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Converting a BMP file to a proprietary format

Multimedia Systems

Report

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1. Description

The subject of the project is to create a specification for a raster graphic file and an application that allows the conversion of a .bmp file to a proprietary .z25 graphic format, and from a proprietary .z25 file format to .bmp.

The application allows you to customize the conversion:

- Selecting recording mode:
  - RGB565
  - RGB888
  - YCbCr888
- Select color mode:
  - Colorful
  - Grayscale
- Dithering selection:
  - No dithering
  - Bayer array dithering
- Selecting compression type:
  - Lossless (LZW)
  - Lossy (DCT transform)
  - None
- Choosing a prediction algorithm:
  - None
  - Type 1 prediction
- Select whether to subsample chrominance components (Only for YCbCr)
  - No
  - Yes

The application allows for any configuration of the described modes, except for lossy compression, where the prediction algorithm is not available, and chrominance component sampling, which is only available in the YCbCr recording mode.

The .z25 file header is used to identify the file and to read metadata about the image. The elements of the header and their meaning are listed in the table below:

Name	Offset	Size	Values and purpose
Identifier	00	2 bytes	"KW" - used to identify the file
Image width	02	2 bytes	Specifies the width of the image
Image height	04	2 bytes	Defines the height of the image
Recording mode	06	1 byte	Values: 1-3 1 - RGB565 2 – RGB888 3 – YCbCr888
Color mode	07	1 byte	Values: 0-1 0 - Colorful 1 – Grayscale
Dithering	08	1 byte	Values: 0-1 0 - No dithering 1 – Bayer Table Dithering
Prediction algorithm	09	1 byte	Values: 0-1 0 - None 1 – Prediction type 1
Compression type	10	1 byte	Values 0-2 0 - Lossless compression 1 – Lossy compression 2 – No compression

Conversion Description

I. Model and recording mode
   - RGB565
     Data is stored as 16 bits, where the first 5 bits correspond to red, the next 6 bits correspond to green, and the last 5 bits to blue.
     In the case of grayscale, it is stored as all 16 bits (values 0 - 65535), which helps with accuracy during calculations but may generate errors due to rounding.
   - RGB888
     First we write all the red data to the file, then all the green data, and finally all the blue data.
     Grayscale takes up only 8 bits.
   - YCbCr888
     The notation is analogous to RGB888, first all Y values, then Cb, and finally Cr.
     The grayscale is contained in the Y value, so we only record that value.

     The data is read in the same order and then converted to specific RGB values as needed.
     When a grayscale image is read, the same values are assigned to all RGB values.

II. Bayer array dithering
   All RGB component values are dithered separately. In the case of YCbCr, dithering is performed before conversion to this model.

III. Compression type
   - LZW lossless compression
     All components are compressed sequentially and stored as 8-bit values.
   - DCT transform
     All components undergo the transformation separately and are written to the file in order. In the case of RGB565, they are written as 16-bit values.

     Recording with no compression is described in subsection I.

IV. Prediction algorithm
   We used the first type of prediction, which means that the subsequent values in the row are the values: current - previous. Each component goes through this process separately. They are written in order, again RGB565 is written as a 16-bit value.

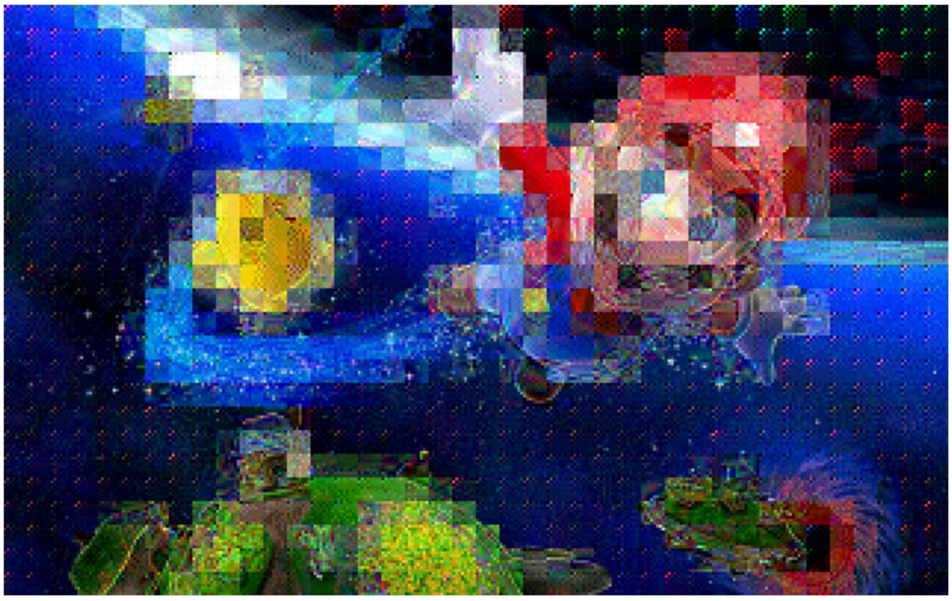
V. Component sampling
   This is an operation that is performed only when the YCbCr888 model is selected. We used 4:2:0 sampling, i.e. the chrominance values are averaged in a 2x2 square.

