

Creating Various Materials for Remote Lectures with TeX, KeTCindy and Computer Algebra Systems

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COVID-19 has drastically changed the style of mathematics classes at college level. Many teachers often use presentation slides instead of black/white boards. However, comparing with the latter tools, the formers have several problems that need to be overcome:

- (1) to display mathematical expressions without frustration.
- (2) to use figures, free curves in particular, freely.
- (3) to put components in the most suitable position.
- (4) to display expressions step by step.

Although (1) of the above is the main reason almost all mathematics teachers use TeX, there probably aren't so many teachers who have a good command of (2) and (3). These are weaknesses of TeX itself. We began to develop KeTpic/KeTCindy since 2006 to compensate them. KeTpic was a macro package of Maple, Mathematica and Scilab, whereas KeTCindy, current version, is that of R and Cinderella. The followings are screens of Cinderella.

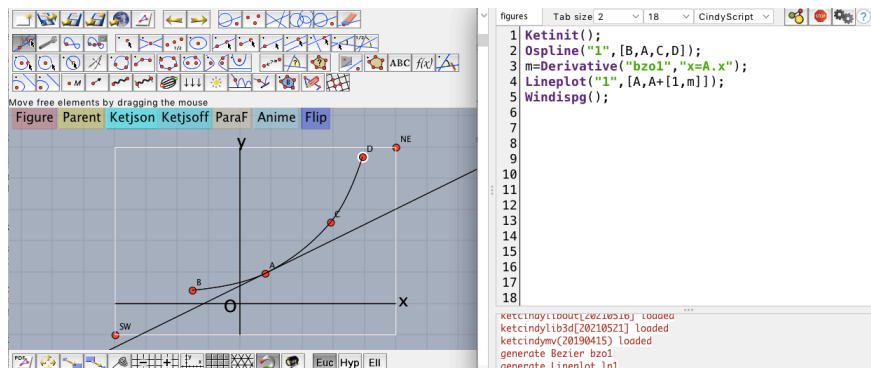


Fig. 1 Cindy screen and Cindy script editor

As a simple example, we demonstrate steps to draw a Bézier curve and its tangent.

(1) Put points A,B,C,D on Cindy screen(see Fig.1).

(2) Write the following scripts in the script editor:

```
Ospline ("1", [B, A, C, D]);
m=Derivative ("bzol", "x=A.x");
Lineplot ("1", [A, A+[1, m]]);
```

(3) Press button 'Figure' on Cindy screen, then the left of Fig.2 will be obtained.

(4) Add other accessories as the right of Fig.2.

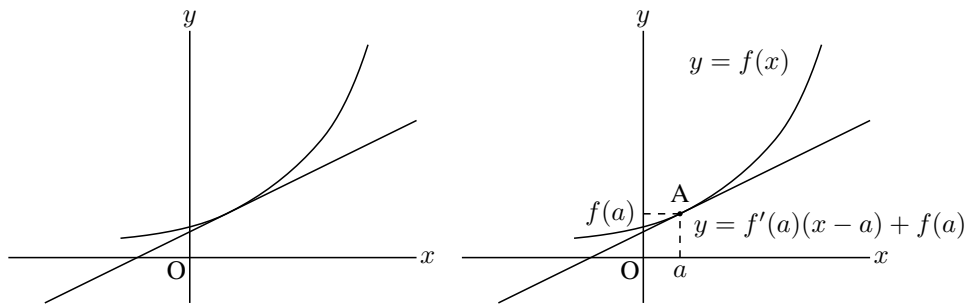


Fig.2 Bézier curve with the tangent

Here, 'layer environment' we have developed is used for page layout as follows. This is our solution for problem (3).

```
\begin{layer}{140}{0}
\putnotese{3}{2}{\scalebox{0.6}{\input{fig/bezier1.tex}}}
\putnotese{68}{2}{\scalebox{0.6}{\input{fig/bezier2.tex}}}
\end{layer}
```

We have also added the function to produce T_EX presentation slides to K_ETCindy, which supports step-by-step displays.

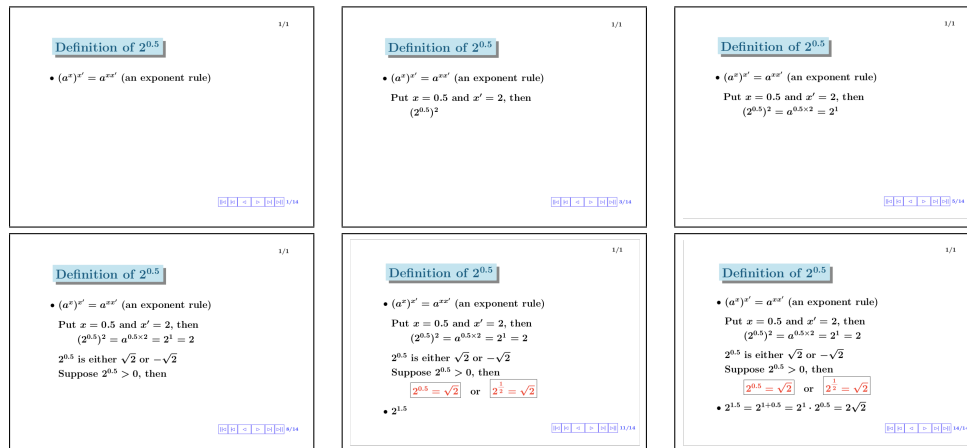


Fig.3 Slide page divided into 14

We remark each page should be divided into as many pieces as possible and the number of characters in the page should be reduced considering the educational effect at college level.

