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Tunepal: searching a digital library of traditional music scores

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Abstract

Purpose – This paper aims to describe the Tunepal project as an example of a music information retrieval (MIR) system that is having an impact on how musicians access, learn and play traditional Irish music around the world.

Design/methodology/approach – This paper describes the functionality of the Tunepal system: consisting of the tune corpus, the web site tunepal.org and mobile apps supporting iOS and Android OS. Tunepal facilitates query-by-title and query-by-playing music (QBP) searches and allows a musician to retrieve and playback scores amongst other supported functions.

Findings – Tunepal has been favorably received and musicians report that the system is being used in a variety of scenarios including archiving and the preparation of sleeve notes for commercial recordings. Tunepal has a growing user base in 25 countries.

Originality/value – The comprehensive tune corpus (over 16,000 compositions), the query-by-playing technology and the fact that the mobile apps provide access to the corpus *in situ* in traditional music sessions and classes make this project uniquely useful.

Keywords Music information retrieval, Query-by-playing, Traditional music, Music, Searching, Information retrieval

Paper type Case study

1. Introduction

This paper describes Tunepal, a popular search engine and music retrieval tool for musicians playing traditional Irish dance music. Tunepal is accessible free of charge through the web site tunepal.org and through mobile apps available at minimal cost on iOS and Android OS. Tunepal connects musicians to the scores and metadata of 16,700 traditional Irish, Welsh, Scottish, Breton, American marching band and Canadian dance tunes drawn from community sources, such as the web site thesession.org and “standard” references including Aird’s *Airs*, O’Neill’s *Dance Music of Ireland* and Breandán Breathnach’s *Ceol Rince Na hÉireann* series. Tunes can be retrieved by typing in a title or through a unique query-by-playing interface that allows users to find tunes by playing a 12 second extract from the tune on a traditional instrument. Tunepal on mobile devices can be used *in situ* in traditional music sessions, classes and concerts. Tunepal has proven very popular both in Ireland and internationally, with users in 29 countries.

Section 2 of this paper presents some background information on the types of music Tunepal is designed to work with. Section 3 describes the ABC music notation language – the native notation format that Tunepal can import. Section 4 presents the



features of the tunepal.org web site while section 5 presents the Tunepal mobile apps. Section 6 shows how Tunepal is being used around the world, while section 7 presents conclusions and future work.

2. Background

In common with the folk music of many cultures, repertoire in Irish traditional music is primarily acquired aurally. Musicians playing Irish music learn by hearing tunes played by fellow musicians (Wallis and Wilson, 2001) rather than from tune books. Since the 1960's it is common for musicians to play and learn tunes in sessions – semi-formal gatherings of musicians and occasionally dancers that often take place in pubs (Figure 1).

Often sessions are anchored by one or two core musicians who may be paid to play, though sessions are generally open to guests of appropriate standard. Because of the significant size of the canon of traditional music (over seven thousand compositions) many musicians playing music in sessions are unaware of the title or origin of the tunes they play (Driscoll, 2004). The most common forms of dance tunes are: reels, double jigs and hornpipes. Other tune types include marches, set dances, polkas, mazurkas, slip jigs, single jigs and reels, flings, highlands, scottisches, barn dances, strathspeys and waltzes (Larsen, 2003). These forms differ in time signature, tempo and structure. For example a reel is generally played at a lively tempo and is in 4/4 time (written as eight quavers in a bar) while a waltz is generally played at slower pace and is in 3/4 time. The time signature, tempo and structure of a tune form are determined by the dance it accompanies. Most tunes consist of a common structure of two parts traditional musicians refer to as the *A* part and *B* part. Musicians playing traditional Irish music have a personal repertoire of up to a thousand tunes. Many of these tunes are known by multiple names, while many more are known simply as “gan anim” (without name) (Driscoll, 2004). In the modern age, Irish traditional musicians play fiddles, uilleann pipes, tin-whistles, flutes, concertina's accordions, banjos and harps. Other less popular instruments include the mandolin, harmonica and dulcimer (Vallely, 1999).