2. **Examples of operation:**
    1. Image before conversion:

    2. RGB565, no dithering, lossless compression, no prediction

    3. RGB565, no dithering, lossless compression, type 1 prediction

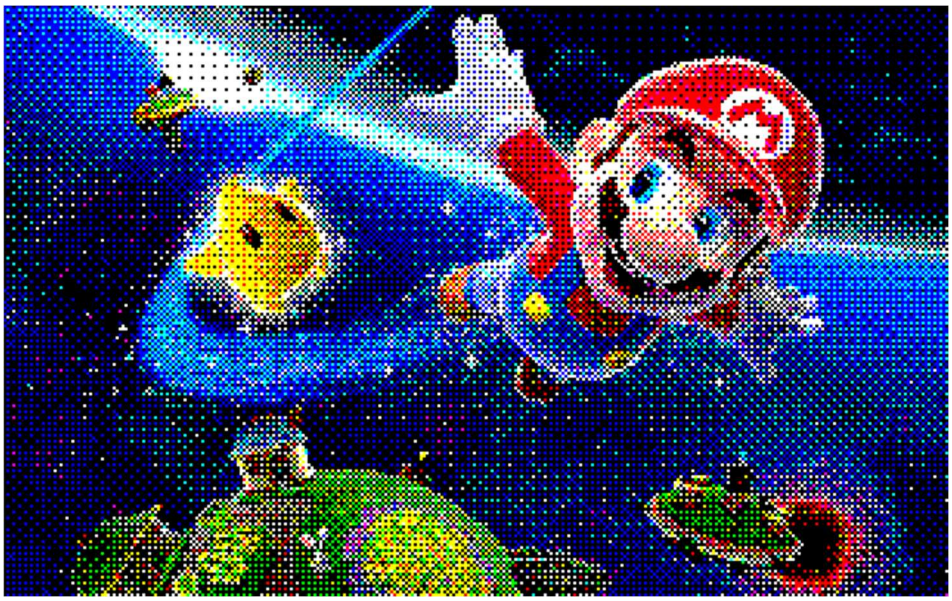
4. RGB565, no dithering, lossy compression



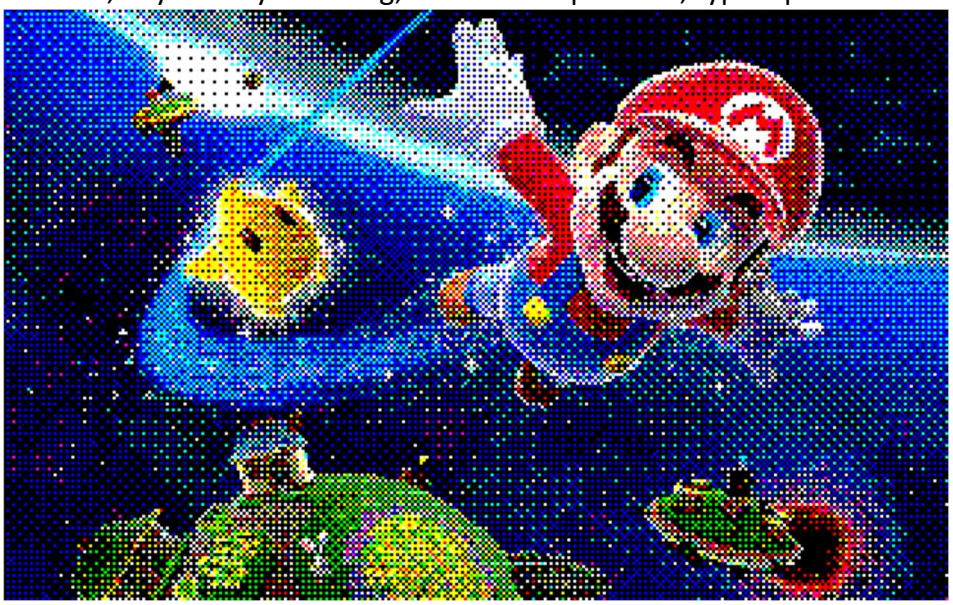
5. RGB565, no dithering, no compression, no prediction

6. RGB565, no dithering, no compression, type 1 prediction

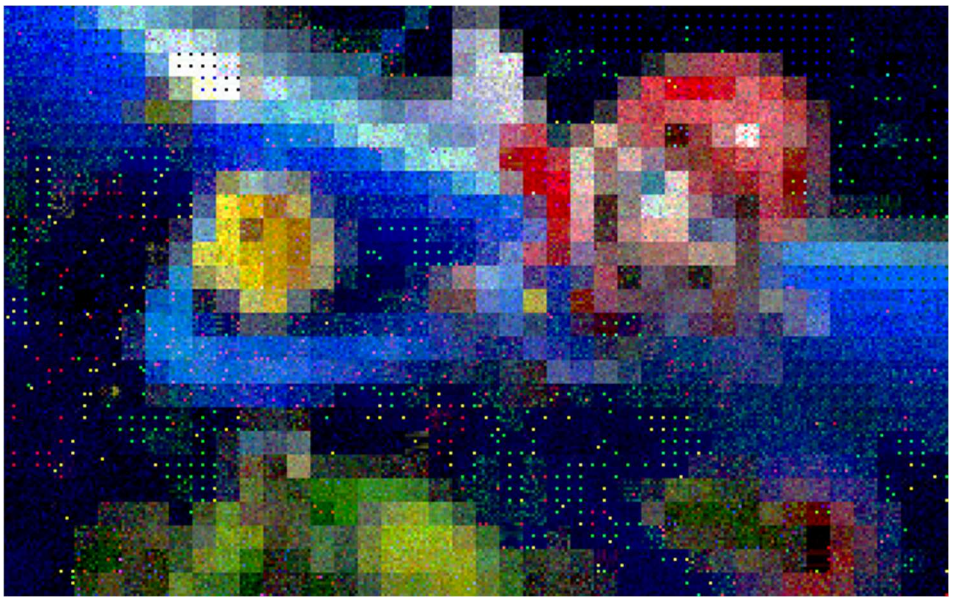
7. RGB565, Bayer array dithering, lossless compression, no prediction



