the Sabotaging Piano. We looked for improvisers whose styles used to some extent tonality as we wanted the remapping to be intrusive (for styles like *free improvisation* or *free jazz* where tonality might be disregarded, the sabotaging character of our piano might not be that evident).

We gave pianists a period of 1.5 months to rehearse with the Sabotaging Piano to prepare a final improvisation live concert, to be held in the 11th International Workshop on Haptic & Audio Interaction Design [15]. We asked them to prepare a  $\sim 30$  minutes improvisation for the concert, without asking any particular style or structure. The three pianists have professional formation on piano and had experience with piano improvisation. A brief description of pianists is shown in Table 1

Performer	Background
P1	Contemporary / Chamber music
P2	Classical / Cuban / Multi-instrumentalist
P3	Composer / Minimal and pop

Table 1: Performers musical backgrounds and styles

#### 3.2 Data collection

We used different data collection methods for assessing the performers experiences with the Sabotaging Piano.

##### 3.2.1 Pedal and MIDI keys data:

Both expression pedal and key pressing temporal patterns can be easily collected. For the key presses, information of the onset of each note and also the velocity and duration of them is directly collected in MIDI format. We collected data for both the rehearsals and final concert. For this work, we are only using the final concert MIDI data.

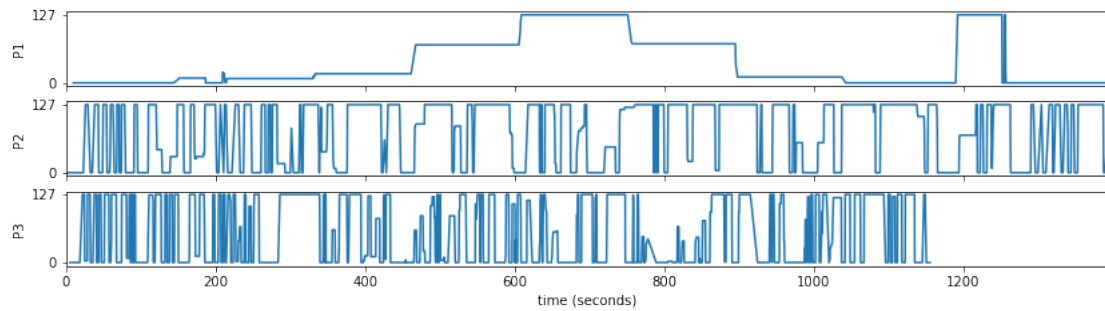


Figure 2: Evolution of pedal pressing during the final concert for each one of the three performers.

### 3.2.2 Rehearsal reports:

We asked each performer that after each rehearsal session they send us an audio or written note describing what they did, what they tried, anything new that they noticed, and strategies or techniques that they had developed with the piano.

## 4. RESULTS

Although further quantitative and qualitative analysis are needed for having a broad picture, here we show the first results emerging from the raw data. We will focus our results and discussions around the strategies that performers developed both in the rehearsals and final concert.

Videos of the final concert are available in the project website <sup>1</sup>.

### 4.1 Different uses of the pedal

From Figure 2 we can find marked differences in how each performer used the pedal. In particular we notice that P1 (upper panel) used the pedal by smoothly changing values and keeping fixed values for a while. Instead, P2 and P3 (second and third panel) used the pedal in an all-on all-off way. The smooth and structured movement of the pedal of P1 can also be seen in their rehearsals. In their notes for the second rehearsal we can find a written structure of the pedal pattern:

“Today I did:  
 No alteration  
 50% alternation  
 No alteration  
 100% alteration  
 No alteration”

### 4.2 One-note trill

The particular structure of the remapping produces what we have called a *one-note trill*. This happens when two adjacent keys are mapped to the same pitch - for example  $F(C4) = B3$  and  $F(B3) = B3$ . The particularity of this mapping is that allows to create an effect of trill with one note. The performer rapidly plays both keys interspersed, but as both have the same pitch, it sounds as they are playing only one key with an apparent extremely high speed. This technique was discovered and reported by the three performers. P3 used it repeatedly during the concert. One can listen that they “look” for the trill by going up and down

<sup>1</sup><https://teodannemann.wordpress.com/sabotaging-piano-concert/>

the keyboard until they found a pair of keys that has the particular remapping combination.