3. Music collections and the ABC music notation language

There have been notable initiatives to catalogue the canon of Irish traditional music (Petrie, 1855; Bunting, 1840; Joyce, 1909; Shields, 1998) but the majority of traditional



Notes: Set dancers (left). Fiddle player Colm Logue, the author and flute player Patsy Hanley at an informal session at Fleadh Ceol na h'Eireann 2008 (right)

Figure 1.

tunes were not transcribed until the turn of the twentieth century when Francis O'Neill, the then police chief in Chicago, transcribed and documented a large body of dance tunes and airs from immigrant Irish musicians.

In 1903, he published a book of his collected tunes entitled *The Music of Ireland*. The 1,850 tunes presented in the collection were classified according to tune-type (airs and songs, O'Carolan compositions, double jigs, slip jigs, reels, hornpipes, long dances, marches and miscellaneous). In 1907, he published *The Dance Music of Ireland – 1001 Gems*. This collection focused entirely on the dance music repertoire and contained many tunes published in his previous collection (Figure 2). O'Neill's second book was considered the definitive source for traditional musicians and musicians would often refer to a tune by its reference number in the book (Wallis and Wilson, 2001).

Breandán Breathnach's *Ceol Rince Na hÉireann* series in five volumes is regarded as the most significant and influential collection of traditional Irish music after O'Neill's books (Breathnach, 1999). Breathnach's books contain tunes from many sources including field recordings, commercial recordings and manuscript collections of dance music held in private hands.

By identifying duplicates and variations Breathnach sought to identify the earliest occurrences of tunes and trace their history through printed manuscript collections and recordings. His books contain detailed bibliographic notes on each of the tunes included.

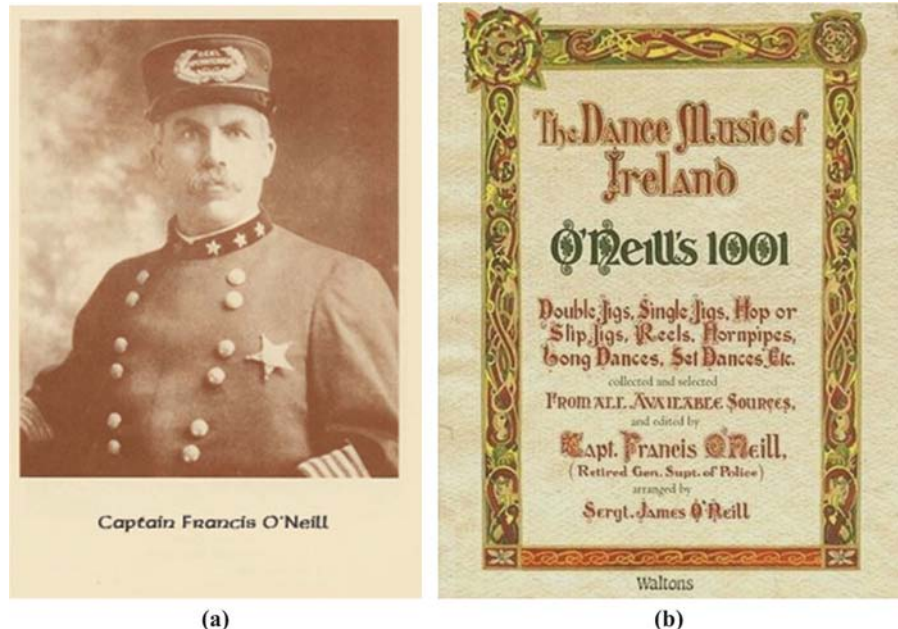


Figure 2.
Police Chief Francis
O'Neill and the cover of
O'Neill's *The Dance Music
of Ireland*