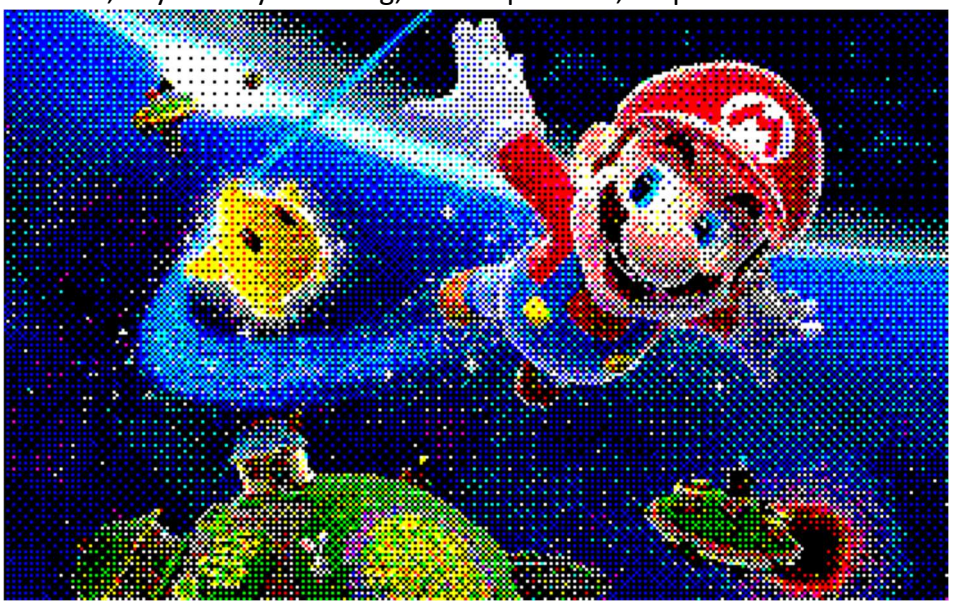
8. RGB565, Bayer array dithering, lossless compression, type 1 prediction



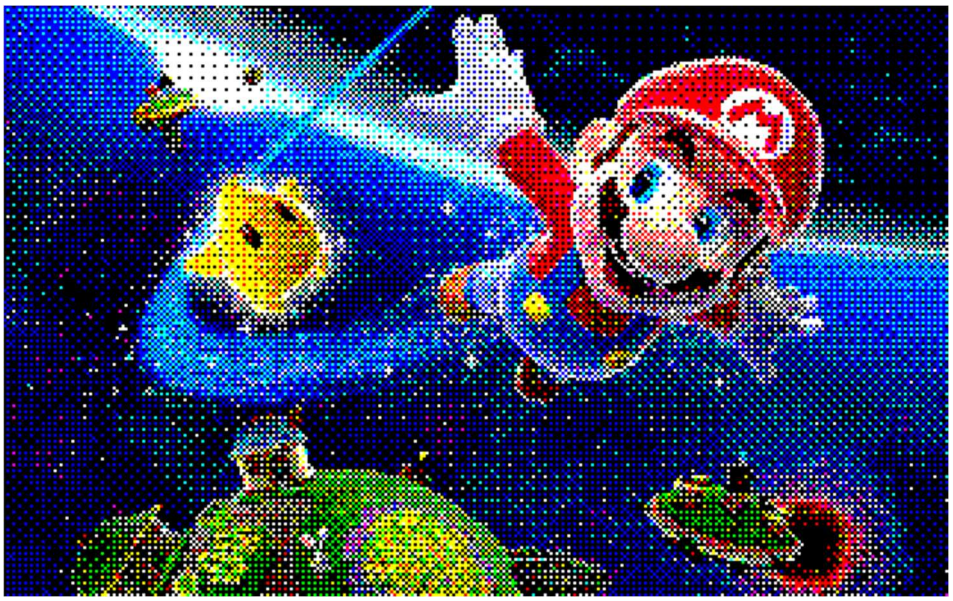
9. RGB565, Bayer array dithering, lossy compression



10. RGB565, Bayer array dithering, no compression, no prediction



11. RGB565, Bayer array dithering, no compression, type 1 prediction



12. RGB888, no dithering, lossless compression, no prediction

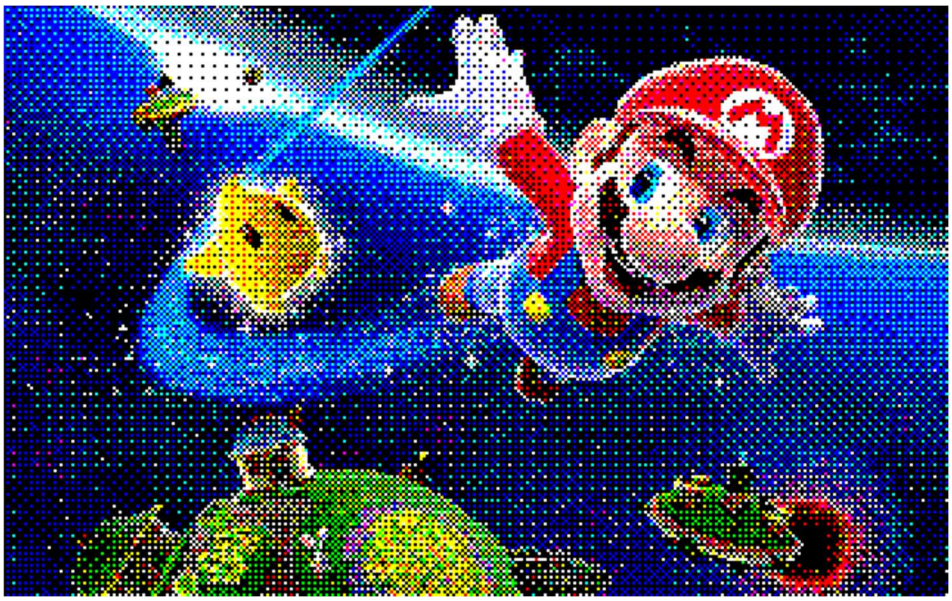
13. RGB888, no dithering, lossless compression, type 1 prediction

