FFT v1.2 (Flash app)

Fast Fourier Transform for the TI-89/92+

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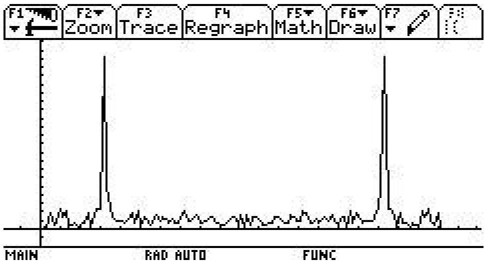


Description:

This program computes the radix-2 FFT (or inverse FFT) of a list or matrix, using the signal-processing convention for the FFT by default:

FFT = $\sum_{j=1}^{n} \frac{u_j}{e^{-2p\cdot \boldsymbol{i}\cdot(j-1)\cdot(k-1)/n}}$ Inverse FFT = $\frac{1}{n}\cdot\sum_{k=1}^{n} v_k \cdot e^{2p\cdot \boldsymbol{i}\cdot(j-1)\cdot(k-1)/n}$

The user can also specify two additional conventions.

This Flash application is freeware – it can be sent to and run on any TI-89 or TI-92 Plus calculator. It was my submission for TI's Flash app contest for 2001.

Syntax:

FFT**.**FFT(list[,direction[,convention]])

If there is no variable called FFT in the current folder, you can simply use FFT(...)

Evaluating FFT() shows a help message in the status line. The Catalog FlashApps screen also shows a help message.

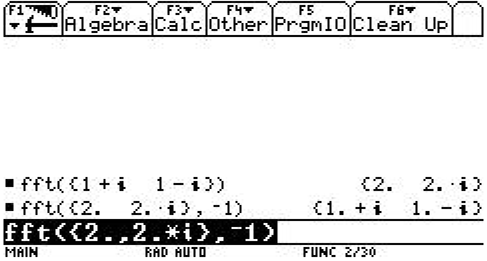
Notes:

- *list* can have complex numbers, but it must be numeric, and it also cannot have numbers like ***e***. It can be a list or matrix.
- The length of *list* (or if it is a matrix, both dimensions) must be a power of 2.
- *Direction* positive/negative: Forward/Inverse FFT
- *Convention* can be one of the following:
  - "s" or "signal" (signal processing, default)
  - "p" or "physics" (physical sciences – forward and inverse transforms are exchanged and multiplied by sqrt(dim(*list*))^(-sign(*direction*))
  - "d" or "data" (data analysis – forward and inverse transforms are exchanged)
- To abort a calculation, press [ON]

Examples:

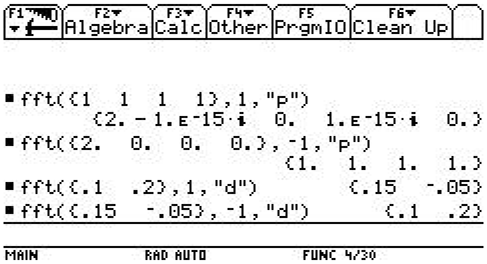
FFT({1+***i***,1–***i***}) returns the forward FFT {2, 2·***i***}
FFT({2, 2·***i***},-1) returns the inverse FFT {1+***i***,1–***i***}

Here is a screenshot of the above example:



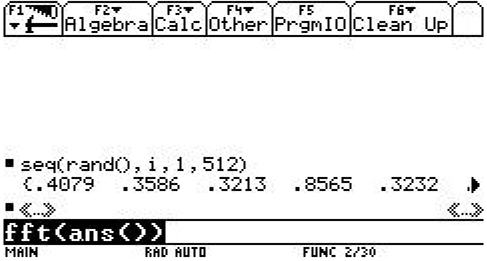
```
■ fft({1 + i   1 - i})              {2.   2.·i}
■ fft({2.   2.·i}, -1)        {1. + i   1. - i}
fft({2.,2.*i},-1)
MAIN          RAD AUTO          FUNC 2/30
```

This shows how to use the other conventions:



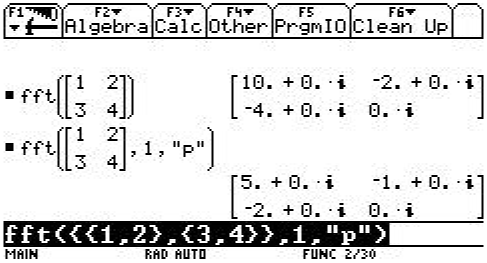
```
■ fft({1   1   1   1},1,"p")
      {2. - 1.E-15·i   0.   1.E-15·i   0.}
■ fft({2.   0.   0.   0.}, -1,"p")
                        {1.   1.   1.   1.}
■ fft({.1   .2},1,"d")           {.15   -.05}
■ fft({.15   -.05}, -1,"d")         {.1   .2}

MAIN          RAD AUTO          FUNC 4/30
```

This shows the FFT of a somewhat large list. The result is too large and is therefore not displayed by the AMS:



```
■ seq(rand(), i, 1, 512)
 {.4079   .3586   .3213   .8565   .3232   ▸
■ «...»                                  «...»
fft(ans())
MAIN          RAD AUTO          FUNC 2/30
```

This shows the FFT of a matrix, using two conventions:



```
      ⎛⎡1  2⎤⎞      ⎡10. + 0.·i   -2. + 0.·i⎤
■ fft ⎝⎣3  4⎦⎠      ⎣-4. + 0.·i   0.·i      ⎦
      ⎛⎡1  2⎤        ⎞
■ fft ⎝⎣3  4⎦, 1, "p"⎠
                    ⎡5. + 0.·i    -1. + 0.·i⎤
                    ⎣-2. + 0.·i   0.·i      ⎦
fft({{1,2},{3,4}},1,"p")
MAIN          RAD AUTO          FUNC 2/30
```

The title screenshot shows the amplitude plot with two symmetric peaks of a slightly noised periodic signal.

Thanks to:

- E.W.
- Mike Grass
- Texas Instruments, especially Heidi and S.H.
- The TIGCC team

What's New:

- The user can choose two additional common conventions for the FFT
- The *direction* argument is now optional (if you want to do a default forward FFT)
- FFT of a matrix is now supported (but it probably needs some optimization)
- Fixed a memory leak that used to occur when the calculation was aborted

Future plans:

- Convolution and correlation
- Allow ***e*** and **π** in input list/matrix
- Remove restriction on length/dimensions of list/matrix
- This program is *very* fast compared to a TI-Basic implementation I tried, especially for large lists. For example, the FFT of a 512-element array of floating-point random numbers took about 24 seconds (excluding result display time) on a HW2 TI-92+ with AMS v2.05. Still, I will try to speed it up as much as I can.

For updates and other programs:

http://triton.towson.edu/users/bbhatt1/ti/

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