Sources: (a) Francis O'Neill, collector/unidentified photographer, Chicago: Lyon and Healy (1903) Copyright: Francis O'Neill (1903). (b) *The Dance Music of Ireland*, O'Neill, Francis; O'Neill, James, Chicago: Lyon and Healy (1907)

4. Collections in electronic format

ABC is a music notation language introduced by Chris Walshaw in 1991 (Walshaw, 2011) for typesetting traditional tunes. The format was designed primarily for folk and traditional tunes of Western European origin, which can be written on one stave in standard classical notation (Walshaw, 2011). The tune given in Figure 3 is typical of the transcriptions that can be sourced in ABC from publicly available databases.

In this transcription the transcriber has helpfully included useful metadata with the notation for the tune such as similar tunes and variations. ABC files are ASCII text files and so can be edited by any text editor, without the necessity for special software. Each file (known as a tunebook) can contain multiple tunes. File sizes are typically measured in kilobytes and this facilitates easy transmission over the internet.

The header section contains amongst other fields, the title, composer, source, tempo, key, geographical origin and transcriber (Mansfield, 2011). As tunes can have several titles, the title field can be repeated for a given tune. The tune body contains the notation for the tune. The body encoding supports such features as ornaments, bar divisions, sharps, flats, naturals, repeated sections, key changes, guitar chords, lyrics and variations. There is an active and vibrant community supporting ABC notation and a range of tools have been developed for a variety of platforms and purposes.

Between 1997 and 2000, a group of musicians under the leadership of Dan Beimborn and John Chambers, undertook a grass roots project to transcribe three of O'Neill's books to electronic format using ABC notation. As copyright had expired on O'Neill's original books, they made their work freely available on the internet (Chambers, 2011). Many of the tunes from O'Neill's books are played differently by musicians today, as is normal with a living tradition. Around the same period (the late 1990's) Henrik Norbeck collected nearly two thousand tunes in ABC notation from various sessions and recordings. Again this collection was made freely available on the internet. This collection contains many modern settings of tunes from O'Neill's books (Norbeck, 2011). Similarly, Bill Black a musician from Cape Cod, USA has transcribed a selection of Breathneach's books in ABC notation and made these freely available on the internet.

Web site thesession.org (thesession.org, 2011) contains an extensive; crowd-sourced collection of over eleven thousand traditional tunes in ABC notation entered by the traditional music community. The collection can be searched using text queries by any of the metadata associated with a tune or by melodic queries in ABC notation. The web

```
X:1
T:Kiss the Maid behind the Barrel
R:reel
H:Similar to "The Dogs Among The Bushes"
K:GMaj
|: DG~G2 AG~G2 | DG~G2 cAFA | DG~G2 AGFA | defd cAFA :|
dg~g2 ag~g2 | dg~g2 agfe | df~f2 af~f2 | defd cAFA |
...
...
"Variation"
DG~G2 AGGF | DG~G2 cAFA | DGGB AGFA |1 defd cAGF :|2 defd cAFA ||
dg~g2 aggf | dg~g2 agfe | df~f2 af~f2 | defd cAFA |
dg~g2 agfg | abag ~f3g | afge fde^c | d^cde fd=cA ||
...
...
```

Figure 3.
An extract from the tune
"Kiss the Maid behind the
Barrel" in ABC notation

site is significant, because it is supported by an active community of thousands of musicians who regularly contribute tunes, report on traditional music sessions and engage in lively discussions.

5. The tunepal.org web site

The tunepal.org web site (Figure 4) presents users with a search interface to a corpus of 16,700 tunes in ABC notation.