14. RGB888, no dithering, lossy compression

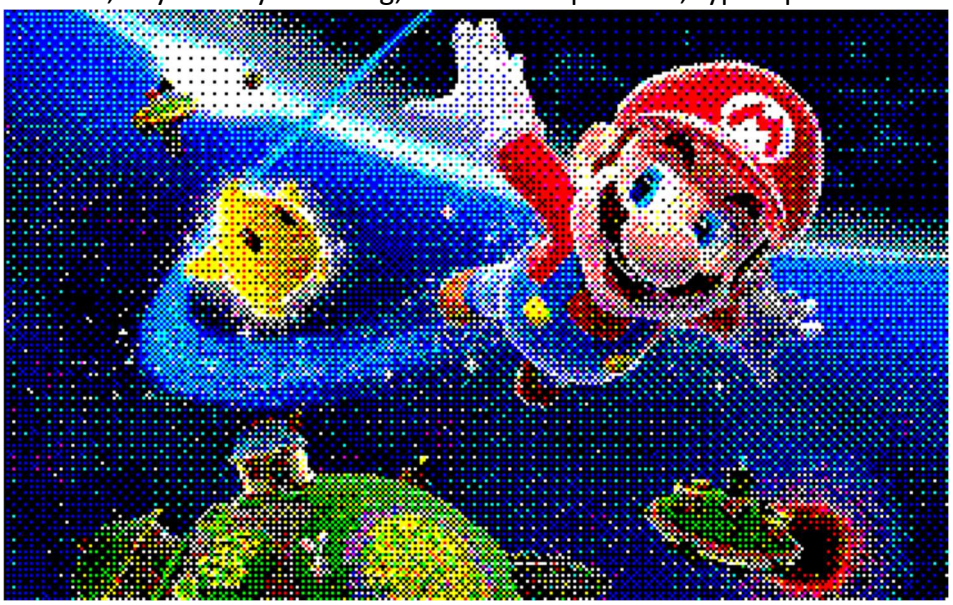
15. RGB888, no dithering, no compression, no prediction

16. RGB888, no dithering, no compression, type 1 prediction

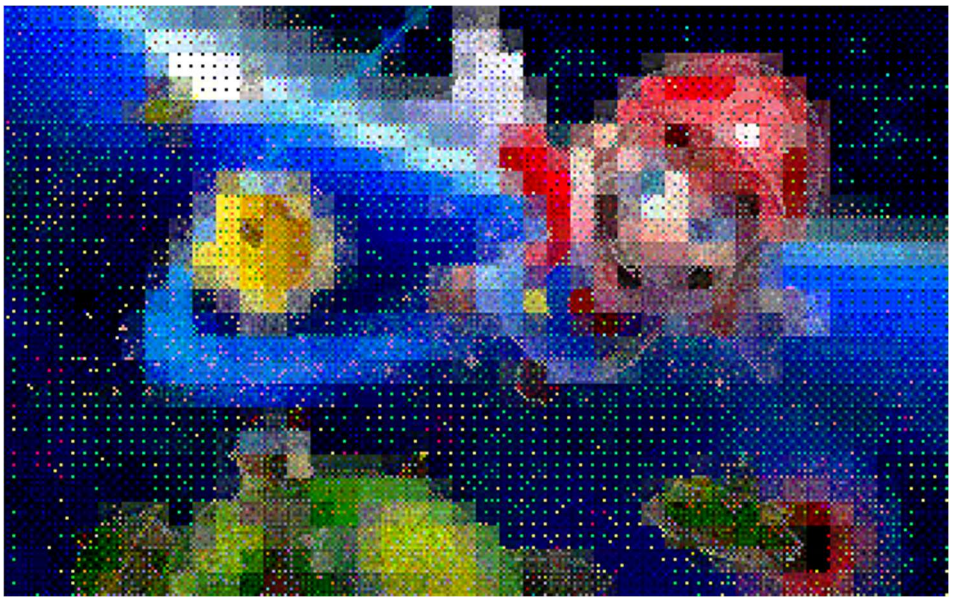
17. RGB888, Bayer array dithering, lossless compression, no prediction