$\mathbb{K}\mathbb{E}\mathbb{T}$ Cindy can call Maxima from inside and use the result in the subsequent Cindy scripts. As an example, we demonstrate to find finite continued fractions of $\zeta(3)$. Maxima has functions `bfzeta` to get numerical value of $\zeta(s)$ and `cfa` to get continued fraction representation, so we only write the following Cindy scripts.

```
cmdL=[
  "z:bfzeta(3,10)", [],
  "c:cfa(z)", [],
  "z::c", []
];
CalcbyM("ans", cmdL, [""]);
```

The result `ans` is a list of strings like

```
[[1.202056903b0, [1, 4, 1, 18, 1, 1, 1, 4, 1, 9, 9, 2, 1, 2, 5, 1, 1, 1, 27]]]
```

Using the next formula, we can obtain the sequence of finite continued fractions $\{\frac{p_n}{q_n}\}$.

$$p_n = a_n p_{n-1} + p_{n-2}, \quad q_n = a_n q_{n-1} + q_{n-2} \quad (1)$$

The scripts are as follows.

```
aL=parse(ans_2);
cvL=[];
pm1=1; pm2=0; qm1=0; qm2=1;
forall(0..10, nn,
  p=aL_(nn+1)*pm1+pm2;
  q=aL_(nn+1)*qm1+qm2;
  cvL=concat(cvL, [[p, q]]);
  pm2=pm1; pm1=p; qm2=qm1; qm1=q;
);
```

The result is:

```
[1, 1], [5, 4], [6, 5], [113, 94], [119, 99], [232, 193], [351, 292], ...
```

Remark

Recently, $\mathbb{K}\mathbb{E}\mathbb{T}$ Cindy has become to be able to call Wolfram Engine for Developers(WE) as well. Using this, scripts are simpler, as WE has `Convergents` to get finite continued fractions directly.

```
cmdL2=[
  "z=N[Zeta[3]]", [],
  "c=Convergents[z,10]", [],
  "c", []
];
CalcbyW("ans", cmdL2);
```

The result is:

```
{1, 5/4, 6/5, 113/94, 119/99, 232/193, 351/292, 1636/1361, ...}
```

Moreover, $\mathbb{K}\mathbb{E}\mathbb{T}$ Cindy has the function to create an HTML file using CindyJS.

<https://cindyjs.org>

For example, the HTML of Fig.1 can be obtained only by (1) creating the original HTML from Cindy menu and (2) pressing button `Ketjsoff` on Cindy screen.

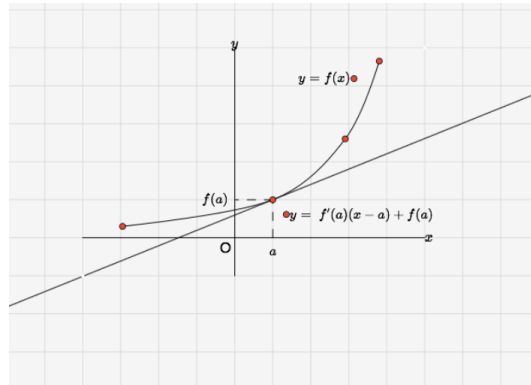


Fig.4 an HTML display of the first example

We have uploaded the file at

<https://s-takato.github.io/ketcindysample/forpapers/>.

Students can move the elements interactively with their own device such as a smartphone, iPad, PC and so on. They need no other softwares except for a browser , so these HTML, whose size is so small, will be useful in remote classes. Other various samples will be found at

<https://s-takato.github.io/ketcindysample/>.

The last example is an HTML of Ford Circles of finite continuous fractions of $\zeta(3)$.

Continued fraction : $\zeta(3) = [a_0, a_1, a_2, a_3, \dots] = [1, 4, 1, 18, 1, 1, 1, 4, 1, 9, \dots]$
 k -th approximation $\frac{p_k}{q_k} : \frac{p_0}{q_0} < \frac{p_1}{q_1} < \dots < \zeta(3) < \dots < \frac{p_k}{q_k} < \frac{p_{k+1}}{q_{k+1}}$
 $p_k = a_k p_{k-1} + p_{k-2}, p_{-1} = 1, p_{-2} = 0, \quad q_k = a_k q_{k-1} + q_{k-2}, q_{-1} = 0, q_{-2} = 1$
 See [Paper by Prof.Hirata lab \(J\)](#)

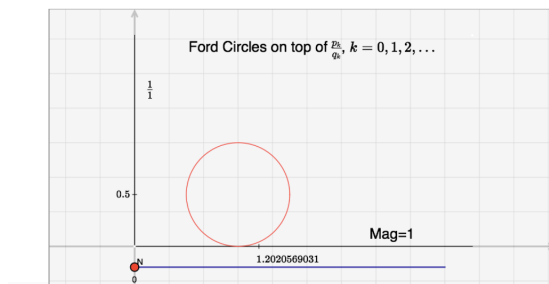


Fig.5 Ford Circles

Click inside Fig.5, then the HTML will appear.

References

- [1] S.TAKATO, *What is and how to Use KeTCindy – Linkage Between Dynamic Geometry Software and Collaborative Use of KetCindy and Free Computer Algebra Systems and L^AT_EX Graphics Capabilities* – ICMS 2016, LNCS **9725**, 371–379, Springer, 2016.