Users can enter a tune title or perform an advanced search by limiting matches to one or more tunebooks from the collection. To perform a query-by-playing (QBP) search (the most popular method of searching), a Java applet records a twelve second extract and transcribes the recording to ABC notation using an approach described in detail in (Duggan, 2009). The tunepal.org web site has been tested on a wide range of traditional instruments including the concert flute, tin-whistle, uilleann pipes, accordion, concertina and banjo – though it works best with instruments played “legato”. The system compensates for various expressive elements in the user’s playing such as the use of ornamentation (Duggan *et al.*, 2009). Users are also offered the ability to change the transcription fundamental. This changes the frequencies used by the pitch spelling algorithm, so that tunepal.org can work with differently pitched instruments, such as Eb flutes and uilleann pipes pitched in B and C.

Matching is performed on the server using a variation of the classic edit distance algorithm (Navarro and Raffinot, 2002) against “search keys” – normalised strings of musical notes extracted from the scores during the import process (Duggan, 2009). These are stored in a MySQL database while matching is powered by a J2EE web application. QBP searches return the top ten matching tunes from the corpus in order of descending confidence. The web site tunepal.org gives the correct tune as the closest match for 93 percent of queries in experiments using field recordings of traditional musicians from sessions, classes, concerts and commercial recordings including solo and ensemble playing on traditional instruments recorded in a variety of real-world settings such as noisy public sessions (Duggan *et al.*, 2009). The closest matching tune for each query is logged in the database each time a query is made. The web site incorporates a feedback system, so users can however proof listen to the results and give feedback as to which (if any) of the returned tunes was the correct one.

Each returned tune can be played back, displayed in ABC notation or staff notation. Additionally, each matching tune links to the original source of the ABC notation on the web, a discography for the tune (which in turn links to an Amazon MP3 store search) and a YouTube search for recordings of the tune can be made. Stave notation display uses ABCJS, an open source, browser hosted rendering engine for ABC notation (Dyke and Rosen, 2010) (Figure 5).

The Tunepal corpus aggregates collections of Welsh, Scottish, Breton, Canadian and American marching band music in addition to several different transcriptions of the same tune from the canon of Irish traditional music. Table I presents a breakdown of sources of the tunes in the Tunepal corpus.

The tunepal.org web site was launched on 31 July, 2009. It can be accessed on Windows, Mac and Linux systems running a variety of modern web browsers. The web site was promoted on popular traditional music discussion forums such as thesession.org and the Chiff and Fipple forum (Chiff & Fipple, 2011). The web site has

also available on:  Android  iPhone


tunepal Irish Traditional Music

Home Zeitgeist Help Links Blog About me

Indexing 16700 tunes

Search by Playing

Search by title Search Advanced Search

Done... 


Silence threshold:




Fundamental:

ABC to search for:



#	Title	Source	Type	Conf	MIDI	Correct?
1	Swallow's Tail, The	thesession.org	Reel	80%		
2	The Swallowtail	The Microphone Rambles	Reel	80%		
3	Swallow's Tail, The	Norbeck	Reel	78%		
4	The swallow's tail	O'Neill's	Reel	77%		
5	The Swallow's Tail	Nottingham	Reel	65%		
6	Tom Martin's	thesession.org	Reel	64%		
7	Rainy Day, The	Norbeck	Reel	62%		
8	A rainy day	O'Neill's	Reel	62%		
9	Taylor's Quickstep	thesession.org	Polka	62%		
10	Chris Droney's Favorite	thesession.org	Reel	61%		

Web Queries: 21629 | iPhone Queries: 35937 | Android Queries: 7040 | Powered by **MATT2**

 **An Roinn Turasóireachta, Cultúir agus Spóirt**
Department of Tourism, Culture and Sport

Send feedback | Troubleshooting | Support tunepal.org.
Buy my book which explains how it works. Just \$15!
Mac users, please view this page in Safari.