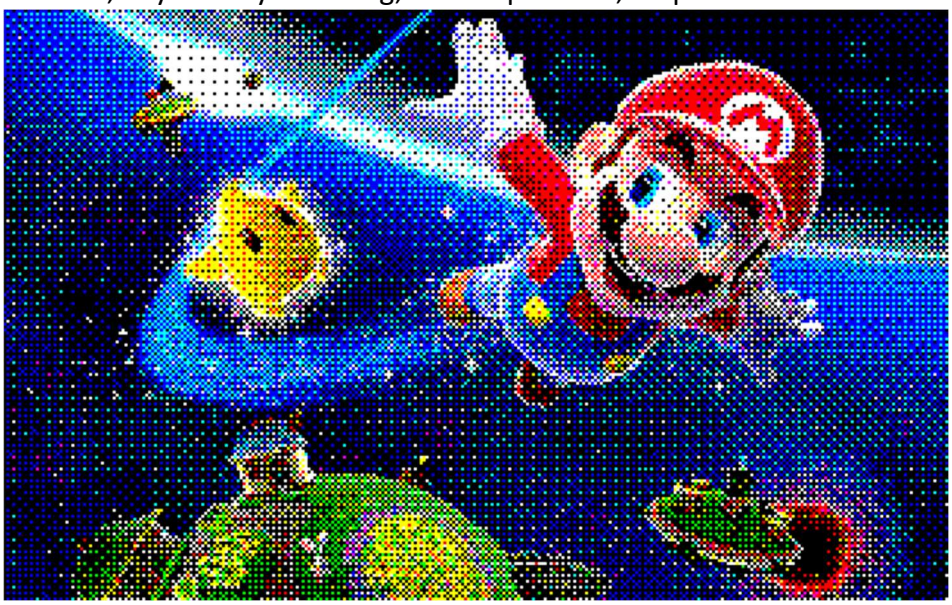
18. RGB888, Bayer array dithering, lossless compression, type 1 prediction



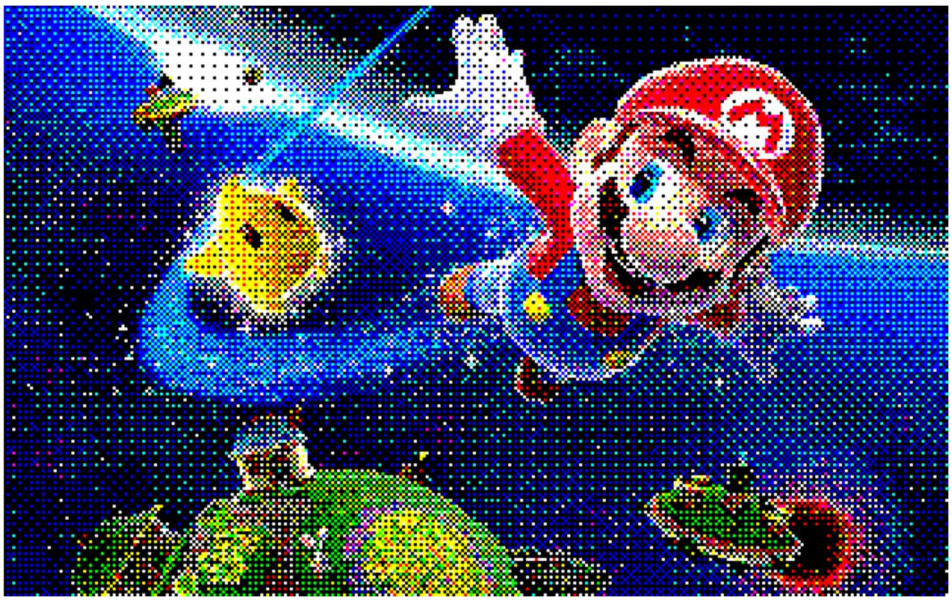
19. RGB888, Bayer array dithering, lossy compression



20. RGB888, Bayer array dithering, no compression, no prediction



21. RGB888, Bayer array dithering, no compression, type 1 prediction



22. YCbCr888, no dithering, lossless compression, no prediction, no subsampling

23. YCbCr888, no dithering, lossless compression, no prediction, 4:2:0 subsampling

24. YCbCr888, no dithering, lossless compression, type 1 prediction, no subsampling

25. YCbCr888, no dithering, lossless compression, type 1 prediction, 4:2:0 subsampling

26. YCbCr888, no dithering, lossy compression, no subsampling

27. YCbCr888, no dithering, lossy compression, 4:2:0 subsampling

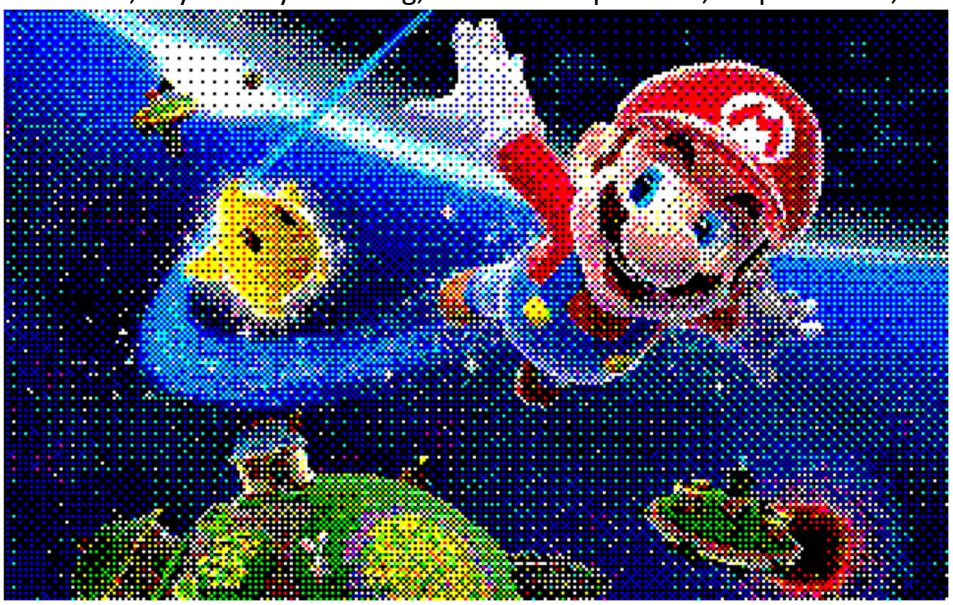
28. YCbCr888, no dithering, no compression, no prediction, no subsampling