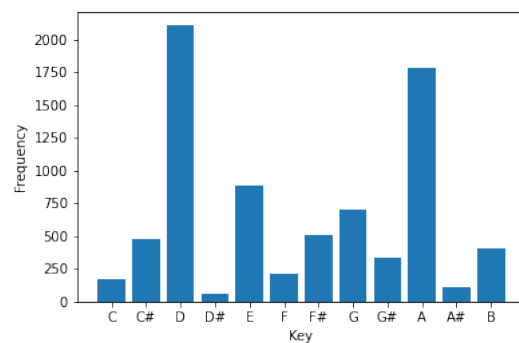


Figure 3: Histogram of key pressings for P1. The marked high frequency of *D*, *A* denote a key of *D*. The low frequency of *F* suggests the key of *D* major.

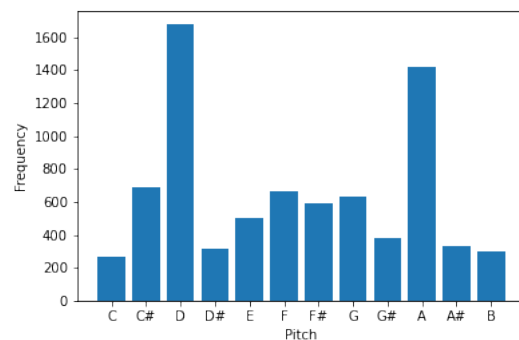


Figure 4: Histogram of resulting pitches for P1. The frequencies are less marked here than in figure 3 as the tonality is inevitably lost when adding a random factor

### 4.3 Pedal as source of tension

The quick pressing and unpressing of the pedal used by P2 and P3 and referred in section 4.1 was fundamented as a source of tension for the performance. As P2 says in one of their rehearsals recording:

“I found that fully pressing the pedal was a good source of tension. For example, I tend to keep simple repeated arpeggios, starting with

no pedal pressing. Then, suddenly pressing the pedal in full adds full tension to the arpeggio that waits for a resolution. Then I simply get back to the unmodified arpeggio and it resolves naturally.”

This strategy was also described by P3. In both cases, they showed a complete openness to whatever the pedal would bring. This contrasts with P1 strategy, who aimed to explore and understand which specific notes were remapped in order to consciously use them:

“Specially in the lower levels of alteration, what happened is that, since I knew there would be some alterations although I couldn’t always perceive it, many times I was actually trying to find the key which had the tuning altered. And of course this ‘search’ took a certain shape within the improvisation.”

#### 4.4 Grounding through octaves and fifths

P1 showed a particular strategy that can be clearly noticed several times in the performance. These moments corresponded to short pauses followed by the following sequence of notes: *D1, D2, D3, D4, D5* or some variation of it. This moments happened specifically whenever P1 had changed the level of the pedal. Also, from the frequency histogram of key pressing (Figure 3) we can notice that the piece was clearly being played in tonal mode, in this case, in a D major scale. Through playing the tonic keys P1 is actually prompting, exploring to see whether they are being remapped or not, for each value of the pedal. This is corroborated again in their rehearsal notes:

“I decided to base my improvisation in intervals of 5ths and octaves, aiming that, together with the constant return to the the original piano tuning, it could help to perceive the alterations.”

#### 5. FUTURE WORK

As described above, we have discovered preliminary strategies that performers have used to cope with the sabotaging piano, but also new techniques that have emerged from the sabotaging.

More thorough analyses are needed to have a complete picture of how and in which ways the Sabotaging Piano is modifying the interaction and what can this bring of new in the creative realm. In particular, future analysis may concern how the pressing of the pedal is making - or not - performers to neglect tonal rules. This is suggested by the discussion given in section 4.3. Of course, the use of pedal always leads to a loss of tonal structure, as it can be appreciated by comparing the pressed keys histogram (Figure 3) with the resulting pitches histogram (Figure 4). The important question, however, is whether the keys pressing pattern changes depending of the pressing level of the pedal. Are performers playing more tonally when the pedal is not pressed? Our future analysis, then, entails obtaining distribution of key presses (similar to figures above) but now depending on the level of pressing of the pedal.

#### 6. CONCLUSIONS

In this work-in-progress paper, we present the Sabotaging Piano, an electronic prepared piano that remaps the keys depending on the level of pressing of an expression pedal.

We also show the preliminary results of three pianists using the Sabotaging Piano. Through documented rehearsals and a final improvisation concert, we grasped some initial ideas of the strategies that might emerge when coping with the piano. We propose that these strategies are not only a response to compensate, but they can lead to new exploratory and creative behaviour.

#### Ethical Standards

The data, audio and video recording protocol during the concert was approved by the Queen Mary University of London Research Ethics Committee and consent by participants.

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