Source: www.tunepal.org

Figure 4. Performing a QBP search with the tunepal.org web site

Tunepal:
searching a
digital library

Ciara And Dave's Wedding

X:8636
T:Ciara And Dave's Wedding
M:4/4
L:1/8
R:hornpipe
K:Dmaj
(3DEF|GBdB=cdeg|fd =cA DEFD|GBdB =cdeg|fdef ~g3f|
~g3b afd|e=ceg dBGF|GBdB =cdeg|fd=c AG2:|
|:fg|adab ~g3d|eggf ~d3g|a=c'ba gbag|ed=ced2(3efg|
adab ~g3b|=c'bag e2de|ggged gf=ce|df=ce d2:|

Source: thesession.org

Stats:
2 tunepal.org QBP queries
0 Mobile QBP queries
40 mobile downloads

Download:



Share:

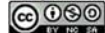


Ciara And Dave's Wedding

hornpipe



Using ABCIS by Greg Dyke and Paul Rosen



Source: www.tunepal.org

Figure 5.
Tune display from the
web site tunepal.org

Source	Count
thesession.org	9,652
Henrik Norbeck	1,474
O'Neill's 1001	994
Ceol Rince na hÉireann 1	73
Ceol Rince na hÉireann 2	192
Ceol Rince na hÉireann 3	37
Ceol Rince na hÉireann 4	220
Johnny O'Leary	196
Nigel Gatherer	794
The Microphone Rambles	194
Welsh Music (John Tose)	197
Scottish Flute Music (Jack Campin)	241
Company of Fife and Drum	238
Nottingham Music Database	1,034
Aird's Airs (Jack Campin)	1,164
Total:	16,700

Table I.
Sources of Tunepal tunes

proved very successful and is now well known amongst traditional musicians having been profiled in several Irish national newspapers (Long, 2009; Lillington, 2010).

6. Tunepal mobile apps

Traditional Irish music is most commonly played by groups of musicians in a community setting known as a session (O'Shea, 2006). Sessions usually take place in shared public spaces in the evening times and often take place in pubs. The Tunepal mobile apps can be conveniently and discretely used in traditional music sessions to access to the collections described in section 4. There are optimised, native mobile clients for iPhone/iPod Touch (Figure 6), Google's Android OS and a special version known as Tunepal HD for iPad. All the apps offer identical functionality, but Tunepal HD has a redesigned user interface which takes advantage of the bigger screen size on the iPad. In common with the tunepal.org web site, the apps support queries by tune title or by playing on a traditional instrument. The Tunepal apps allow searches over the entire tunepal.org tune corpus. This is not in fact stored on the devices themselves. Instead, the corpus is stored "in the cloud" on the tunepal.org server and tunes are downloaded on demand. For query-by-playing (QBP) searches, 12 seconds of audio is sampled at 22Khz, transcribed as described in (Duggan, 2010) and submitted to the tunepal.org J2EE web service for matching. When a tune is retrieved using Tunepal, it can be played back, transposed, speeded up or slowed down, displayed in ABC or stave notation, emailed or posted to Facebook. Additionally a discography can be retrieved, which refers the user to iTunes or the Amazon MP3 store to purchase the recording. YouTube search results for a tune can also be displayed. The Tunepal apps also allow users to edit music scores in ABC notation and to compose new tunes that can be instantly displayed in stave notation or played back. Figure 6 illustrates a typical workflow – recording a query, finding a match, displaying the stave, retrieving the discography, performing a YouTube search for a recording of the tune and finally, posting the tune to Facebook.



Figure 6.
Screenshots of Tunepal
running on an iPod Touch
illustrating a typical
workflow

Retrieved tunes are stored in a “My Tunes” section on the user’s device, in order of most recently found to facilitate future retrieval for learning purposes. Playback is achieved using ABC2MIDI (Shlien, 2011) and the FMOD audio engine on iOS devices (FMOD, 2011). Android devices support MIDI playback natively. The Tunepal mobile apps also allow the user to switch the interface between Irish Gaelic (Figure 7) and English. The mobile versions of Tunepal have one major advantage over the tunepal.org web site and that is the ability for accurate geocoding of queries.

With the users permission, each query made using the mobile apps is geotagged and the latitude and longitude is logged in the tunepal.org database. This makes it possible for users to track their queries on a map (Figure 7) on their devices.