29. YCbCr888, no dithering, no compression, no prediction, 4:2:0 subsampling

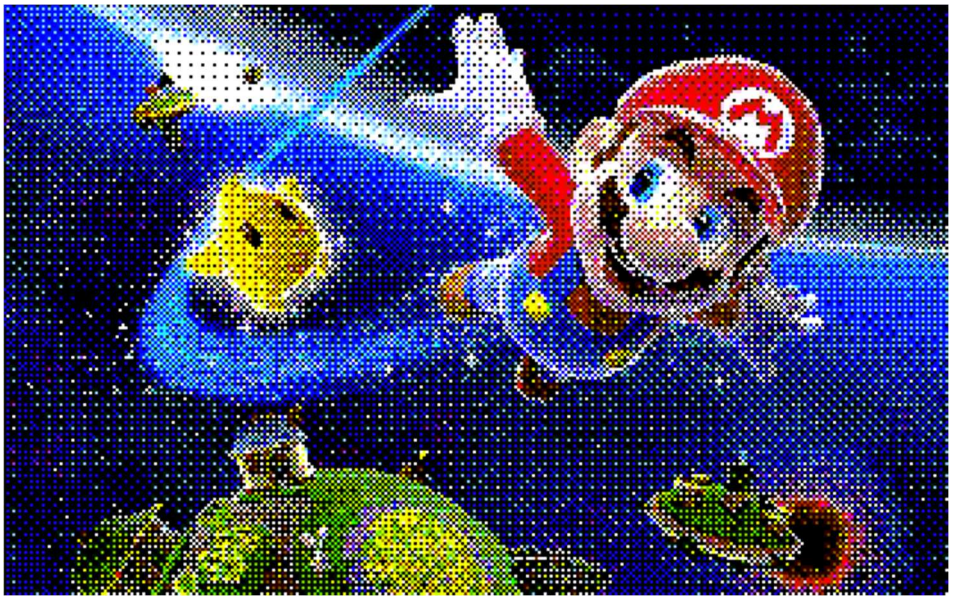
30. YCbCr888, no dithering, no compression, type 1 prediction, no subsampling

31. YCbCr888, no dithering, no compression, type 1 prediction, 4:2:0 subsampling

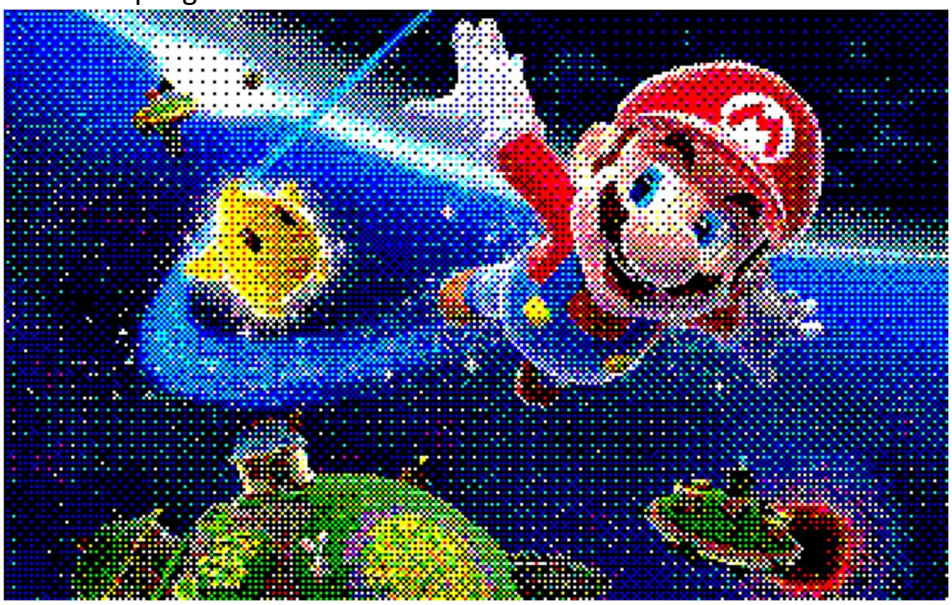
32. YCbCr888, Bayer array dithering, lossless compression, no prediction, no subsampling



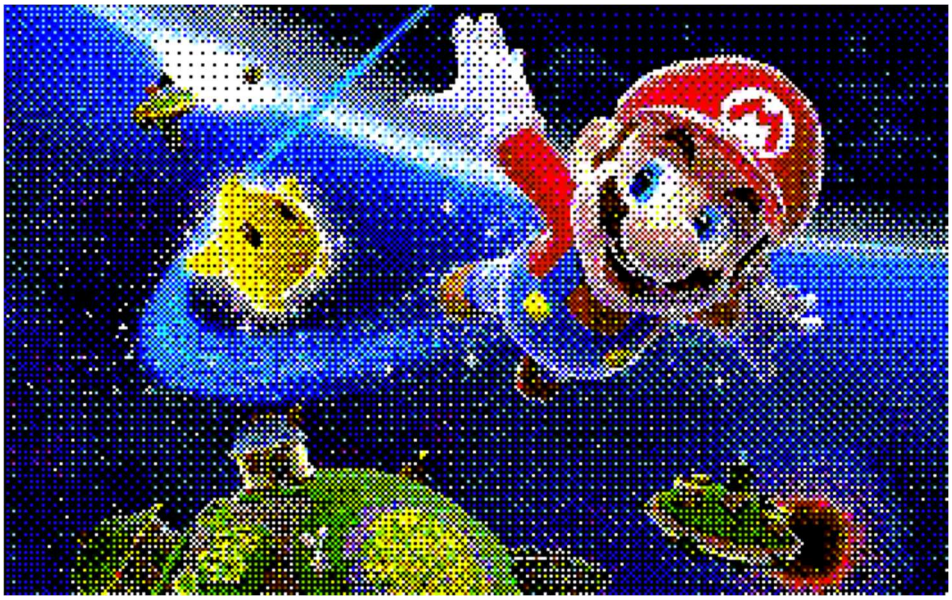
33. YCbCr888, Bayer array dithering, lossless compression, no prediction, 4:2:0 subsampling



