

SMARTPHONE APPS FOR MATHEMATICS

Michael Croucher, Peter Rowlett, and Hazel Lewis present an up-date on the world of 'smartphone apps'

Introduction

In recent years, mobile phones have developed into mini computers, far exceeding the computational power of anything found in the classroom in the preceding decades. From a technological point of view, tablets are essentially just large smartphones; slightly more powerful but running almost identical software and operating systems.

This technology is increasingly cheap and available so a natural question is whether these are useful tools on which to do mathematics? This article will explore some of the possibilities open to users of the two most popular smartphone and tablet platforms: Apple's iOS i.e. iPhone, iPad and iPod Touch, and Google's Android - on devices from a variety of manufacturers. The intention is not to give a complete record of mathematical software for these devices, a difficult task given the number of pieces of software giving results that will quickly date, but rather to indicate something of the range of potential applications.

About apps and how to get them

Smartphone and tablet devices come with a limited range of functionality built in and this is extended through software applications called 'apps'. There are thousands of these available, almost all of them from central locations directly accessible from the device. Users of Apple devices get their apps from the 'App Store' and Android users get theirs from 'The Market'. It is not possible to run Apple apps on Android devices, or vice versa. However many developers make a version of their app for both devices. You can find the apps mentioned in this article by searching from your device. Prices vary, with many apps being available for free, or less than a pound. App listings usually provide a short description, screenshots and feedback from previous users. Quality varies substantially, but users are able to give feedback as an average star rating and a short text review.

Examples of types of app

Illustrative examples of types of app are given with current prices.

Calculators

Many simple calculators are available for both platforms, for example *Appcyclon* - graphical calculator for iOS; £1.49, *s/calc* - easy to use programmable calculator for iOS; £1.49, and *Algeo* - graphical calculator for Android; Free.

An interesting development in this area is calculator emulators. Some calculator designs have reached an almost cult-status among users and this has led developers to build apps that emulate the look and functionality of classic devices. Examples include *i48* - iOS, emulates the HP48GX; Free, *i41CX RPN Calculator* - iOS, emulates the HP-41CX; £5.49, and *Andie Graph* - Android, emulates various machines from Texas Instruments; Free.

Advanced mathematics

Fully-fledged computer algebra systems for Windows and Mac, such as Maple, Mathematica and Matlab do not currently have versions for mobile operating systems. There are some very capable alternatives available. *Maths Studio* - formerly *SpaceTime Mathematics*, for instance, is capable of symbolic calculus, 2-D and 3-D graph plotting, curve fitting, programming and more. It is significantly more powerful than a graphical calculator and costs less than £15. *Maths Studio* is currently available for iOS, £13.99, and for Android £12.99. Additionally, there is a free, fully compatible version available for Windows, and an inexpensive version for Mac, £6.99. This ability to run the same calculations on mobile and desktop platforms is apparently currently unique.

Other noteworthy mobile computer algebra systems include *PocketCAS Pro*, iOS; £6.99, *MathScript*, Android; £3.01, *iCAS*, iOS; £10.49 and *Symbolic Calculator*, iOS; £1.49.

Access to online mathematics software

Most smartphones, and, some tablets have access to the internet, which means that they can be used to access services like Wolfram Alpha, which can be thought of as a computational version of

Google. When given a mathematical question, Wolfram Alpha will calculate the solution and display other relevant calculations and results. Users of mobile devices can access the site from the built-in web browser, or access the service through one of several apps that provide a more mobile-friendly interface.

Interactive geometry software

Apollonius, iOS; £2.49, allows you to make geometric constructions - such as those made using a compass and straightedge/ruler - and move their parts smoothly.

Simulation and programming

Mobile devices are powerful enough to run reasonably demanding simulations. Both platforms, for example, have several implementations of Conway's Game of Life, a simple 2-D cellular automaton. Other examples of simulations include particles under gravity, generating fractals and simulating electrical circuits.

It is also possible to write your own simple simulations directly onto mobile devices via apps that provide easy to use programming languages. Although not suitable for computationally intense problems these languages are suitable for learning about programming.

Maths Studio, iOS; and Android, mentioned above, is capable of on-device programming. Other options include *Mintoris Basic*, Android; £3.84, *MathScript* - an implementation of Python for Android; £3.01, *Hand Basic CBM* - iOS; *Free and Coders* - an implementation of the language Lua for iPad; £2.99.

Mathematical games

Many mathematical games, such as Sudoku, Dots and Boxes, Tangrams, Sprouts, Nim and Pentominos are available on mobile platforms. Some of these offer one player options - competing with the software - and some offer multiplayer modes within the device or between devices online. Many traditional mathematical puzzles, such as Knight's Tour and Towers of Hanoi, are also available.

Other apps offer mathematics teaching in game form - *Euclid – Geometric Constructions*, iOS; £0.69, offers geometric constructions, in the form of a puzzle game.

Textbooks and reference

Users can purchase electronic versions of traditional textbooks via apps such as the Apple iBook Store, iOS, and Amazon's Kindle app, iOS and Android. Beyond this, mobile platforms allow the possibility to combine text, video, audio, simulation and computation. A current example, which points in the direction of what is possible, is *The Elements: A Visual Exploration* by Thodore Gray for the iPad, £9.99.

MathsCard, iOS, or Android; Free, from Loughborough University, offers A-level maths formulae. Other maths reference guides include *iMathematics*, iOS and Android; Free, and *Math Ref*, iOS; £0.69. *Learn Statistics*, iOS; £2.49, is a statistics tool, which includes dynamic graphs.



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Note: The prices quoted in the article reflect charges made at, or before, the date of publication.

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