Tunepal for iPhone was released on 11 February, 2010. This was followed on 1 July 2010 with Tunepal for Android and on 15 December 2010 with Tunepal HD for iPad. New versions of the apps with additional functionality and accuracy were released at intervals culminating in a public press launch for all the apps on 15 December 2010 attended by luminaries from the world of traditional music. The apps are now in use by thousands of users in 29 countries worldwide.



© Google Maps (2011)

Figure 7.
Geotagged tunes
displayed within Tunepal
on the iPhone

Dissemination

At the time of writing (26 January 2011), 53,403 queries have been logged by iOS users, while 10,095 queries have been logged by Android OS users. A total 20,813 QBP queries have been logged through the web site. This represents a total of 84,311 tune queries. Table II presents a breakdown of mobile queries by OS.

A total of 74 percent of queries made on mobile devices are geotagged. Google maps plotting the usage of Tunepal geographically were developed so that the geographic profile of Tunepal usage could be visualised. The maps display a drop pin for each geotagged query on the map. Pins link to callouts that display the closest matching tune for each query and an icon indicating whether the user was on an iOS or Android OS device. Live maps plotting the last two thousand geotagged queries performed can be viewed at the web site tunepal.org. Figure 8 shows a selection of geotagged QBP queries on the map of Ireland.

In order to get a numeric breakdown of where these queries were being made, 30,167 geotagged QBP queries were reverse geocoded using the Google Maps web service to

	iOS QBP	Android OS QBP	iOS Title	Android OS Title	Total
Geotagged	25,032	5,135	13,755	3,118	47,040
Non-Geotagged	8,704	1,096	5,912	746	16,458
Total	33,736	6,231	19,667	3,864	63,498

Table II.
A breakdown of Tunepal
mobile queries



© Google Maps (2011)

Note: See www.tunepal.org

Figure 8.
Geotagged Tunepal
mobile QBP queries
plotted on a Google map
(see tunepal.org)

retrieve the approximate geographic address. This revealed that queries originated from 29 different countries. Table III shows the top 20 countries in descending order.

It is significant that the majority of international queries originate in the USA and the UK, these being major centers for the Irish diaspora and also countries where traditional music sessions take place regularly. Interestingly Japan is also a significant source of queries, reflecting the growing popularity of traditional Irish music and culture in that country.

Analysis of the queries of Irish origin (of which there are 10,613) reveals the top counties in Ireland for queries. Dublin, being the capital generates significantly more queries than the other counties; however Galway and Clare are also significant sources of queries, these being centres of Irish music and culture. In particular county Clare hosts a number of prominent traditional music festivals, where aficionados of traditional music from around the world gather to play and listen to Irish music. By plotting the Irish queries over the course of the day, a profile can be established as to

Country	Query count
Ireland	10,613
USA	9,093
UK	4,507
Canada	1,136
Australia	1,046
France	987
Germany	804
Japan	695
Denmark	209
Netherlands	195
Spain	165
Sweden	148
Italia	126
New Zealand	98
Croatia	66
Switzerland	58
Romania	43
Norway	41
India	39
South Africa	23

Table III.
Sources of Tunepal
mobile QBP queries by
country

when traditional music is most commonly played. The x-axis in Figure 9 is the hour of the day in 24-hour format, while the number of queries is on the y-axis.

The hypothesis that the Tunepal mobile apps are most commonly used in traditional music sessions is clearly supported by this profile. Traditional music sessions most commonly take place in the late evenings and this is when the majority of queries are made.

Tunepal for iPhone was listed in the top twenty cultural apps available on the iPhone by the *Sunday Times* (an Irish national newspaper) alongside apps such as Shazam and Spotify, IMDB and an app from the British National Gallery (Sunday Times, 2010). Tunepal has also been extensively discussed on traditional Irish music forums (Chiff & Fipple Forum, 2010).