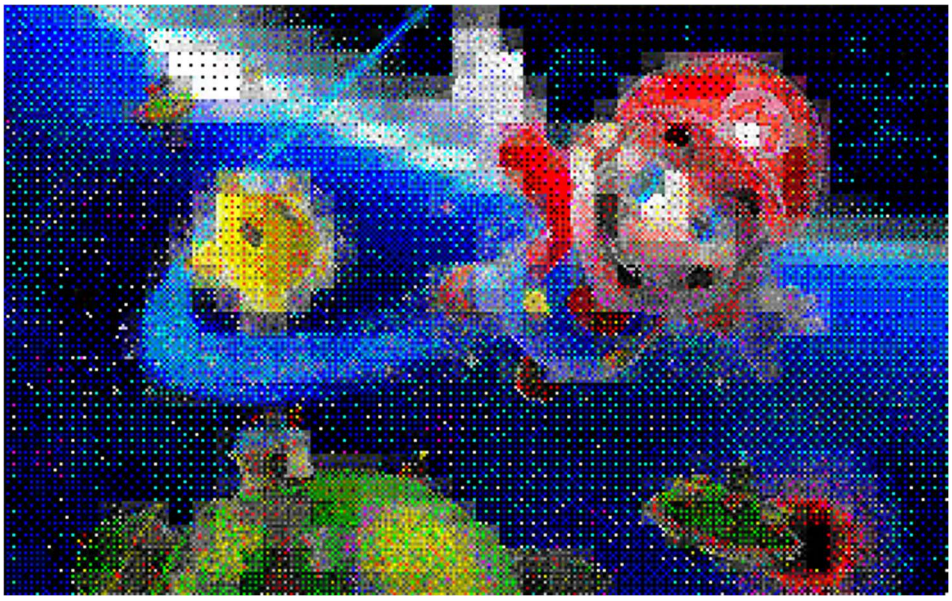
34. YCbCr888, Bayer array dithering, lossless compression, type 1 prediction, no undersampling



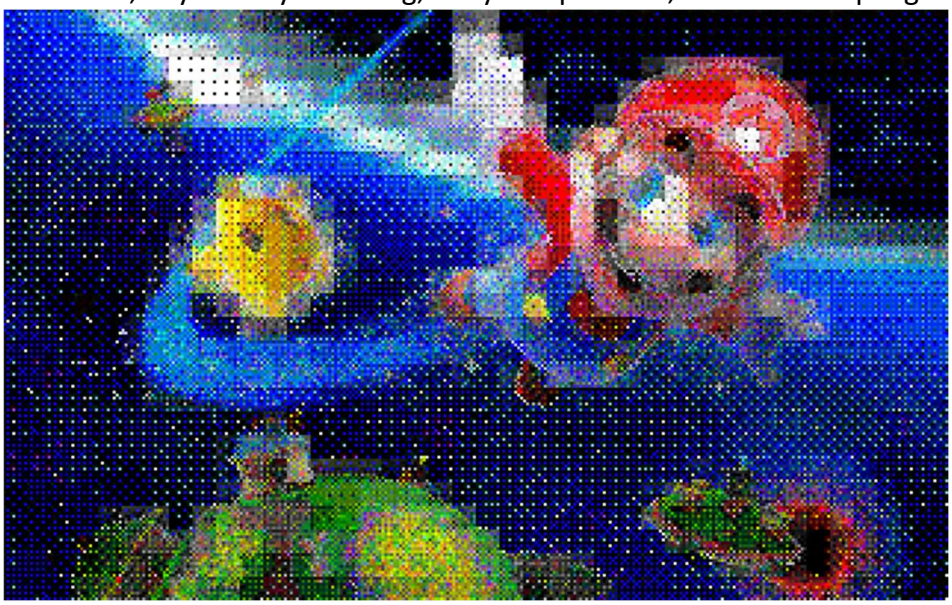
35. YCbCr888, Bayer array dithering, lossless compression, type 1 prediction, 4:2:0 subsampling



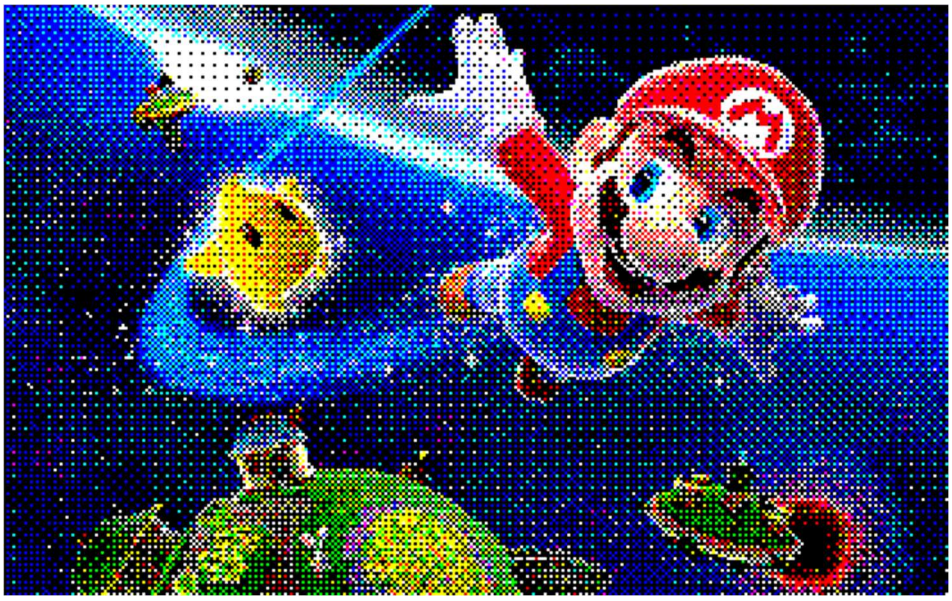
36. YCbCr888, Bayer array dithering, lossy compression, no subsampling



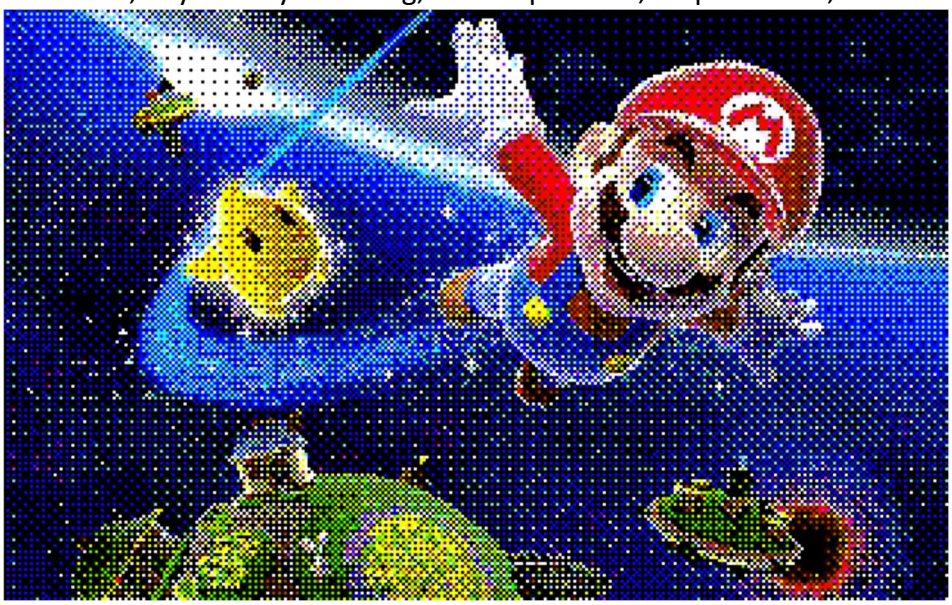
37. YCbCr888, Bayer array dithering, lossy compression, 4:2:0 subsampling



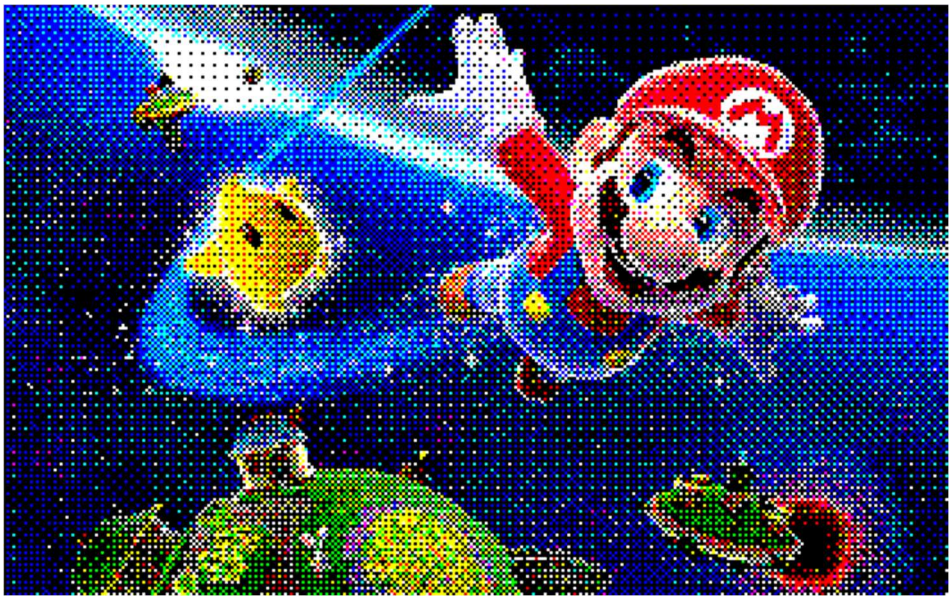
38. YCbCr888, Bayer array dithering, no compression, no prediction, no subsampling



39. YCbCr888, Bayer array dithering, no compression, no prediction, 4:2:0 subsampling



40. YCbCr888, Bayer array dithering, no compression, type 1 prediction, no subsampling



41. YCbCr888, Bayer array dithering, no compression, type 1 prediction, 4:2:0 subsampling