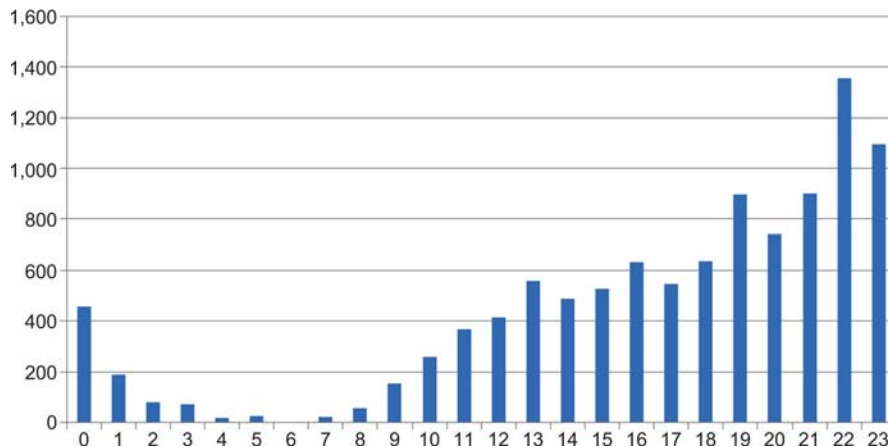


Figure 9.
QBP queries originating in
Ireland plotted by time of
day

8, Conclusions and future work

In this paper Tunepal was presented – a query-by-playing digital library project for traditional music that developed from academic research. The Tunepal tools have become very popular, being used by musicians around the world to connect their playing with scores, tune names and biographic data. To achieve this, a corpus of 16,700 compositions collected by both the traditional music community and noted collectors such as O'Neill and Breathnach has been aggregated in the Tunepal database. Interfaces have been developed to allow this database to be searched by title or by playing an audio query on a traditional instrument either over the web or on mobile devices such as the iPhone, iPad or Android OS Phones. Matching tunes can be downloaded to a mobile device, edited, displayed in ABC or stave notation, played back and transposed. Tunepal also facilitates discography, YouTube, iTunes and Amazon music searches for tunes. This paper also presented an analysis of the logs collected on the usage of these systems since launch.

Tunepal has been favorably received and musicians report that the system is being used in variety of scenarios including archiving and the preparation of sleeve notes for commercial recordings. Nevertheless, a minority of musicians report skepticism of the use of technology in traditional music sessions (ironically on internet forums).

In future work it is hoped to expand the corpus of tunes to include many more tunes from different traditions. Additionally it is hoped to be able to link Tunepal with digital archives of recordings and videos of traditional music as it is felt that this will greatly enhance the potential for Tunepal to fulfill its role in the learning and dissemination of traditional music worldwide.

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About the authors

Bryan Duggan is a Lecturer in the School of Computing in the Dublin Institute of Technology. He received his PhD on the topic of "Machine annotation of traditional Irish dance tunes" in October 2009. This work proposed new algorithms and systems for the analysis of recordings of traditional Irish dance music. He has published extensively on the topic of query-by-playing music information retrieval systems. Bryan is also the author of *Tunepal for iOS and Android*, popular apps used by thousands of musicians around the world to search for music. In his spare time, Bryan enjoys playing traditional Irish music on the concert flute. Bryan Duggan is the corresponding author and can be contacted at: bryan.duggan@dit.ie

Professor Brendan O'Shea graduated from NUI Galway with a BSc and MSc in Mathematics. He pursued his PhD studies and research at Royal Holloway College (London University) and University of Nebraska. His topic of research was "Efficiency of algorithm for solving large sets of coupled differential equations". Having graduated with PhD from London University in 1971 he took up an appointment as Lecturer in the Department of Mathematics and Computer Science at Dublin Institute of Technology. He progressed to Senior Lecturer, Assistant Head of Department and most recently Professor and Head, School of Computing.